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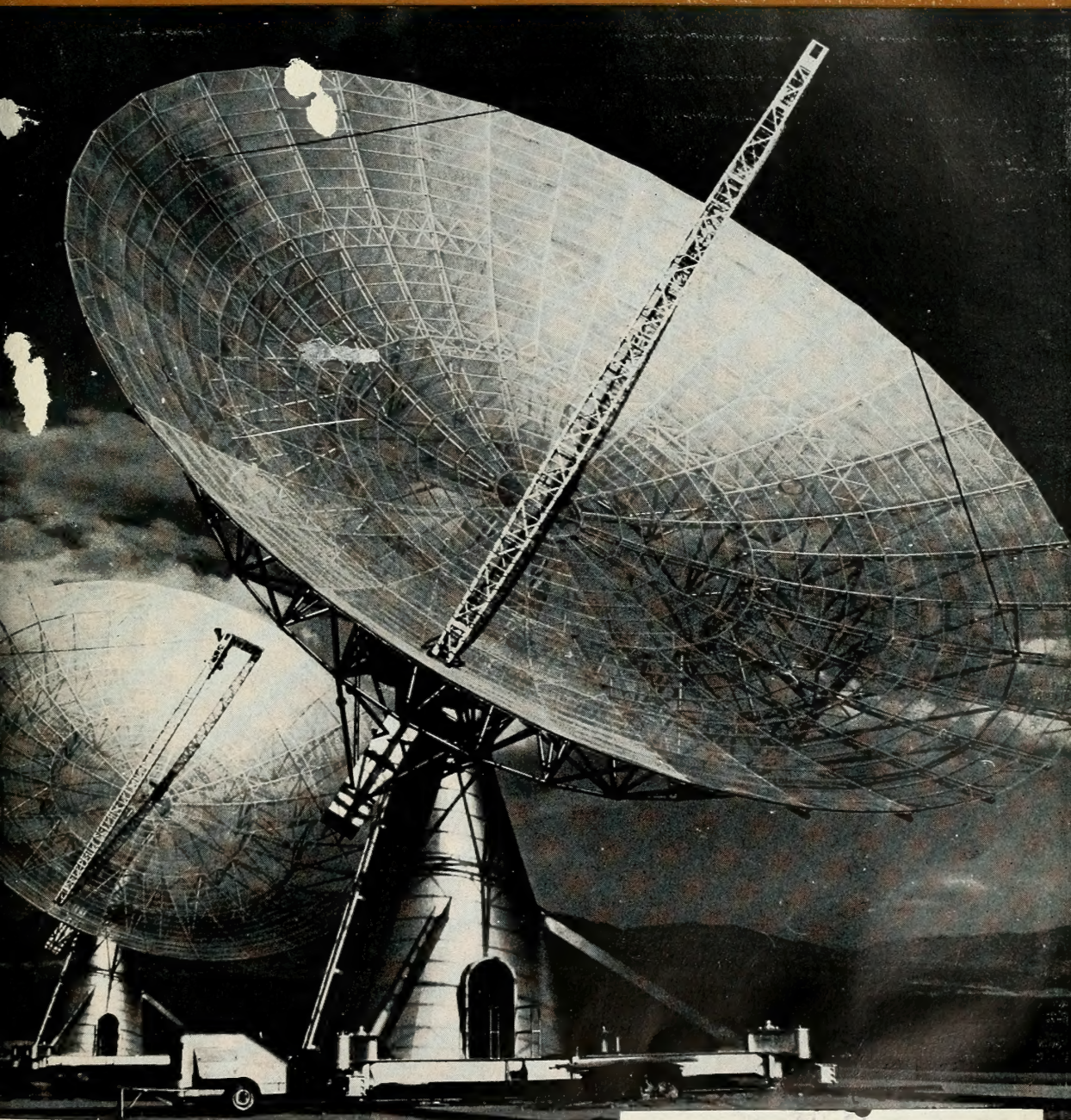
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May 2, 1960

missiles and rockets

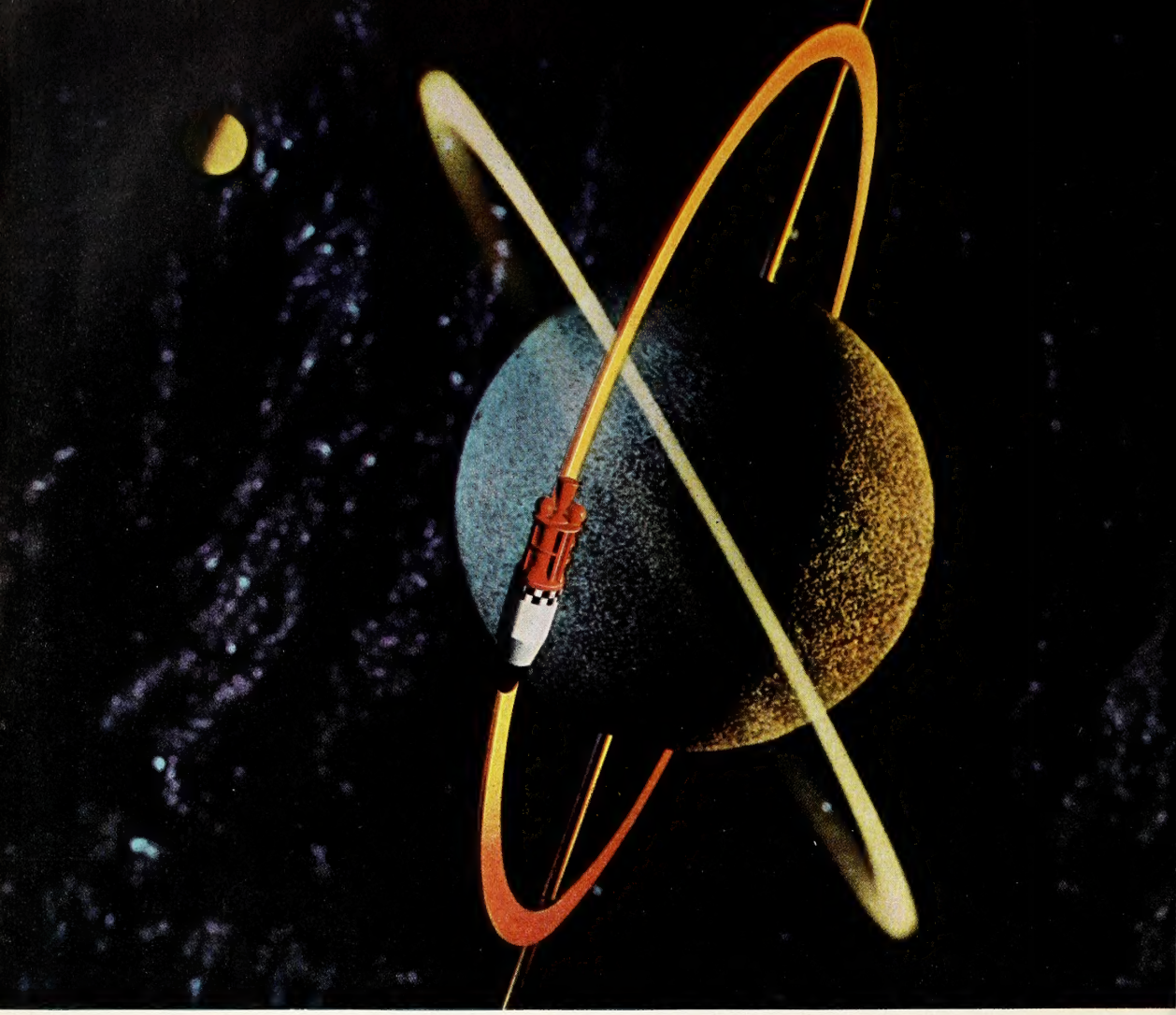
THE MISSILE/SPACE WEEKLY



Navy Telescope Locates New Radio Sources

Navy Bids for Space Launcher Role ....
Digital Decommutator Is Big Advance ..
Latest Edition of the M/R Astrolog 25

AN AMERICAN AVIATION PUBLICATION



Bell-powered Agena satellites in orbit — symbolized.

THE ENGINE WITH THE FUTURE

Reliability . . . Efficiency . . . Flexibility.
In space, these words have a million-dollar meaning.

Vast sums of money and vital scientific data ride on these built-in attributes of Bell Aircraft's rocket engine for Lockheed's Agena satellite, second stage of the Air Force Discoverer series.

The Agena engine, designed with space in mind long before space became a household word, has fulfilled its every mission and has placed more tons of useful payload into orbit than any other power plant. Its operational reliability is backed by six years of development and 5,000 test firings.

This Bell engine now has re-start capability — the first in the nation. This means that its satellite can change orbit **in space** without the penalty of extra engines. Presently in production, this engine also is adaptable to new fuels and new assignments and, consequently, is programmed for important military and peaceful space ventures of the future.

Agena's engine is typical of the exciting projects in Bell's rocket propulsion center. It is part of the dynamic new approach of a company that's forging ahead in rocketry, avionics and space techniques. These skills serve all government agencies. Engineers and scientists anxious for a new kind of personal challenge can find it at Bell.

Niagara Frontier Division

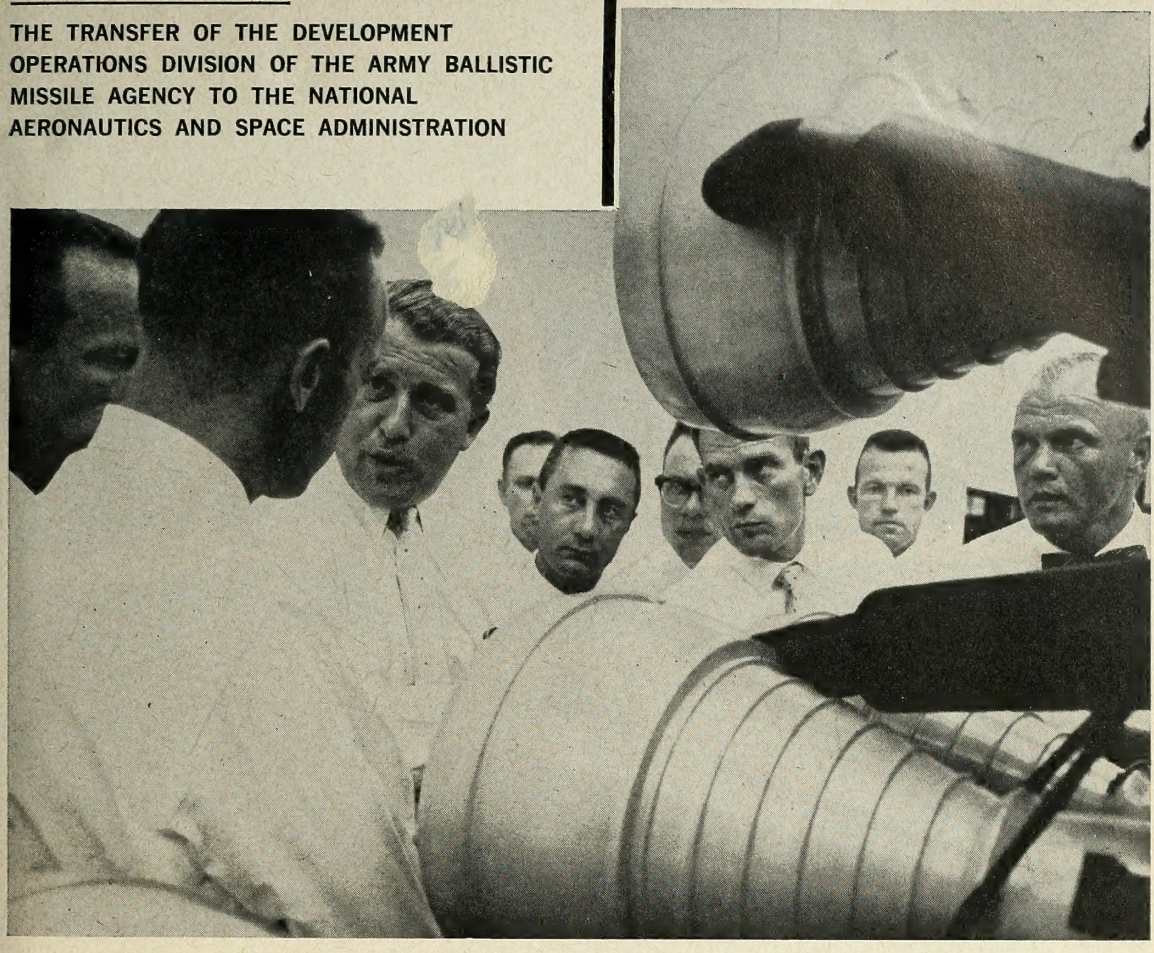
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NASA announces . . .

THE TRANSFER OF THE DEVELOPMENT OPERATIONS DIVISION OF THE ARMY BALLISTIC MISSILE AGENCY TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



Dr. Wernher von Braun, director of the new NASA Marshall Space Flight Center in Huntsville, Ala., pictured with NASA's Mercury Astronauts

Dr. Wernher von Braun and his space team join NASA

The National Aeronautics and Space Administration leads the nation's efforts to find, interpret and understand the secrets of nature as they are revealed in the laboratory of space.

This vigorous effort requires boosters for space vehicles which greatly exceed the thrust of any boosters currently available. For this reason, the $100 million Huntsville plant, together with its famous space team, are being transferred to NASA. The new NASA facility in Huntsville will be known as the George C. Marshall Space Flight Center.

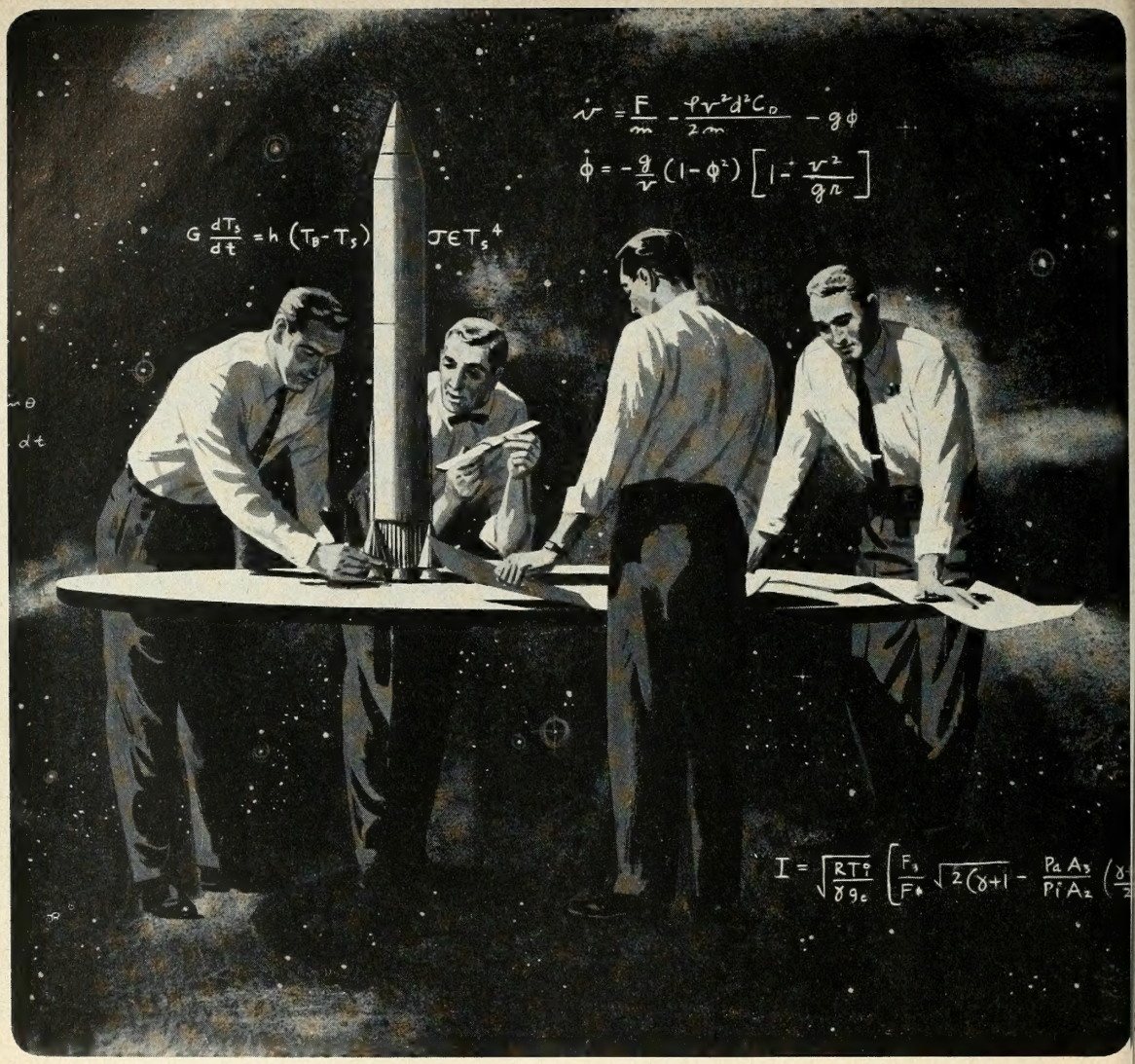
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THE MISSILE / SPACE WEEKLY

missiles and rockets

May 2, 1960 Volume 6 No. 18

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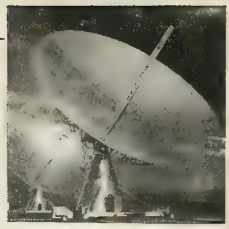
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THE COVER

Navy's new twin radio telescope built and operated by CalTech has already located nine radio sources from outside our galaxy. Its two 90-ft. antennas are mounted on rails.

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30,988 copies this issue

ASW Department Welcomed

To the Editor:

The ASW write-up in your April 11 issue is the most factual I have seen. It presents the subject in excellent perspective. Budgetary facts, which you have presented well, are of basic interest to industry. The description of the ASW problem and of systems and equipment is accurate and interesting. I also note with pleasure the touch of humor under "Strippers."

Harry Sanders
Director, ASW Engineering
Chance Vought Aircraft, Inc.
Dallas

To the Editor:

I was very pleased with what your April 11 issue contained, since the establishment of the new Anti-Submarine Warfare Department will mean increased coverage in the field dear to my heart.

Your coverage of the Navy Capability and needs in the article "Tools the Navy Needs in ASW" was excellent. It was particularly worthwhile to see the ASW budget breakdown and FY comparison.

I feel that you have made an excellent start and with your intended purpose in mind, I expect to be a continued avid reader of your publication.

Earle A. Williams
Manager, Advanced Systems Projects
Defense Electronic Products
Radio Corp. of America
Camden, N. J.

To the Editor:

It was a pleasure to see that you have inaugurated a new ASW department in M/R.

ASW, like every other "anti," is difficult to define. It is neither a weapon nor a system, but is so general that it is difficult to come to grips with it. When the subject is broken down into its parts we have detection, tracking, localization, classification and the kill. However, during the cold war the parts that become of most importance are detection, classification and tracking. Perhaps there is another very important facet to the cold war situation which might be called policy. That is, the attitude that a country will assume if the problems of detection, classification and tracking are solved—then what?

In other words, at what point would the situation of enemy submarines lying close to our shores and pointing nuclear-armed missiles at us become intolerable? Then what would we do about it? I would think that we would come to this eventually, or that USSR would, if the presence of our *Polaris* submarines became an unbearable threat to them.

These are just random thoughts.

With best of luck,

C. B. Momsen
Vice Admiral, USN (Ret.)
Arlington, Va.

To the Editor:

I noted the establishment of a new section in M/R covering ASW Engineering. My only comment is that this is a fine initial start and something that has been required for some time.

As you are aware, advancement in the technology of underseas environment has been extremely limited. On the other hand, the importance of conquering the seas is at least equal to, if not greater than, the importance of conquering space. I would therefore suggest that articles be included which would excite scientists in pursuing studies in underseas phenomena for military and peaceful application of the knowledge and resources of the world's seas.

G. F. Blunda
Assistant to the Vice President and General Manager for Development Planning Radioplane Division of Northrop Corp., Van Nuys, Calif.

To the Editor:

I think your April 11 edition was a very excellent initial coverage of ASW, and I think it was an excellent decision on your part to start this department. One can hardly comment on how you could improve the department after one issue, but I have read many ASW articles by various magazines and I do have a comment as to how you could improve over the general approach.

Namely, it has been my impression that most ASW articles try to cover entirely too much in each issue. I think it would be a better approach to have a special coverage of one important phase of undersea warfare in each issue. Then, perhaps, in order to keep abreast of other phases, you might have a single page or half page written in the *Newsweek* "periscope" style.

I think the idea of having a guest editorial by Vice Admiral Hayward was very good and would suggest such an ASW editorial weekly if possible, but at least monthly.

F. G. Selby, Rear Adm. USN (Ret.)
USW Staff Coordinator
Goodyear Aircraft Corp.
Akron, Ohio

...All aspects of ASW Engineering will be explored in forthcoming articles which will be geared to giving engineering management a more basic understanding of the problems of the field.—Ed.

Saturn Fabrication

To the Editor:

I saw the April 18 M/R yesterday, and

Electronic Engineers

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Inquiries should be directed to the Industrial Relations Office, Dept. C

NRF

U.S. NAVAL REPAIR FACILITY
San Diego 36, California

Mr. Maus' article (on *Saturn* fabrication) certainly looks good. You gave it very fine treatment.

Joseph M. Jones
Headquarters, Army Ordnance
Missile Command
Redstone Arsenal, Ala.

IRC's *Tiros* Solar Cells

To the Editor:

The April 11 issue of M/R carried a complete report on Project *Tiros* ("*Tiros* Presages Long-Range Forecasts").

May we call your readers' attention to one correction. The 9200 solar cells on the *Tiros* satellite were supplied by the International Rectifier Corporation, not Hoffman Electronics Corporation as reported in your article. The performance of *Tiros* is indicative of the fine cooperation RCA has received from IRC on the solar power subsystem in the satellite.

M. G. Staton
Administrator, Planning
Radio Corporation of America
Astro-Electronic Products Division
Princeton, N.J.

To the Editor:

Congratulations to M/R, and particularly to Paul Means, for the very fine and timely article on the *Tiros* weather satellite which appeared in your April 11 issue.

You undoubtedly have been contacted by RCA, pointing out that you credited the 9200 solar cells used in the project to Hoffman Electronics Corporation, when in fact the cells were manufactured and supplied to RCA by International Rectifier Corporation. We received a wire from RCA on April 11, advising us that M/R had made this error in the article, and that they would be happy to verify the fact that we supplied all of the cells used on the *Tiros*.

Within the next few days an RCA spokesman called and stated that he had conferred with NASA on the problem and that they felt it was RCA's responsibility to correct this erroneous impression. I assume this has been done.

You will be interested to know that your publication is well read by members of the financial and investment community as well as by scientists, as indicated by the number of letters we have received calling our attention to this misstatement. It is a testimonial to the excellence of your reporting in this dynamic industry, and to the presentation of your editorial material. Again—congratulations.

William E. Wilson,
Director of Public Relations
International Rectifier Corp.,
El Segundo, Calif.

Get Thee Behind Me, *Saturn*

To the Editor:

Re your cover picture of April 18.

How did you resist the temptation to use the caption, "Rings of *Saturn*"?

Robert L. Mahin, Staff Engineer
Sigma Corporation,
Pacific Palisades, Calif.

It wasn't easy.—Ed.

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JUNIOR ELECTRONIC ENGINEERS

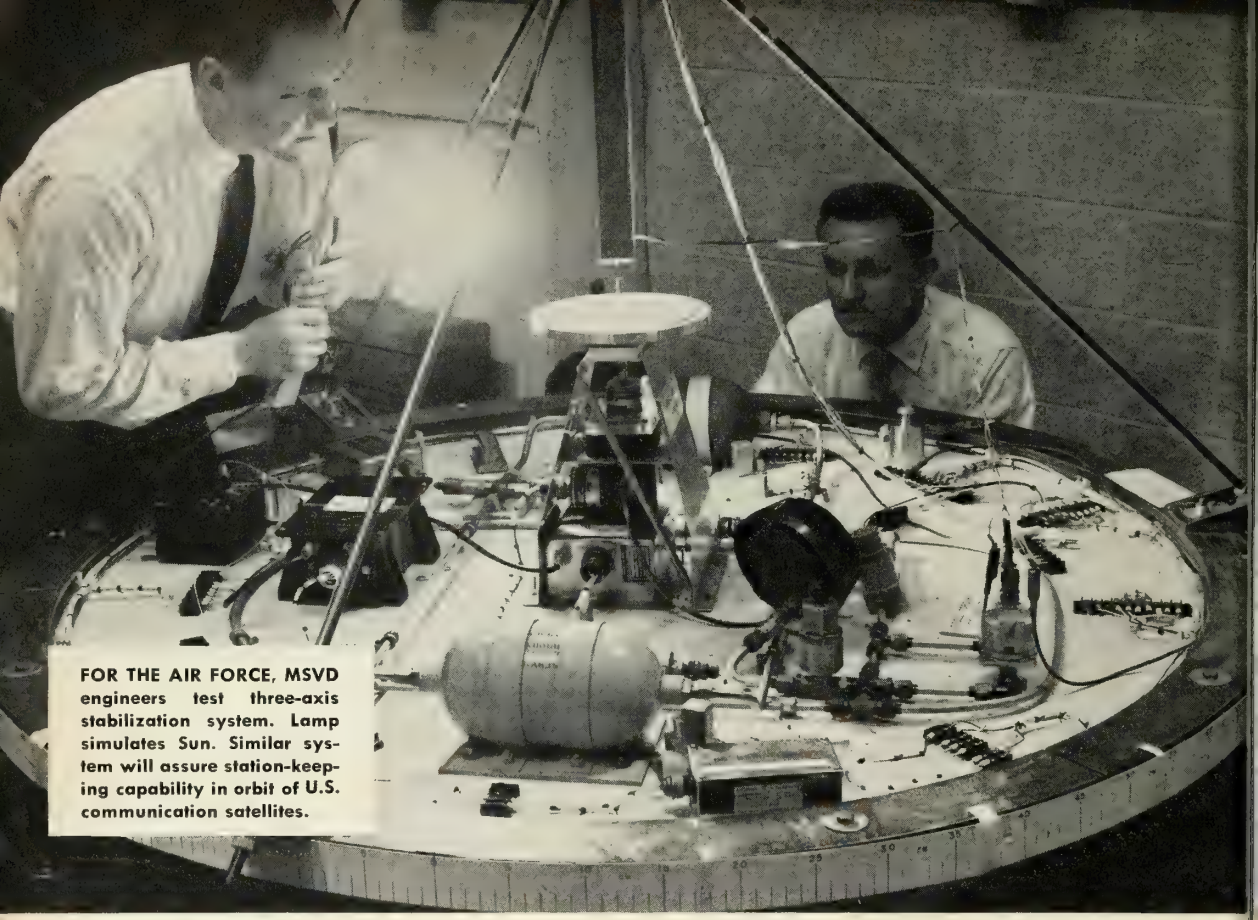
To assist Senior Engineers and Scientists in the development of HF communications and data process equipment. Should have formal electronics schooling and 2 years' experience in circuit design, checkout or analysis of HF communications, Radar Pulse, Analog/Digital or Data Recovery equipment. Construction of prototypes of new and interesting equipment and design of individual components of communications and data processing systems will comprise the major efforts of selected applicants.

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FOR THE AIR FORCE, MSVD engineers test three-axis stabilization system. Lamp simulates Sun. Similar system will assure station-keeping capability in orbit of U.S. communication satellites.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in space vehicle navigation

As space vehicles probe further and further away from the Earth, and as their missions become more and more complex, the need for accurate, high-precision space navigation and control becomes increasingly vital.

General Electric Missile and Space Vehicle Department engineers are now developing and testing space vehicle control equipment for the 24-hour-orbit communication satellite program. They have already designed and flight-tested on space vehicles a three-axis stabilization system as well as orbit computation and correction techniques. Using the Earth and Sun as reference points, this MSVD three-axis system successfully controlled the attitude in space of U.S.A.F. *Atlas* and *Thor* re-entry vehicles during a major portion of their ballistic flights. The control accuracy attained on these flights could be duplicated on flights further into space, using other planets and stars as check-points.

For more information about MSVD's space navigation and control work for the Air Force and its other contributions to U.S. space technology progress, write to Section 160–73, General Electric Missile and Space Vehicle Department, Philadelphia 4, Pennsylvania.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, MSVD

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The Countdown

WASHINGTON

No Strategic Unification

Navy officials are resisting strong pressure to bring *Polaris* missiles under a single strategic command. Their argument: communications. They contend it is both impractical and unwise to try and control submarines at sea from a land-based headquarters which might be destroyed in an initial nuclear attack. Similarly, they feel it would be wrong to put complete retaliatory command control aboard a sub which also might be destroyed. Hence, the AF's ICBM's and *Polaris* are expected to remain under dual commands

Europeans Need Range

The United States may be asked next to finance a European missile range for the training and re-training of *Thor* and *Jupiter* crews. One of the big problems is finding a suitable location. Africa appears out because of political instability. Best bet: a launching complex in Portugal to fire into the Atlantic.

To be Opened New Year's

Look for a revival of the B-70 program next year. DOD officials privately expect funding of the Mach 3 missile-launching bomber will be increased "considerably" with the change in administration and plans for a step-up already have been packaged.

Switch to Tactical Missiles Coming

With the end of the strategic missile build-up in sight in the mid-60's, top DOD planners already see a switch in funding emphasis to tactical weapons for limited war. Market for small missiles to be used by infantry and tanks is expected to increase perceptibly in FY '62.

Far-out Nuclear Testing

The United States now possesses a capability of launching a one-megaton atomic warhead one million miles into space, according to Dr. Reuben F. Metler, executive vice president of Space Technology Laboratories. He said it could be triggered at that distance for test purposes.

INDUSTRY

Space without Bankruptcy

New cost analysis study by the Rand Corp. shows the United States could support a $5-billion to $10-billion annual space expenditure. If build-up is gradual and geared to expansion of the nation's economy, there would be no need for either wage-price controls or reduction in military spending.

Chemical Warfare Contracting Up

Army spelled out its requirements in chemical, biological and radiological warfare for 500 industry representatives at a three-day briefing this past week. Several companies will submit bids on their own proposals—where the Army provides classified information and the company pays for the work.

Full *Saturn* Static Firing Due

All eight engines of the *Saturn* space booster will be static-fired simultaneously for the first time this week at Huntsville. Thrust will be at a level of 1,320,000 lbs., each engine operating at 165,000 lbs. In later tests, the total thrust will rise to 1.5 million lbs.

Titan Storable Fuel Plant Started

Olin Mathieson Chemical Corp. will build a $10-million to $50-million plant for the production of anhydrous hydrazine at Saltville, Va. The top priority program, COUNTDOWN has been told, will furnish high-energy storable fuel for the later model *Titan* ICBM's.

Centaur Moves West for Tests

Pratt & Whitney will ship the LOX-hydrogen *Centaur* engine from West Palm Beach, Fla., to Sycamore Canyon, near San Diego, in a few weeks. A final checkout stand is being completed and static firing could start next month.

INTERNATIONAL

Germany Gets Space Mission

West Germans have taken a NASA offer to participate in the U.S. space program on a rather large scale. The country will help make satellite instrumentation and may build equipment for space capsules.

French Form Materials Company

Seven French concerns, including C. F. Thomas-Houston and Sud Aviation, have joined in the formation of a new corporation—SERMIAT (Societé d'Etude et de Realisations de Materiels et d'Installations Aeroterrestres.) The group will research and manufacture new materials for space vehicle use.

NATO Squabbles over IRBM

One of the major objections to the purchase of *Polaris* by NATO is being raised by France. The French want an IRBM they can base in North Africa which would require a 2500-mile minimum range. *Polaris'* present range is 1200 miles and it is expected to be two years or more before it is increased to 2500 miles.

For Technical Countdown, See Page 21



Sealed and Shock-Resistant ...precision

Hermetically Sealed "HR" Switches

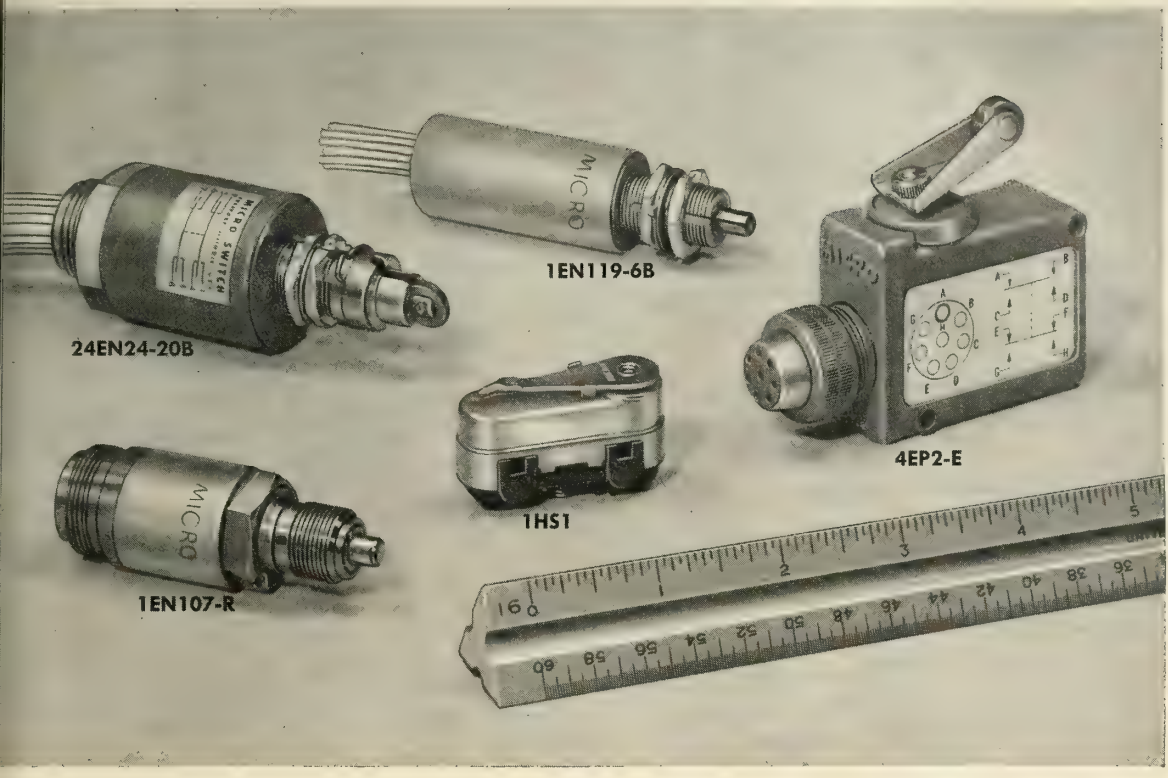
Explosive shock or high temperatures from missile exhausts present no problem to MICRO SWITCH "HR" switches. They are hermetically sealed to maintain constant operating characteristics regardless of changes in atmospheric or environmental conditions. "HR" switches operate dependably in a temperature range of −65° to +600°F. All exposed parts are corrosion resistant. To qualify as a true hermetically sealed switch, the chamber containing the switching element is evacuated and filled with inert gas; the conductor sealing is glass-to-metal and metal-to-metal, and the contained switching unit is actuated through a sealed metal diaphragm. An ice scraper ring on the actuator shaft removes ice or mud which might cause jamming or binding. Write for Catalog 77 which describes "HR" and other MICRO SWITCH enclosed switches for airborne equipment.

12HR1-S and **22HR1-S**—Both contain two single-pole double-throw snap-action switching units. 5 amp. (resistive), 28 vdc.

12HR8-6—Has high-temperature lead-wire extending from internally threaded conduit hub. 5 amp. (resistive), 28 vdc.



12HR1-S 22HR1-S 12HR8-



switches for missile launchers

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1EN107-R Meets BUORD requirements, can withstand 1,000 pounds of sea water pressure per square inch. Has two high-shock basic switches. Write for Data Sheet 176.

4EP2-E Sturdy housing, exceeds shock and vibration resistance tests MIL-S-6743 and MIL-S-6744. Also meets immersion tests for MIL-E-5272A. Conduit hub houses sealed solder terminals and elastomer seal gland. Write for Catalog 77.

1HS1 Single-pole double-throw contact arrangement, conductors sealed in glass. Metal housing is evacuated and filled with dry inert gas under pressure, a true hermetic seal. Write for Catalog 78.

1EN119-6B and **24EN24-20B** Both are used on missile test stands. Environment-proof seals with ice scraper rings on actuator shafts to remove ice or mud which might cause jamming or binding. Write for Data Sheet 176.

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Major new space role?

Navy Bids for Space Launching

Memorandum says HYDRA concept would save billions of dollars over Air Force type of land launchings

POINT MUGU, CALIF.—The Navy is advancing a plan for launching giant rocket boosters from the ocean's surface which would give it a major new space role. The Navy says the proposal will save the nation's space effort billions of dollars over the next 15 years.

Floating of multimillion-pound-thrust space boosters vertically in the ocean for launch would eliminate the need for expensive land-based ground support equipment, the Navy says.

Test firings of small solid-propellant rockets have been made successfully at Pacific Missile Range to prove the feasibility of the system. To support its proposal, the Navy released a lengthy technical memorandum on the concept here last week and at the same time opened a test firing to the press.

The Navy plans additional tests, not only of solid-propellant rocket vehicles but also of vehicles with storable liquid motors and other types of rocket boosters.

The technical memorandum was illustrated with a drawing of a typical Air Force-type launch pad and gantry which the authors said could be eliminated under the new proposal.

Details of the Navy concept, named HYDRA, came from scientists at the Naval Missile Center here. The plan calls for building of large space vehicles in drydock, casting propellant at dockside, towing the vehicles to a launch area by tugboat, and firing them while they float vertically.

"The proposed system for water launch of solid-propellant booster vehicles will represent a significant advance for scientific as well as military exploitation of space," the Navy technical memorandum asserts.

Although the Navy says the concept is not applicable to any present weapon system, it is expected to provide significant advantages to large boosters using either solid propellants or nuclear powerplants. Non-storable liquid propellants are not compatible with a sea launch, the memorandum states.

The Navy says the concept is being put forward as a means of advancing the national space effort and is accordingly oriented to non-military applications. It says development could begin almost immediately by modifying existing solid-propellant hardware such as *Scout* and then proceeding to larger solid-propellant booster vehicles, either single-chamber or clustered, with almost no upper limit on vehicle size.

The technical memorandum suggests that all of the rendezvous problems anticipated in constructing space stations might be eliminated by using water launch of extremely large solid booster clusters with the entire space station as the payload.

Although the Navy emphasized the non-military aspects of the HYDRA concept and specifically denied any attempt to adapt *Polaris* to the technique, it is apparent the system has military applications. Using the HYDRA concept, large numbers of ballistic missiles could be launched without use of special *Polaris*-type submarines, although probably at some sacrifice in accuracy. A standard World War II fleet submarine could tow the missiles to chosen sites and launch them with little difficulty (M/R, February, 1957).

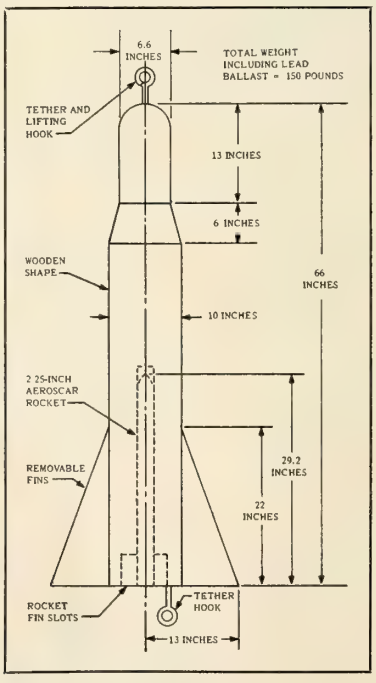
The HYDRA technique, developed by the Missile and Astronautics Directorate of the Naval Missile Center, is said to be economically feasible only in the case of boosters somewhat larger than *Atlas*.

The Navy's technical memorandum says the greatest single advantage of the proposed water launch for the national space program is the relative ease with which logistics and handling problems of large space boosters are met.

It notes that land-based launch complexes require quite extensive facilities to support liquid-propellant rocket firings, including fuel and oxidizer storage, cryogenics systems, concrete launch pads with water-cooling systems, large steel gantries, and armored blockhouses. It points out that frequently support equipment is three to five times as expensive as the vehicles themselves. Much of this equipment also is needed for land-based solid propellant boosters, it is pointed out.



HYDRA 1 test vehicle shown in flight.



SKETCH of vehicle's design details.

rom Sea

By contrast, the ocean offers a "no-cost, self-healing, water-cooled launch pad," the Navy asserts.

"Even more important than the savings effected in the handling, logistics and launch phases, is the extreme mobility gained by such a water-launch system," the proposal states. "Immediately, 70 per cent of the earth's surface becomes a potential launch site. A simple, practical means of obtaining equatorial orbits without diplomatic haggling or tribute paid to foreign powers is within our grasp."

The proposal envisions a fleet of launch and telemetry ships which could be recalled to base after a launch and then used in other areas as desired.

Navy officials here emphasized that no major modifications would be required to adapt standard vehicle designs to sea-launching. They cite the example of using an air-to-air rocket in the demonstration vehicle with little change. Even the ignition of the propellant while underwater has proven quite simple, the Navy says.

The sea-launch test vehicle HYDRA I, was a 150-lb. missile with a wooden shaped body and removable fins. Overall length was 70 in. and maximum diameter, 10 in. The rocket motor was a 2.25-in. Aeroscar, modified for the sea-launch test and delivering 890 lb. thrust for 0.45 sec.

The Navy's technical memorandum says no major technological breakthroughs are necessary to overcome the expected problem areas of corrosion, watertight integrity, guidance, air/sea interface effects during launch and payload checkout techniques.

Contrary to appearances, the prospect of rough water is expected to disturb a floating vehicle very little. Navy calculations and tests show that a rough sea would cause a disturbance in the vehicle's longitudinal axis of five degrees or less.

The technical memorandum says that in order to effectively cope with the motion of the booster vehicle while floating in the upright position, some form of inertial platform will be a prime requirement. It says the form of the guidance platform probably will be a local vertical system, since a system mounted within the vehicle's upper stage can be erected to the local vertical by self-contained means.

"Similarly, alignment can be also accomplished inertially, using advanced gyrocompassing techniques," the memorandum states, adding that miniaturization and advanced digital techniques would be extensively employed.

A suggested alternate form for platform orientation is the use of star-trackers coupled with an inertial platform, while the upper stage is floating out of water. Immediately prior to launch, the star-tracking equipment would be removed and the burden of accurate guidance placed on the low drift rate gyros.

Many of the facilities to implement the HYDRA technique are now in existence: drydocks for fabrication and checkout; LSD (landing ship, dock) vessels to transport the vehicle to a launch site (if towing were not used) and support craft to service it before launch.

A catamaran-type vessel to straddle the protruding nose of the vessel could attach payloads, check guidance, and act as a floating gantry to the booster. The only thing left behind the booster after launch would be the firing lead wiring.

The advantages of the HYDRA system increase as the size of the vehicle increase, according to the Navy.

When nuclear boosters become operational, a concept such as HYDRA will be ideal from a number of standpoints, the studies show. Safety, an overriding consideration in the nuclear rocket program, would be maximum during a launch on the high seas. Security would also be at a maximum level during such an operation, as attested by the undetected nuclear launches of the *Argus* program from the USS Norton Sound in the South Atlantic.

On the problem of corrosion and marine growth at sea, proper design is held to be the answer. One such solution would involve a plastic envelope surrounding the booster. The envelope would be stripped off the vehicle automatically at launch.

Structural design of the wet-launch booster would not differ from present standards, it is noted, since stresses applied during flight will always exceed those loads applied during handling by seaborne equipment.

In a test at Point Mugu for benefit of the press, Navy officials successfully demonstrated underwater ignition of a rocket designed for aerial ignition; stability of underwater launching techniques; no water instability resulting from rocket exhaust; no choking of the supersonic exhaust by water inertia effects, and the pop-out phase.

For most efficient operation, a solid propellant rocket should have a specific gravity of about .9. This would leave appoximately 10% of a vehicle protruding from the water before launch. Most present solid rockets are in the specific gravity range of 1.02 to 1.40 (with regard to sea water), and some additional buoyancy is required.

Air Force Releases Funds For Glider-shaped *Dyna-Soar*

The Air Force this last week finally released funds for the first phase of the huge *Dyna-Soar* space bomber program.

The action followed years of haggling and frustration ended by a final lengthy review aimed at determining whether the vehicle should have a ballistic shape or be a glider as originally planned. The glider won.

The Air Force announced on April 27 that it had released $29.7 million for "design and ground testing necessary to build a boost-glide aerospace test vehicle." The money was released to the *Dyna-Soar* industry team led by Boeing, developers of the vehicle, and Martin, developers of the booster, which will be a modified *Titan* at least in the first stages of the program.

The funds were all the Air Force had planned to spend on *Dyna-Soar* from past appropriations. However, the FY 1961 budget includes $58 million for the program.

Official estimates put the cost of the program by 1966 at more than $800 million.

• **Step-by-step**—Under Phase 1 of the program as announced so far, Boeing will build 11 space gliders—three for ground tests, four for unmanned flights and four for manned flights. The first manned flights will be sub-orbital. They will be launched from Cape Canaveral.

The first glider flights are expected to be unpowered air drops from a B-52 jet bomber. The first manned powered flight is expected to come in the mid-1960's under the presently planned rate of spending.

Later phases of the program—if approved—would give the United States an operational space bomber—the first military space craft.

Power Says *Minuteman* Will Cost Far Less Than *Polaris*

The coming Air Force-Navy struggle over strategic weapons rumbled through Congress this past week.

Gen. Thomas Power in newly-released testimony told the House Military Appropriations Subcommittee that the *Minuteman* system would be eight times cheaper than *Polaris*.

"I am not saying that to take a crack at *Polaris,*" he said. "I am saying we should be cost-conscious regarding the system we are going into.

"The mobile *Minuteman* is a relatively cheap system and has a very high survivability factor. I think there is a great challenge to use existing rolling stock wherever you can, a great challenge to put austerity in this program, a great challenge to use existing railroad personnel to run the trains and put the specialists there to fire the missiles."

Only a few days before the Power testimony was released, a *Polaris* test missile soared more than 1150 statute miles down the Atlantic Missile Range. The missile—launched the night of April 25—was the first in the *Polaris* series to exceed 1000 miles.

• **Double challenge**—Power said his figures on the comparative cost of the *Polaris* and *Minuteman* systems "may be subject to question." But he said his "people have worked them up carefully."

"I think the great challenge is to have the weapon systems that are not only effective from a military point of view but also competitive from a cost point of view. This is what we have addressed ourselves to and why we in SAC like the *Minuteman*. It is a cheap system, relatively. It is cheap in manpower and cheap in initial cost."

The Power testimony came as the overall national defense debate continued across the country:

• Secretary of Defense Thomas S. Gates told Associated Press editors at a luncheon in New York that the United States was going to Geneva backed by military forces that are strong and ready for all-out or limited war. He reiterated past denials that any "deterrent gap" exists.

• Gen. Maxwell Taylor, retired Army Chief of Staff, predicted at the 1960 National-Military Industrial Conference in Chicago that if present trends continue there will be a "dangerous imbalance" of military strength in favor of Russia within the next four or five years.

• Gen. Thomas White, Air Force Chief of Staff, denied charges that the United States is risking disaster by pursuing a philosophy of "overkill" in building strategic striking power. The charge was made by Maj. Gen. John B. Medaris, retired chief of the Army Ordnance Missile Command. White said at a luncheon in New York that he was "not sure what overkill is in a war for your survival."

• Gen. Laurence Kuter, North American Air Defense Commander, told the Senate Armed Services Committee in Washington that he was "deeply concerned" over cutbacks in the *Bomarc B* program and cancellation of the program to build the F-108 Mach 3 interceptor.

ASTIA Speeds Work with Automation

ARLINGTON HALL STATION, VA.—Automated operation of the Armed Services Technical Information Agency (ASTIA) has begun with the completion of the first phase of a complete mechanization of its technical information retrieval and distribution services.

The DOD scientific information center, operated by ARDC, has stepped up its efficiency an estimated 30% with new electronic computer equipment. The second phase of the mechanization program, scheduled for completion by July, will up this efficiency gain to 40%, according to ASTIA officials. A third phase will allow the agency to greatly expand its services to the military and DOD contractors.

The new electronic data processing system—centered around a Univac 90-column solid-state computer—cost $105,000 and an estimated 25 man-years of personnel time. The end result of the modernization will be much faster and better service to ASTIA's "customers" as well as significant savings in operating costs.

• **Major job**—The prime function of ASTIA is to provide scientists and engineers in military research and development with reports on work and findings on previous projects. Such information allows research personnel to keep abreast of scientific progress and apply the findings to current work.

Scientific reports in the ASTIA collection now number more than 750,000. New titles are catalogued at a rate of 30,000 per year. Approximately half a million copies of reports are furnished to requesters each year. The agency serves nearly 3000 qualified industrial users, 1400 military agencies and units, and 17 NATO and SEATO countries.

Practically all military R&D contracts require the contractor to furnish copies of reports on their work to ASTIA. These reports are screened, categorized, assigned reference numbers, and catalogued. Titles and abstracts of these reports are listed in a Technical Abstract Bulletin issued twice monthly and distributed to all qualified users. Copies of these reports may then be requested and furnished to those with an established need-to-know and military certification.

All reports are microfilmed and this film used for reference and to produce copies of the reports for distribution. An additional print of the microfilm is stored in vaults outside so-called "war-hazard" areas.

• **Big speed-up**—The addition of the electronic processing equipment has greatly simplified and speeded up the retrieval and distribution process. Titles are recorded on punched cards according to a just-completed "Thesaurus of ASTIA Descriptors" which categorizes the subject matter of the reports. Other punched cards contain information on all qualified users including pertinent contract numbers, need-to-know, and areas of interest.

Requests for copies are also entered on punched cards and these are fed into the computer along with the catalog and organization cards. The computer determines the validity of the request and prints out security classification information, inventory control data, reproduction instructions, and shipping labels. Copies of the requested report, if not in stock, are made from the microfilm by continuous process using either photoreproduction or the Xerox method. Shipment is usually made within three days from receipt of request.

In addition to copies of reports, ASTIA will also furnish bibliographies on specific subjects. These are furnished in the form of reproductions of catalog cards containing titles and abstracts of all available information on that particular subject. Printed bibliographies on major fields of science and technology in which there is wide interest are also made up periodically and distributed.

All contractors and subcontractors of the military services with a legitimate need for R&D scientific and technical information are eligible for ASTIA services. Eligibility is established through cognizant military project offices.

NASA Spurs Lunar Impact Program

The National Aeronautics and Space Administration set into motion two contracts last week which should culminate in the rough landing of a 300-pound instrument package on the moon in the spring of 1961.

In two separate releases NASA announced that:

• Aeronutronic Division of Ford Motor Co. has been selected to prepare a $3.5-million advanced capsule design study for a 300-pound package to be impacted on the moon by the *Atlas-Agena-B*.

• NASA will buy 16 *Agena-B* launching vehicles from Lockheed during the next three years at a cost of about $50 million.

The early launching date for the lunar impact vehicle, given by NASA officials in testimony before Congress, was somewhat of a surprise because the program had been injured by the cancellation of *Vega*. (See M/R, Dec. 21.) Besides not having the thrust of *Vega*, the *Agena-B* also lacks the midcourse guidance necessary for lunar probe shots. NASA officials think they can correct this deficiency during the next year.

The package which Aeronutronic will design is scheduled to contain a seismometer and a temperature-recording device, and the body of the space craft will carry a television camera system for photographing the moon.

At a distance of about 20 to 25 miles from the moon, the mushroom-shaped package will be detached and a retro-rocket will slow its speed to impact at less than 300 miles an hour.

The parent craft containing the television camera and weighing about 500 pounds will be destroyed as it impacts the moon at a speed of more than 5000 miles an hour. It is being constructed at the Jet Propulsion Laboratory.

Protecting the payload during rough-landing will be a honeycomb crushable material designed to absorb severe impact. The instruments are designed to radio back information to earth for a month or longer.

NASA lost time on its lunar impact program with the cancellation of *Vega*. The present schedule indicates that all of this time will be made up.

• **Background**—The conflict between *Vega* and *Agena-B* arose out of the President's national launch vehicle program, set up in 1959. Under this program, NASA was given the go-ahead on *Vega*, and any new launch vehicle system proposed by a service was to be cleared through the White House. *Agena-B* was not, and the President is said to have reacted with criticism of the Air Force.

But since the Air Force's *Agena-B* program was a fait accompli, either the *Vega* or *Agena-B* had to go. Decision was in favor of the *Agena-B*. NASA sources say the decision was political, based on the fact that Congressional criticism would be greater when an Air Force program is cancelled than it would be if a NASA program is cancelled.

• **Comparison**—The *Vega* engine, developed by General Electric, would have produced 35,000 pounds of thrust, had a start-restart capability, which, with its midcourse guidance system, gave it the capability of performing nearly circular orbits and placing payloads on the moon with great accuracy.

Vega would have been ready by the Spring of 1961.

Agena-B, which will not be ready for NASA use with *Atlases* until *Vega* would have been, develops only a little over 15,000 pounds of thrust from its Bell Aircraft nitric acid and UDMH engine. Though it has a start and restart capability, this is mated with an IR horizon scanner guidance system which is good for only roughly circular orbits.

The *Atlas-Agena-B* will have, however, the capability of placing the proposed 800-pound spacecraft on deep space missions, and will be able to rough-land 300 pounds of the craft on the moon.

The NASA announcement of the spring of '61 launch indicates its confidence that the mid-course guidance system can be introduced to the system by this time.

Douglas Aircraft Corp. has been selected from 34 other bidders to negotiate with NASA for fabrication of Saturn's *second stage. Estimated cost of development and production of nine second stages, including two spares, will be more than $65 million.*

Douglas's job will be to fabricate a frame for four 20K Pratt & Whitney LOX-liquid hydrogen engines. The stage, designated S-4, will be the second stage of the original Saturn *configuration, and the fourth stage of the final configuration.*

Dougulas will build the stage at its Santa Monica, Calif., Div., from where the stages will be barged through the Panama Canal up the Mississippi River into the Ohio River and into the Tennessee River to Huntsville for checkout and mating to the eight-engine Saturn *first stage. Then it must retrace its steps down the Mississippi River into the Gulf of Mexico through the Florida canal system into the Banana River to Cape Canaveral.*

This adds up to more than 10,000 miles of barge travel for the 50-foot-high, 18-foot-diameter stage from manufacturer to launch.

—news briefs—

NASA-NEGOTIATED CONTRACTS—National Aeronautics and Space Administration would have to submit complete data to Congress on all its negotiated contracts under a provision tentatively adopted this last week by the House Space Committee. Details required would include price, number of bidders and their proposals. The amendment to HR 9675 was an outgrowth of NASA's refusal to supply information on the Rocketdyne F-1 rocket engine award to General Accounting Office and the Space Committee.

ASW SUB LAUNCHED—First Nuclear-powered ASW killer submarine, the Tullibee, was launched last week at the Electric Boat Yard of General Dynamics Corp. Vice Adm. Edmund B. Taylor, commander of the Atlantic Fleet Anti-submersible Defense Force, called it America's most advanced weapon against the Soviet undersea fleet.

ATLAS **FROM COFFIN**—Air Force said last week its new coffin launching complex for the *Atlas* at Vandenberg Air Force Base is operational. First shot from the coffin launcher on April 22 impacted 4300 miles west, near Wake Island. Missiles are stored horizontally in the coffin launchers, then erected for firing.

DOD is Killing Proposed Gag on Ads

As M/R went to press this week a proposed Department of Defense directive which would give DOD the power of censorship over all defense industry advertising, speeches and press releases appeared to be dead and awaiting burial.

A Defense Department spokesman quoted Murray Snyder, assistant DOD Secretary for Public Affairs, as saying he was "going to recall the damned thing." Credit for its recall was given to the publicity which followed a news leak on the story. This was followed by a blast from Congressman John E. Moss, chairman of the House Government Information Committee, and a defensive statement by Snyder.

The Defense spokesman said that the proposed directive, which would virtually have placed all statements and advertising by military contractors under Snyder for "policy" control, was not prepared by Snyder's office. It was put together, with Snyder's concurrence, he said, in the office of Perkins Mcguire, Assistant DOD Secretary for Supply and Logistics, and in its original form was actually much more stringent than in the version which leaked.

All three military services protested the proposed directive when it was sent to them for coordination. Defense contractors when they learned of the proposed censorship also protested violently.

"Under the circumstances," said the spokesman, "it would be impossible to get the directive out now."

• **Advertising "czar"**—Moss protested that the directive would have given Snyder "the powers of an advertising czar." If the plan went into effect, he said, "I fear it would do a great deal to prevent intelligent discussion of defense policies which may mean life or death to the United States."

The directive was viewed as interfering with freedom of speech under provisions (see Section VIII below) automatically disapproving the release of any material by contractors which could be interpreted "as intended to influence the adoption, revision or cancellation of plans, programs or policies of the government, including legislation."

Mcguire defended the directive as the only way he knew of stopping "objectionable" advertising. But critics said it went far beyond suggestions of the Hébert Committee to stop questionable ads.

Text of Snyder Ad Censorship Directive

I. Purpose

The purpose of this Directive is to set forth guidelines and procedures for the security review and clearance for public release by defense contractors (including subcontractors) of advertising material and other public information concerning products and services purchased by the Department of Defense.

II. Cancellations

DOD Directive 5230.3, dated 18 January 1952, and DOD Directive 5230.5, dated 24 September 1953 are hereby cancelled.

III. Policy

Persons and firms furnishing products and services to the Department of Defense, (including non-profit organizations and educational institutions) and officers, employees, representatives and agents of such persons and firms, shall not release, for public dissemination, information regarding products or services except as authorized in this Directive or approved in advance by the Secretary of Defense or his designee.

IV. Delegation of Approval Authority

The Assistant Secretary of Defense (Public Affairs) is hereby named as designee of the Secretary of Defense for the purpose of approving or disapproving requests for clearance of information coming within the scope of this Directive, this clearance to be exercised through the Office of Security Review. In appropriate cases decisions shall be made in coordination with the General Counsel and The Assistant Secretary of Defense (Supply and Logistics).

V. Authorized Issuances

A. Contractors shall be authorized to release to the public, without advance approval, the following information pertaining to unclassified or classified contracts for products and services purchased by or furnished to the Department of Defense:

1. Statements that a contract has been awarded.

2. The type of product or services involved, in general terms (such as aircraft of standard types, tanks, trucks, ammunition, clothing, construction; or study of a new electronics system or a high altitude research study, etc.), provided the designation of the product or services is not itself classified.

3. With respect to unclassified contracts only, releases may include the name of the Department of Defense contracting office, a brief description of the product or service involved, the quantity of products to be furnished, and the dollar amount.

4. Help-wanted and recruiting information, which does not divulge classified material.

5. A general statement of the kinds and numbers of additional employees which will be required by the facility involved.

6. Announcement of subcontracting opportunities for unclassified subcontracts, providing no classified material is made public concerning the prime contract or higher tier subcontracts.

7. With respect to research and development work performed by nonprofit organizations and educational institutions, unclassified information of public or professional interest pertinent to accomplishments under a con-

ract, provided the release of such information is not limited by terms of he contract. The release of unclassified information derived from research nd development contracts is encouraged, as the dissemination of such nformation will accrue to the general enefit of the United States.

8. The specific information, in the pecific format previously approved ursuant to VII below.

B. In order that manufacturers olding classified Department of Defense contracts may make state of usiness reports to stockholders, stock exchanges, etc., the total company-vide dollar value of backlog may be released provided:

1. That only the Department of Defense total is used and not broken down by individual military service or item.

2. That the release does not reveal the quantity or volume of individual orders.

3. That the report is not made for period of less than three months.

C. In case of doubt as to the releasability of information pursuant to this paragraph, contractors should follow the procedures of VII below.

VI. Issuances Requiring Prior Approval

Contractors shall not be authorized to release information other than that set forth in V above without prior aproval of the Office of Security Review, Office of the Assistant Secretary of Defense (Public Affairs). Paragraph VIII below sets forth those types of releases which will not be approved, and therefore should neither be released nor submitted for approval. Examples of information which may not be released without such approval are:

1. Production schedules, future planning on production schedules, or rates of delivery.

2. Information on sources of supply, quantities and qualities of strategic or critical supplies and movements, assembly or storage of supplies or material.

3. Information on sabotage attempts or plant security measures.

4. Information any research and/or development projects, except as provided in V. A. 7, above.

5. Information on any missiles, nuclear devices or weapons; "BW-CW" agents, materials or weapons; and other new weapons or weapon systems.

6. Information, including any photograph, sketch or plan concerning first models of weapons or equipment, outstanding production achievements, or performance of weapons or equipment.

7. Information on material for shipment to allied governments under MDAP, NATO, etc.

8. Movement of military aircraft or naval vessels. (This restriction is applicable to all cases, including those where actual movement order is unclassified.)

VII. Approval Procedures

A. Persons and firms (including non-profit organizations and educational institutions) desiring approval to release information other than of the type set forth in V. above, shall forward requests for approval in writing to:

Office of Security Review
The Assistant Secretary of Defense (Public Affairs)
Washington 25, D.C.

The military departments are authorized to provide in contracts that requests for approval shall be submitted through designated departmental officials or offices. Subcontractors shall forward requests through prime contractors, who shall be responsible for initial screening of submitted material.

B. The information proposed for release shall be attached to the request, precisely in the format and substance desired to be released, including any photographs, sketches, plans, blueprints, models (if practicable), charts, etc., or other art work which are proposed for release.

C. Approvals are restricted to the specific release submitted for approval. Any change whatsoever in format, art work, or substance requires a new approval.

VIII. Issuances Which Shall Not Be Approved

Proposed releases containing the following types of information shall not be approved:

1. Inaccurate, incomplete, or misleading material. (E.g., inappropriate claims of operational availability or operational capability of products under research or development or furnished to the Department of Defense).

2. Appraisal of the military effectiveness or ineffectiveness of weapons and weapon systems of the United States or other countries, or discussion of the economic impact of award or cancellation of specific defense contracts, or continuance or discontinuance of specific procurement programs or the military strategy and tactics upon which such programs are based, where, in either case because of timing, content, magnitude or a combination of any of these elements, release of information could reasonably be interpreted as intended to influence the adoption, revision or cancellation of plans, programs or policies of the Government, including legislation.

3. Discussion of the relative merits of conflicting military strategies and tactics, which may affect the purchase or development of products or services by or for the Defense Department.

4. Classified information, or information pertaining to research, methods, or end products that develop a security classification in an otherwise unclassified contract.

5. Statements concerning movements of military aircraft and naval vessels, unless screened by the responsible commander.

6. Statements concerning qualifications, acceptance or approval of products or services furnished to the Department of Defense; that a contractor is the sole supplier of a product or services or, the percentage of prime contractor's requirements provided by a subcontractor, in terms of quantity or dollar value.

IX. Implementation

A. The following contract clause shall be inserted in all contracts involving research, development and experimental work, classified contracts, and all other contracts for more than $100,000:

"The Contractor shall not release for public dissemination information regarding products or services purchased by the Department of Defense except as authorized or approved in advance by the Secretary of Defense, or his designee. Procedures for securing approval shall be as set forth in Appendix F, Armed Services Procurement Regulation, entitled "Manual for Release of Information By Contractors," issued [date], as said Manual may from time to time be amended, which is hereby incorporated by reference with the same force and effect as though fully set forth. The substance of this clause shall be inserted in all subcontracts involving research, development and experimental work, classified subcontracts, and all other subcontracts for more than $100,000. Authorization or approval for release under this clause shall not be construed to authorize or approve payment for the cost of releasing information."

B. The substance of this Directive shall be published in a "Manual for Release of Information by Contractors" and inserted as an Appendix to the Armed Services Procurement Regulation.

C. Violations of this Directive shall be brought to the immediate attention of the Office of Security Review and, as required, the Assistant Secretary of Defense (Public Affairs) will consult with the General Counsel and the Assistant Secretary of Defense (Supply and Logistics) concerning appropriate action.

Temco Consolidating with Ling-Altec

Temco Aircraft and Ling-Altec Electronics last week disclosed plans to merge into Ling-Temco Electronics, a combination expected to both diversify and strengthen the two companies in missiles and electronics.

The proposal is to be acted upon shortly by stockholders and directors of the companies, both headquartered in Dallas.

Temco, prime for the Navy's *Corvus* air-to-surface missile, suffered a setback in sales during 1959 and earnings slipped from $1.50 a share in 1958 to 68 cents last year. The company had a backlog of about $83 million on March 31, 45% in missile and electronic work.

Temco recently picked Clyde Skeen, former vice president of weapons system program management of Boeing's aerospace division, to be its general manager. He is to become president of the new company.

A major component supplier, Ling-Altec is an integrated company with considerable electronic research and development facilities. It had sales of about $48 million last year compared to $100 million for Temco. Combined assets of the two companies total about $69 million.

The merger announcement said management and key operational employes of both companies would remain much as they are now. Slate of officers of Ling-Temco would have Robert McCulloch, Temco's president, as board chairman and chief executive officer; Ling-Altec chairman James J. Lang would be vice chairman and chairman of the executive committee. Lee D. Webster of Ling-Altec would be executive vice president.

mergers and expansions

AERONUTRONIC DIVISION—Ford Motor Co. has dedicated its partially completed 200-acre Engineering and Research Center at Newport Beach, Calif. Aeronutronic expects to employ approximately 3700 persons at the facility by 1962.

UNITED CONTROL CORP. is planning a 136,000 sq. ft. combined engineering and production facility on a 30-acre site in Overlake Industrial Park, east of Seattle. Employment will be 1000 persons by completion in Feb. 1961.

TELECOMPUTING CORP. of Los Angeles has purchased the previously unacquired 13% of its Frank R. Cook Co. subsidiary to make it wholly-owned . . . Materials Products Corp. (Melcor) is planning an 80,000 sq. ft. expansion adjoining its present site in Trenton, N.J. The less than year-old firm manufactures thermoelectric modules for cooling applications.

SCINTILLA DIVISION of Bendix Aviation Corp. has broken ground for a 30,000 sq. ft. engineering and production plant for Bendix cabling operations at Santa Ana, Calif.

ASTRONAUTICS, INC., is the name of a new engineering, manufacturing and technical firm establishing in Eau Gallie, Florida. Three former RCA managers of the AFMTC are part of the executive committee; George W. Soderquist of Eau Gallie, Herbert Kilberg and Robert E. Wilkinson. More members will be added to the board of directors.

SYLVANIA ELECTRIC PRODUCTS INC. is planning another expansion. A 180-acre, campus type electronic data processing center will be built in Newton, Mass. with some 200,000 square feet for development of data processing techniques and equipment.

BELL & HOWELL company and its subsidiary, Consolidated Electrodynamics Corp. have combined research activities and will add 30% more personnel than the two previous departments.

ELECTRONIC ENERGY CONVERSION CORP. has acquired 82% of the common stock of Behlman Engineering Co. of Los Angeles, and its subsidiary Custom Magnetics, Inc. No changes in personnel or policies are contemplated, according to the company.

NORDEN DIVISION of United Aircraft has purchased a 35-acre tract in Costa Mesa, to build a 50,000 square-foot engineering, research, and manufacturing facility for its Data Systems department. Operations now being conducted in leased plants in Gardena and Santa Ana, Calif. will be moved to Costa Mesa.

JACK & HEINTZ, INC. has bought the business assets and manufacturing rights of Roto-Lock Couplings; Inc., South Gate, Calif. Roto-Lock's inventory and tooling will be moved to Cleveland.

CONTINENTAL ELECTRON CO. stockholders have voted to change the corporate name to Cetron Electronic Corp., under which many of its products are already sold.

IMC MAGNETICS CORP. of Westbury and Los Angeles has acquired 80% of shares of the Arrow Valve Corp of Phoenix, Arizona producers of high precision jet atomizers, valves and filters. Arrow will work closely with the PSP Engineering Division of IMC, Maywood, Calif.

LAMBDA ELECTRONICS CORP. has broken ground on a 76,000 square foot electronics plant at Huntington, L.I., N.Y. to which it will move from College Point.

financial news

Thiokol Chemical Corp.—An explosion at the Longhorn facilities caused a 35% reduction in Chemical Division sales during the first quarter of this year. Sales in the Rocket Division were up 27%, but much of these sales represented reimbursement for costs in excess of original estimates under cost-plus-fixed-fee type contracts so did not contribute to profits. Net earnings for the three months ending March 31 were $817,820, a decrease of 37% from the corresponding period of 1959.

Martin Co.—Both sales and earnings increased in the first 1960 quarter over the last year's first quarter total. Net sales and other income rose to $140 million, 14.9% over 1959's $122 million. Net income rose 14.8% to $3.5 million from $3 million.

Douglas Aircraft Co.—Sales of $251 million for the first quarter of FY 1960 ending Feb. 29 compared favorably with quarter sales of $227 million a year ago. Douglas suffered a loss in income of $6.9 million this quarter compared to a loss of $8.1 million in 1959. Backlog as of Feb. 29 was $1.4 billion, of which $746.2 million or 52.8% was in military orders. This total is some $79 million less than total backlog at the end of the first 1959 quarter.

At 00h00m01s GMT, May 1, 1960, Martin logged its 523,692,000th mile of space flight



To keep the lonely vigil . . . *Martin PM-1 air-portable nuclear reactor, to supply electricity and heat at remote Air Force stations, is now being developed and produced for the AEC.*

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Technical Countdown

ELECTRONICS

Solid-State Breakthrough Due

Watch for announcement of a major breakthrough in solid-state devices in the next few months. The work is in progress at a university research laboratory.

IR Detects Long Distance Launchings

Highly successful infrared photographs of missile performance over long distances have been obtained by Perkin-Elmer Corp. under an Air Force contract—results that will have obvious implication for the *Midas* early-warning satellite program. Meanwhile, another *Midas* launching is reported to be very imminent.

Missile Path Detection Studied

Melpar's Applied Science Division is studying the feasibility of recognizing missiles and space vehicles by the paths they leave in space or the atmosphere, under an ARDC contract.

AMR Develops Automated Central Computer

An automated centralized computer center, to be operational by July 1, 1963, is under development at Atlantic Missile Range. Design objectives include computation and display of real-time trajectory and telemetry data, completely reduced data six hours after test, and a final data report containing complete test information.

E-OS Improves Solar Concentrators

Solar concentrators with efficiencies approaching 90% and weighing less than 1/3 lb./sq. ft. have been developed by Electro-Optical Systems. Future units of 5-10 ft. diameters will provide 1200-1500° F temperatures.

Paper Will Bury Us

Chrysler Corp. publications chiefs say a continued "information explosion" will demand an increase of 66,000 technical writers in industry and government by 1970. Tech publications industry now employs 35,000; grosses $4 billion a year.

GROUND SUPPORT EQUIPMENT

LOX Trailer Totals Revealed

Air Products Inc. has built 127 LOX semi-trailers for missile/space use in the last two years, all of 4000-gallon capacity. Company has been awarded a $1,801,632 Army contract to produce *Jupiter* trailers.

Com System Weight Cut

Paraballoon antenna will be used to reduce weight and size on a mobile troposcatter communications system Westinghouse is developing under a $2.6 million Air Force contract.

PROPULSION

Plumbing Worst Headache—Schriever

The biggest problem in developing long-range missiles has been plumbing, says Lt. Gen. Bernard A. Schriever. There are a lot of valves and regulators that must operate under extreme conditions, the ARDC commander said.

Kiwi-A Prime Checks Begin

Cold-flow checks began last week on a mockup of *Kiwi-A Prime*, a device that will be fired this summer as the second test in the Project *Rover* nuclear rocket program. Mockup at Los Alamos Scientific Laboratory is similar to the rocket to be fired at Jackass Flats, Nev., except that it contains no radioactive material.

France Builds Bigger Solids

A solid-propellant grain weighing 2645 lbs. is under development by the Service des Poudres, France's in-house rocket agency, in the nation's IRBM program. During the 1961 budget year, grains will be scaled up to 8-10,000 lbs. and later to 50,000 lbs.

Booster Recovery Design Study Set

Boeing Airplane Co. will prepare a preliminary design for a recoverable booster system under a nine-month contract awarded by ARDC. Although no application was mentioned, a recoverable booster would have obvious *Dyna-Soar* application.

H-power Answer Due in 5 Years

Researchers will know in five years whether magnetically controlled thermonuclear power is feasible, says Dr. Richard F. Post of Lawrence Radiation Laboratory, Post believes the answer will be yes, he told the American Physical Society.

ADVANCED MATERIALS

Lockheed Takes Up Hot Question

A series of 50 re-entry models for Mach 18 manned orbital and interplanetary flight will be studied by Lockheed under an Air Force contract.

Super Insulation Use Licensed

A super insulation developed by National Research Corp. will be used in manufacture of long-term storage vessels for liquid helium, hydrogen and fluorine. Standard Pressed Steel Corp. has obtained NRC license.

Gear Production Automated

A computer will be used to plan production or gear production tools at National Broach and Machine Co. A Bendix Alpha-Numeric computer has been installed.

ASW ENGINEERING

Marine Communication Technique?

The fish and animals of the sea may teach the Navy how to combat submarines. Adm. Arleigh A. Burke, chief of Navy Operations, says a study of sea-animals' communications may provide an answer to the under-sea detection dilemma.

SPACE MEDICINE

Zero-Gravity Plane Planned

Boeing plans to fit a KC-135 tanker-transport to test human reactions at zero gravity. By flying into a ballistic trajectory at 25,000 ft., the plane will be able to simulate weightlessness up to 40 seconds.

Personnel Problem?

Getting people to man space stations, once the romance has worn off, will be as tough as finding lighthouse keepers, concludes North American Aviation engineer Fred Payne. Boredom will be the killer.

Digital Decommutator Is Big Advance

EMR system can be used with any pulse-type telemetry—early model slated for use at Fort Huachuca

by Charles D. LaFond

Electro-Mechanical Research, Inc. of Sarasota, Fla., has developed for the first time a digital decommutator that can be used with any pulse-type telemetry system. Now in production, the system is a significant advance in missile and space vehicle data handling.

With solid-state modular construction throughout, the extremely compact equipment can perform all types of data reduction and decommutation in addition to providing a variety of digital or analog outputs.

EMR, which developed the system at a cost of over $1 million and 2½ years of work, believes there is no equivalent on the market.

Costing roughly $30,000 each (depending on the functional configuration), both the military and many missile primes have contracted for systems now in production. An early version of the system will be installed by Beckman Instrument at the Army's Fort Huachuca test facility in Arizona.

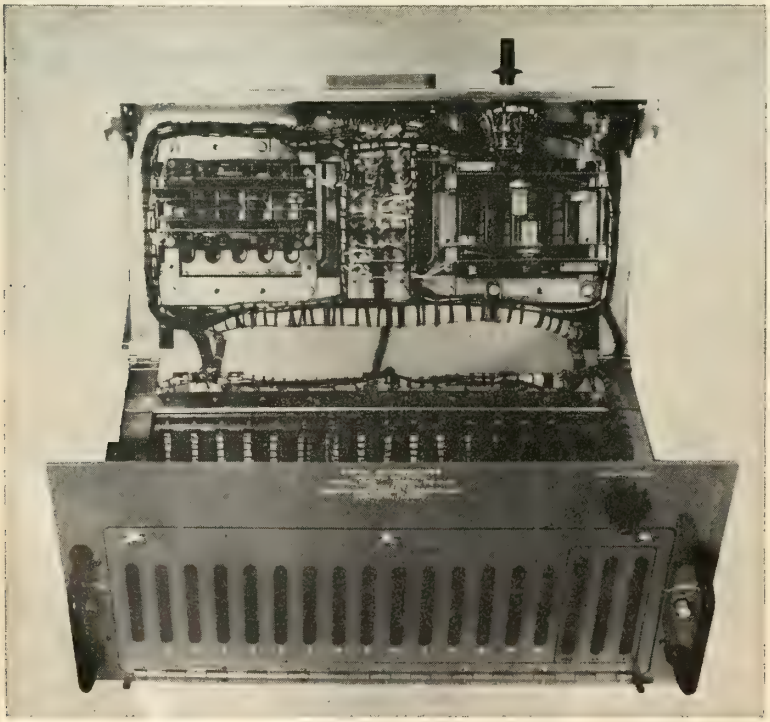
• **Adaptability**—Flexible in its functional configurations, the Model 185 digital decommutator can be adapted by the use of several different subsystems to accept any pulse type telemetry signal input (PAM, PDM, PCM, etc.) over a wide range combination of possible sampling rates and number of channels in a frame, its developers say.

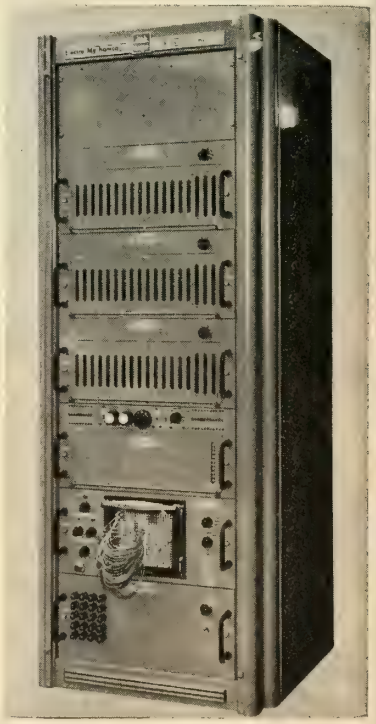
Pure binary and binary-coded-decimal outputs can be provided in multiplexed form for tape recording or decommutated for digital computers and printer readout. If desired, an analog output in decommutated form can be produced with an 8-bit binary display and a 3 x 4 binary coded decimal display. Almost all other forms of standard readout also are available.

Because digital techniques and circuitry are used from input to output, an unusually high degree of stability, freedom from noise and jitter, indifference to missing channels, and overall synchronization are attained.

• **Operation**—The EMR Model 185 will accept PAM (pulse amplitude modulation) or direct and taped PDM (pulse duration modulation, a form of pulse time mod.) signals at any sampling or playback rate from 28 to 4600 pps. From 10 to 128 channels/frame can be processed.

For PCM (pulse code modulation) operation, rates are 128 words/frame and 4600 words/sec. max, with either 28 words/sec. min, or 16 words/sec. min., depending on subsystem configuration.





LEFT: TYPICAL ANALOG output drawer of the EMR Model 185. Top half of the inner chassis swings up exposing vital circuitry for easy maintenance and accessibility. Logic circuitry on modular cards is accessible at the front-panel. RIGHT: EMR MODEL 185 digital decommutator, because of its solid state modular construction, packs a 48-channel decommutator in less than a single rack. The three upper panels each contain a 16-output analog drawer. An 8-bit binary front-panel display is associated with each analog channel and any channel can be selected for front-panel decimal display.

Word and frame synchronization logic for the PCM circuitry is such that a transmission fadeout or change in data bit rate causing momentary loss of sync will not result in an output error. If the proper sync word is not recognized by the synchronization logic within 5% of expected arrival time, all data transfer is inhibited.

Other safety features are built in to give correct recognition and prevent false transfer of data. Transmission mode conversion—PCM to PNM (pulse number modulation) and back to PCM—cannot cause data degradation or increase error rate.

Synchronizing and programing logic is completely digital. Integrations are performed numerically; filtering is handled digitally or in the time domain to achieve flexibility and to provide perfect holding and fast response.

The PCM storage reads out straight parallel binary multiplexed outputs for tape recording at various rates: 10 bits at sampling rates up to 1150 pps—an 11th bit indicates overflow; 8 bits at higher sampling rates. A binary coded decimal storage reads out a multiplexed BCD output (12 bits for 3 digits, 8421 code). A 17-in. oscilloscopic bar chart display also can be provided.

For decommutated outputs, PCM channel data is directed to an output memory by plug-in patchboard. Memories are digital units, capable of indefinite storage without decay, which drive binary-to-analog converters. The converters have similar hold characteristics. A variety of converters can be used for driving the standard types of pen or film recorders.

Decommutated digital outputs also can be provided in straight binary, BCD, or straight decimal form for driving standard printers or type recorders.

• **Characteristics**—In the present system, 10 to 128 channels are available. (Standard 19-inch rack chassis are used.)

Sample rates are variable continuously between 28 and 4600 pps, and nine coarse ranges can be selected by switch.

A 20% pulse rate variation can be obtained beyond the edge frequencies determined by range setting. A 12-cps pulse-rate modulation of ±20% peak amplitude at 900 samples/sec. can be followed without loss of sync.

Synchronization can be held with up to ±12% jitter of the channel-sync pulses. Jitter frequency can be greater than 500 cps, the company says.

Nor will sync be lost with up to 20 consecutive missing pulses, at any sampling rate. In describing the system, a company spokesman said the system locks on the fifth pulse if four consecutive pulses are lost. (This would be at an average sampling rate of 900 cps, modulated at 6 cps to peak sampling-rate drifts of ±20%.) The system also locks on the frame-sync signal after 20 consecutive missing pulses under the same conditions, he said.

From 28 to 1150 pps, resolution depends on number of bits: 0.1% at 10 bits; 0.4% at 8 bits. Resolution is fixed at 0.4% for over 1150 pps.

Linearity is ±0.04% from the best straight line.

Without employing automatic compensation, sensitivity will drift less than 0.5% over a 6-hr. period. With compensation, drift can be held to within 0.1% of full scale with the 10-bit output or to less than 0.4% of full scale for the 8-bit output.

EMR Model 185 Electrical Specification

Type Input	Duty Cycle (%)	Sample Rate (pps)	Bit Rate-Serial (bps)	Word Rate-Serial or Parallel (wps)	Word Length Max. (bits)	Frame Length (words)	Input Impedence (ohms)	Input Level (volts)*
PAM	40–90	28–4600	.....	.....	..	.....	40K	2–100
PDM	(Ref. IRIG Document # 103–56.) Proportional over 900 pps	900–4600	.....	.....	..	.....	40K	0.5–100
PCM	.....	.....	120–60,000	16–4600	16	10–128	40K	0.5–100

* Peak to peak, single- or double-ended, either polarity.

Special Handling Demands Are Basic to Launch Success

PHILADELPHIA—Prelaunch time element and even success of a missile launch depends to a large degree on the unglamorous general handling phases of the missile and its components. Some electrical equipment and materials, said Robert Moyer at the A.I.E.E. Materials Handling Conference here recently, demand special care and attention.

So necessary are these for the internal missile subsystems that improper handling techniques can limit performance and prevent mission accomplishment.

Complex handling problems occur not only with the missile itself but with the ground support equipment too. Missile mission dictates the kinds of problems encountered, says Moyer.

Typical extremes, he said, would be the fixed-installation *Atlas* or *Titan* launch as compared with the highly mobile *Lacrosse*, completely self-contained and carried on an Army 2½-ton truck.

Moyer, electrical lead engineer in Martin's *Titan* firing group at Cape Canaveral, described the following missile and GSE electrical areas offering the greatest need for special handling techniques:

MISSILE SUBSYSTEMS

• **Primary batteries**—Silver-zinc automatically activated batteries are used in many different missiles ranging from the short range artillery types to ICBM's. Special attention is required from the standpoint of temperature control prior to activation and of electrolyte overflow disposal. (The electrolytes are caustic and corrosive—usually a 30% solution of potassium hydroxide.)

For extended periods of exposure (over 2 hours) prior to activation in temperature environments beyond the range of 40°F to 125°F, a temperature control device must be employed to obtain rated energy output.

Low-temperature problems are solved easily by a heater, powered from external support equipment. Although not so frequently encountered as the lower temperatures, temperatures above 125°F require use of air conditioning devices during pre-launch operations.

For ICBM's this is not too difficult since the equipment and power source do not create an unwieldy requirement.

For short-range mobile missiles, the employment of an air conditioning device is more of a problem. To avoid the bulk of a complex air conditioning system powered from an external source, fans may be directed on the batteries. Also, the battery could be installed just prior to launching time, but for operational missiles it is expedient that a missile have a minimum of ready time.

Disposal of electrolyte overflow after battery activation can be readily taken care of by connecting a stainless steel or plastic tube from the battery

vent to an overboard drain. Disposal inside a missile could cause serious electrical short circuits or even damage other components or missile structure.

Activation time of a primary battery must be at the latest possible time prior to launch. This precludes the need for battery replacement if other launch delays occur. Batteries are good for about two hours under no-load conditions, but if a launch delay occurs after the missile loads have been applied, battery replacement is mandatory.

Automatically activated silver-zinc batteries require practically no attention during the unactivated shelf-life period.

• **Secondary batteries**—Rechargeable secondary silver-zinc and nickel-cadmium batteries still have missile-program applications. Larger and heavier than the primary batteries, they require charging within 4 days prior to use. To maintain instantaneous readiness for an operational missile, batteries must be removed every four days for discharging and recharging. This is a cumbersome task.

Charging sometimes involves a tedious process in eliminating internal battery shorts due to electrolyte spillage. Disassembly may be necessary to remove completely the electrolyte spillage. However, during operation no electrolyte overflow drain is necessary.

• **Thermal batteries**—Relatively free from special handling techniques, thermal batteries have application only in those missiles having low electrical power requirements and short operating time (under one minute).

• **Hot-gas APU's**—Gas turbines such as the monopropellant (ethelene oxide) and bipropellant (LOX and RF_1) are much less extensively used at the present time than are batteries as auxiliary power units. So far, the problem of storing and handling of propellants has precluded extensive use of the gas turbine.

When gas turbines are used, provision must be made to protect other components in its proximity from the high temperatures and exhaust gases. Usually in bipropellant systems combustion of exhaust gases takes place when coming in contact with oxygen from the atmosphere.

A distinct advantage of the gas turbine is its relative freedom from the effects of high and low ambient temperatures.

• **Other power equipment**—Inverters, converters, and transformer rectifiers usually present handling problems only when exposed to extreme ambient temperatures. Extreme temperatures can severely affect windings of motor and generator fields, carbon and wire-wound resistors, and transistors.

High temperatures encountered during pre-launch operations result primarily from heat dissipation of electrical and electronic units. Also, missile compartment temperatures have been elevated up to 145°F just from solar radiation.

An external air conditioning system using an external power supply can solve the problem during pre-launch operations. Cooling capability is usually only that which is available from heat sink of the equipment itself. In most cases this amounts to an operating time of only slightly more than that required for flight operating time.

Ambient temperatures can be expected to be as low as –65°F due to geographic location. With proper design, compensation for these low temperatures can be achieved with little weight increase. In liquid-propelled missiles where liquid oxygen is used, compartment temperatures can be expected to go much lower than –65°F; compartment temperature is a function of the time cryogenic propellants are required to be in the tanks prior to launch. This problem exists primarily in the longer range missiles where it has been solved by an external air conditioning device.

• **Connectors and cables**—Missile electrical connectors and cabling present very few problems during the process of operational handling. Missiles located in areas exposed to high relative humidity and salt spray present the greatest problems.

A continual maintenance program is necessary to keep any electrical termination from being exposed to these environments. When necessary to remove individual wires or disconnect electrical connectors, care must be taken to protect against corrosion. The entire connector or exposed termination should be covered with a moisture-proofing compound of silicone-rubber and activator.

Particular care must be taken at all times to prevent wire insulation from being punctured.

Great care must be taken with electrical cables in the proximity of the missile engine. Cable is available now which can be exposed to ambient temperatures up to 1000°F. Additional protection is sometimes added by wrapping a cable with asbestos and aluminum tape.

In liquid-propelled missiles there is the possibility of small fires in the engine compartment due to propellant leakage. If cables are sufficiently wrapped with protective tape they can tolerate small fires without causing electrical system failure.

SUPPORT EQUIPMENT

• **Cables and umbilical connectors**—For pre-launch operations a number of circuits usually are provided to the missile for external power, operation of missile relays and valves, and telemetry. To achieve successful missile operation, disconnect of these umbilicals must be made at a specified time.

Umbilical release is performed electrically, mechanically, pneumatically, and simply by pull-away (or any combination of these methods). Design trend has been toward the pull-away release for improved reliability.

Great care must be taken when installing umbilical connectors to prevent damage or misalignment. Umbilical connectors which contain large power pins sometimes require pin lubrication to assure release. A coating of Dow Corning No. 4 has been used successfully for this purpose.

For pre-launch operations, protection must be provided against moisture and salt spray between the umbilical connector and the missile connector. An application of silicone rubber compound sealing the umbilical connector to the missile provides good protection against corrosion.

At missile launch, umbilical cables are sometimes exposed to very high temperatures from the missile engines. Protection can be accomplished by wrapping the exposed cables with a layer each of asbestos and aluminum tape.

• **Power equipment**—Power requirements for a missile operation vary from a few hundred watts to as much as 1000 kw. For ICBM's the power problem just becomes one of designing an electrical power system large enough to meet the load requirements. For mobile-launched and air-launched missiles, missile-component design is critical from the standpoint of a minimum requirement for external electrical power.

Sufficient power for air launched missiles usually can be derived from generators mounted on the accessory pad of the aircraft's engines.

Missiles operating from mobile launchers, in various environments, sometimes have power requirements greater than that available from the prime mover. When this occurs an auxiliary power unit is required. The attendant operational problems are that of providing a fuel supply and maintaining a battery power source including battery heater for operations in low temperatures for starting purposes.



Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since March 7 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
★ADVENT (ARPA-Air Force)	GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout	Used in DISCOVERER program; larger model to be used with ATLAS and THOR under development; NASA also will use to take place of cancelled VEGA
★ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Two lunar orbit attempts beginning this summer
CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Soft-land 730-lb. on moon; first liquid hydrogen engine; 30,000-lbs. of thrust	First test flight in spring, 1961
COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	R&D; satellite in advanced stage; first to be launched in spring
★DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites	Of first 11 launched, 6 stabilized in orbit; ejected capsules not recovered
★DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN booster	R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	First launch due this month
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Capsule tests on ATLAS to begin; manned capsule launching by REDSTONE down Atlantic this summer; first manned flight scheduled in 1961; first abort capsule test set for May
★MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; early launchings from Cape; later from Pacific Missile Range's Point Arguello; transferred from ARPA to Air Force; first R&D launching Feb. 26 failed because of apparent trouble in second stage; second launching imminent
★NIMBUS (NASA)	Contract to be let shortly	Follow on to TIROS weather satellite	Study
★NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
★ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★PROJECT 3059	No contracts announced	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; study contract expected soon
SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this spring; transferred from ARPA to Air Force
★SATURN (NASA)	NASA Huntsville Facility, prime; Rocketdyne, Pratt & Whitney, propulsion; others not announced	Five-stage vehicle with 1.5-million-lb. clustered booster. Second stage to be cluster of four 200,000-lb. liquid hydrogen engines; third, two 200-K engines; fourth, four 20-K's; fifth, two 20-K's	New timetable; first static firing of two engines a success; full test late spring; first flight late 1961; first operational flight 1963 with 4th and 5th stages on booster; NASA plans to build 30 during 1960's
★SCOUT (NASA-Air Force)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Solid four-stage satellite launcher; 200-300 lb. payload in orbit	Air Force and probably Navy also to use for research; first test in April partially successful; AF test expected soon
★THOR-ABLE (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Early deep space booster; new Air Force upper stage called ABLE-STAR has start-stop capability	Sun orbit shot in Spring—nine months behind schedule. Only two shots left in program
THOR-DELTA (NASA)	STL, prime; IT&T, guidance; Rocketdyne/Aerojet-General/Allegany,prop.	Put 65-lb. satellite in orbit around moon	R&D; first flight early this year; to be used in ECHO and TIROS program
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; three launchings this spring; first launching in April a success; two more this spring scheduled
★TRANSIT (ARPA-Navy)	Johns Hopkins Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50 lbs.	TRANSIT 1B R&D satellite put in orbit April 13
TRIBE (ARPA)		Family of space launching vehicles	Planning
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	Studies
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; later XLR-99 engines to develop 50,000 lbs.	Five powered flights; one plane damaged in landing; second plane hit Mach 2 and more than 80,000 ft. Feb. 11; first X-15 has been accepted by the Air Force, turned over to NASA for testing at Edwards AFB
MISSILES & ROCKETS			
★ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
ASROC (Navy)	Minneapolis-Honeywell, prime	Surface-to-underwater; solid rocket torpedo; nuclear	R&D; operational Jan. 1961
ASTER (Navy)	Ford Instrument, prime	Anti-submarine rocket launched from surface ships; 30-35 mile range; marriage of TERRIER and SUBROC	R&D
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-mile range; liquid; nuclear	44 military launchings: 27 successes, 8 partial, 9 failures; 5 scientific launchings: 4 successes; 1 failure. Two operational at Vandenburg; 11 of 13 sites named
ARM (Air Force)	No contract announced	Anti-radar missile	R&D
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Eight launchings: 1 success, 7 failures; first successful flight April 14. Production program sharply cut back by Air Force.
BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-8 mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
★COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
★DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges	R&D; operational in FY '61
EAGLE (Navy)	Bendix, prime; Sanders, guidance; Aerojet propulsion	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow aircraft	Early R&D
★FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR-1D & GAR-2A & GAR-3 operational; GAR-4 & GAR-9 under R&D; GAR-9 work slowed; GAR-11 contract let
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development; Jan. 29 successfully intercepted Honest John, first known intercept of one tactical missile by another
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
★HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway; B-52 launched one in April after non-stop flight with it to North Pole from Florida
JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and used as AICBM target drone; 29 military launchings: 22 successes; 5 partials; 2 failures. One 15-bird squadron to be deployed in Turkey. Last R&D test shot launched Feb. 4
★LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; to be deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it
★LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	No contract announced	Surface-to-surface; nuclear	R&D
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
★MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on trucked vehicle	R&D
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Avco, re-entry vehicle; AMF, rail launcher	2nd generation ICBM; solid; mobile; nuclear; 3 stages	R&D. Expected to be operational by late 1962 and deployed in 1963; to be installed in hardened sites and made mobile on trains, possibly trucks; tethered full-scale test models successfully fired from silos; guidance systems successfully tested on rocket sleds at Holloman AFB, N.M. First base site named: Malmstrom AFB

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
MISSILE A (Army)	ARGMA to act as prime; six R&D contracts for components scheduled to be let soon	Surface-to-surface; 65-70 mile range; solid	Design studies
NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East
NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; claimed effective against air-launched air-breathing missiles	Rapidly replacing NIKE-AJAX
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands at the rate of about one a month beginning Aug. 26. Five launchings: 3 successful, 2 partial. Test shots in the Pacific against drone missiles planned in mid-1961. Administration has refused to okay Army recommendation to begin production.
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; solid; under 700-mile range; nuclear	R&D; to replace REDSTONE; first R&D launching Feb. 25 from Cape a success; 35 miles as programmed; second April 20, a success
★POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear	58 launchings of test vehicle; 40 successes; 16 partial; 2 failures; launched from surface ship Aug. 27, 1959; expected operational late in 1960; 1100-mile plus range vehicles under test at Cape Canaveral; all major milestones except launching from sub passed
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 20-lb. bazooka-type; IR guidance; solid; conventional	R&D
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe
REGULUS II (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronics, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D; expected to be operational mid-1960's
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new 1-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion	Air launched ballistic missile; more than 1000-mile range; solid; nuclear	R&D; to be purchased by British also
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract aimed at extending range and altitude
SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-50 mile range; solid; nuclear	R&D
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army.
★T-238 (Army)	No contract announced	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; expected deployment 1960 as primary armament of guided missile destroyers; production
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed about mid-1960
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 62 military launchings: 43 successes; 12 partial; 7 failures; 24 scientific launchings; 23 successful, 2 partial; 3 failures; R&D and "hot rod" advanced tests completed Feb. 29.
★TITAN (Air Force)	Martin, prime; Bell, Remington Rand, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear	13 launchings test vehicles: 9 successes; 1 partial; 3 failures. Five sites for 7 squadrons named; 14 squadrons planned
★TYPHON (Navy)	Applied Physics Lab, prime	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
★WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 224 m., apogee: 1573 m., period 114.8 min. (Discovered Van Allen Belt)
VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 409 m., apogee: 2453 m.
LUNIK I "MECHTA" (3245 lbs.)	Russia	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle.
VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 347 m., apogee: 2064, period: 125.85 min., inclination to equator: 32.88°.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory.
EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, perigee: 156 m., apogee: 26,357 m., period: 12½ hours, speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°.
VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 319 m., apogee: 2329 m.
LUNIK III (about 614 lbs.)	Russia	Launched 10/4/59, est. long life, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 341, apogee: 679.
DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months. perigee: 134, apogee: 1074.
★PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever. orbits sun, interplanetary radio communication satellite, passed 6 million miles 12:08 EST April 24.
★TIROS I (270 lbs.)	U.S.	Launched 1/4/60, est. useful life: 3 mos. perigee: 435 m; apogee: 468. Picture-taking weather satellite.
★TRANSIT 1B (265 lbs.)	U.S.	Launched 1/13/60, est. life: 16 mos. minimum; perigee: 233; apogee: 479. First R&D navigation satellite.
★DISCOVERER XI (1700 lbs.)	U.S.	Launched 1/15/60, est. life: brief; perigee: 109; apogee: 380; Air Force advanced satellite R&D vehicle.

Reprints Available

Since MISSILES AND ROCKETS MAGAZINE first started giving a bimonthly report on the status of space vehicles and missiles and rockets, numerous readers have asked about the availability of reprints. The following charges are established:

1 to 100 copies—20¢ each; 100 to 500 copies—15¢ each; 500 or more copies—10¢ each.

Requests for reprints should be addressed to:

Promotion Department, Missiles and Rockets Magazine, 1001 Vermont Avenue, N.W., Washington 5, D.C.

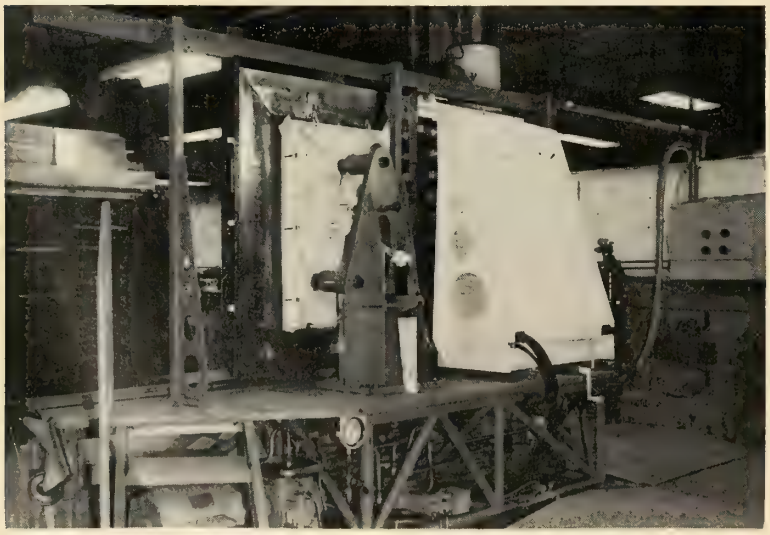
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Norair Method Slashes Brazing Time

Radiant honeycomb method to be used for making advanced missile panels; working time cut from 3-12 hours to 5-15 minutes



THERMOCOUPLES ATTACHED to the outer skin of a brazing envelope containing a stainless steel honeycomb sense temperature variations and instantly apply precise heat corrections during the brazing cycle.



ENVELOPE BEING chilled has just moved from between the banks of radiant brazing lamps at right. Movement from position to position takes 1.25 seconds.

by John F. Judge

Radiant honeycomb brazing, a process developed by Northrop Corp.'s Norair Division, will be the production method used under a new $956,447 Air Force contract for manufacture of stainless steel honeycomb panels for advanced aircraft and missiles.

The process, Nortobraze, reduces brazing time from three to 12 hours down to a range of 5 to 15 minutes depending on the complexity of the part involved. The essence of the Northrop method lies in banks of radiant quartz lamps capable of temperatures up to 6000°F in the brazing of panels in a varity of shapes, sizes and thicknesses.

The workpiece is enclosed in a gas tight envelope of soft auto body steel. Initially, two such steel sheets are stamped to fit the honeycomb configuration. The outer skin of the workpiece is placed on one of these sheets. A brazing alloy sheet is laid on next, followed by the honeycomb core and any solid inclusions. Another brazing alloy sheet, the second skin and edge members, if any, are applied in order. The closing auto body steel sheet is laid on the pile, vacuum and argon lines attached and the envelope is roll seam welded around the edges.

Air is purged from the envelope and argon gas admitted to a pressure of 500 mm Hg. The envelope is tested for leaks and a coating of heat-asborbent paint is applied. The entire piece is then positioned in the vertical brazing rack and the lamp banks moved into place on either side.

The workpiece is brought to a temperature plateau of 1725°F and held there for a period of time determined by the configuration, inclusioned solids and brazing mixture.

• **Uniform heating**—The temperature throughout the brazing cycle is rigidly controlled through a console containing six power control channels, each having a preprogramed function generator. The temperature cycle is plotted beforehand on graph paper and scanning devices within the function selectors follow the graph lines, actuating sections of the lamp banks. Thermocouples located in the envelope provide feedback to complete the loop.

These couples provide localized temperature control at all times during the cycle—maintaining uniform heating despite varying core thicknesses and solid metal inclusions.

When the heating cycle is complete, the envelope is moved to the chill dies and cooling begins in a matter of seconds. The dies, using either water or chemical refrigerants, bring the workpiece down to a temperature where it is dimensionally stable. Then the entire envelope, still filled with argon, moves through a heat treating process. After heat treating the envelope is cut open and the completely brazed panel is removed.

The framework holding the panels during the brazing cycle also shields the thermocouple terminals. A coating of highly reflective ceramic gold maintains near-room temperatures about these terminals—even though the quartz lamps are but inches away.

The current Nortobraze machine can accommodate panel sizes up to 2 x 3 ft. Thickness can vary from 0 to 6 in. The next machine being built will handle panels up to 4 x 5 ft. There is no real upper limit to the size of a Nortobraze process.

Besides the stainless steel family of metals, Nortobraze has been applied to titanium alloys and is adaptable to the niobium and molybdenum groups.

The specific contract just awarded is a production-type agreement, but the parts involved are more likely to be prototypes for some of the advanced concepts of the Air Force. The contract will be administered by the Manufacturing Methods Division of the Aeronautical Systems Division at Wright-Patterson Air Force Base.

Hoffman Hits New High In Solar Cell Efficiency

Silicon solar cells with a guaranteed 13% minimum efficiency are rolling off the production lines at Hoffman Electronics Corp., Los Angeles.

According to Hoffman, this is the first time such cells have been available on a regular basis. Furthermore, none of the currently orbiting satellites have solar power converters with efficiencies greater than 9%.

The increase in efficiency is the result of a production advance involving the addition of nickel-plated, solder-dipped positive contact strips to the surface of the cells. This innovation reduces the series resistance of the "P" layer of the cells, increasing the relative efficiency of each unit by about 15%.

As a direct result of this development, cells with 10% efficiency are being reduced 30% in price. The reduction is felt all down the line.

Biggest Hand-forged Aluminum Piece Made by Alcoa for Douglas Tunnel

The world's largest hand-forged aluminum mandrels are shaping the nickel nozzle liners for the new hypersonic wind tunnel at Douglas Aircraft Co.

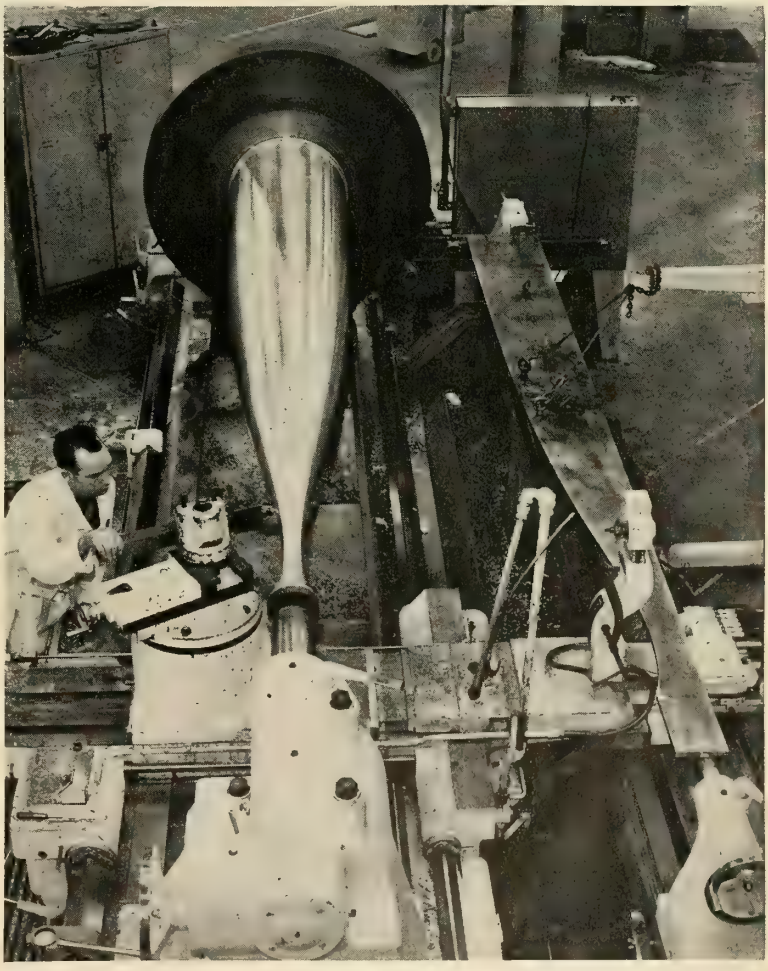
The first forging, produced by the Cleveland Works of the Aluminum Company of America, roughly resembled its final bottle-like shape and weighed 8230 lbs. After an initial machining operation by Hillcrest Crankshaft and Machine Corp., Titusville, Pa., Alcoa heat-treated and artificially aged the mandrel to achieve its best physical properties.

The 12-foot forging was finish-machined by Douglas to exacting diameter tolerances. The piece tapers from 24 in. at one end to 3 in. at the other with 0.001 in. tolerance attained at 1440 measuring stations.

A special electroforming tank at Bone Engineering Corp., Glendale, Calif., deposited nickel on the mandrel to a depth exceeding ⅝ in. The entire assembly was brought to sub-zero temperatures and—since aluminum shrinks more than nickel at the same low temperature—the mandrel separated from the coating.

The perfectly formed nickel liner remaining after withdrawal of the mandrel is ready for immediate installation in the Douglas Mach 6 nozzle.

Two larger mandrels from Alcoa will be required for the Mach 8 and Mach 10 nozzles. A 9650-lb. forging will be needed for the Mach 8 nozzle and an 11,900 lb. piece for the Mach 10 nozzle. All of the mandrels can be re-used.



FINAL MACHINING of the world's largest hand-forged aluminum piece is being performed by Douglas Aircraft Co. Produced by Alcoa, the forging served as a mandrel in the shaping of a nickel nozzle liner for the new hypersonic wind tunnel at Douglas.

Saturn Booster Bulkheads Pose Fabrication Problems

by Frank G. McGuire

MANHATTAN BEACH, CALIF.—Two methods of fabrication are being used by U.S. Chemical Milling Corp. to produce high-strength, lightweight bulkheads for the *Saturn* space booster.

The booster, developed by the Army Ballistic Missile Agency and now under sponsorship of the National Aeronautics and Space Administration, uses both 70 in. diameter and 105 in. diameter tanks.

Basic material for the bulkheads is Reynolds #5086 aluminum alloy. The components and their fabrication present problems not previously encountered by industry because of the size and close tolerances involved. These considerations prevented use of existing techniques for machining the parts.

The tankheads, being basically hemispherical, are ideal shapes for spinning, and this method expedited production while cutting tooling costs. A spun shape, however, has inherent departures from the optimum.

• **Special lathe**—The spinning process creates external surface waviness and thickness variations both radially and longitudinally. It was to overcome these disadvantages that U.S. Chemical Milling Corp. designed and built a special lathe specifically to machine the tankheads being produced for *Saturn*.

The lathe machines the entire outside surface relative to inside surface through a hydraulically actuated tracer valve and enclosed slave system. Thickness tolerances of ±0.005 in. are obtained in production through use of this method.

Physical properties are attained through work hardening. By controlling the process and breakdowns used and by effecting a considerable stretch on the final spinning operation, good ultimate and yield strengths are obtained.

For the 70 in. diameter tanks (which will form a cluster about a central 105 in. diameter tank in the finished vehicle), USCM begins with a workpiece of 100 in. x 100 in. #5086 aluminum alloy measuring 0.300 in. thick.

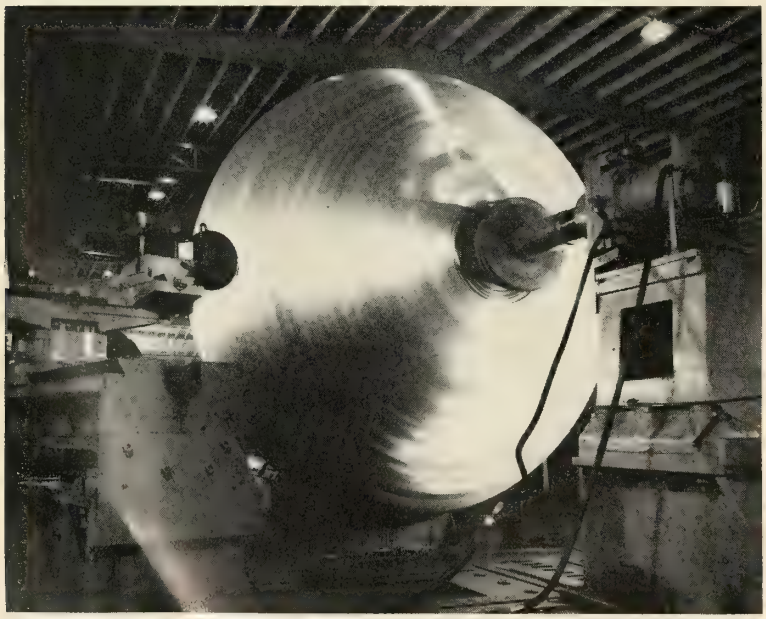
These tankheads are machined on the lathes at the firm's Manhattan Beach facilities, while other parts lend themselves better to pre-machining, then a subsequent overall removal through chemical milling to the final dimensions.

In the 70 in. diameter tankheads, the minimum thickness is 0.142 in. In a variable-thickness tankhead, chemical milling is especially effective because the thickness of the finished part is thinner than is practical to machine.

• **Reduction**—With this type of tankhead the circumferential band remains at 0.125 in. and the principal dome area is reduced to a minimum thickness of 0.020 in. These parts were first machined to a uniform thickness, then chemically milled.

The 105 in. diameter tankhead begins as a blank of material 135 in. x 135 in. and measuring 0.375 in. thick. The aft bulkhead of this central tank is eventually reduced to 0.230 in. overall, while the forward bulkhead is a variable-thickness component measuring a minimum of 0.156 in. near the center, tapering to a minimum of 0.230 in. in a circumferential band about two inches wide around the edges.

The use of this method is expandable so that required tapers in material thickness or the incorporation of radial bands of lighter or heavier gauge material can be accomplished.



FINAL TRIMMING operation on the 105 in. *Saturn* tankhead. Because of the size and tolerances involved, U.S. Chemical Milling Corp. built a special lathe to machine these tankheads.

Lockheed Weightlessness Simulator Being Built

The first insight into how a man will behave under the conditions of long periods of weightlessness in outer space will be gained through experiments with Lockheed's null gravity simulator.

The firm's Human Factors Research Laboratory at Marietta, Ga., has designed and is building the device that will permit close observation of subjects working and sleeping under the effects of weightlessness.

The simulator is actually a large cylindrical tank of water. The subject, equipped with breathing apparatus, will be entirely submerged. The entire simulator will revolve, creating a condition of weightlessness in the water that will closely resemble that of outer space. The spinning will eliminate the subject's sense of direction by confusing the otholith organs of the inner ear. The distribution of pressure by the water will remove the unidirectional pressure so characteristic of gravity.

While in this environment, the subject will perform a series of tests and operations similar to those which would have to be done in a spacecraft. Observers will be able to measure the subject's actions and reactions through instruments.

F. A. Cleveland, Lockheed Georgia Division's chief design engineer says that some of the more serious effects of weightlessness may not appear until after an extended time of exposure. Short time tests cannot achieve such results.

The simulator is also expected to find use as a training means to familiarize astronauts with null gravity conditions.

IT&T Group Plays Heavy Role at PMR

by Richard van Osten

A group of 150 civilian technicians is shouldering heavy responsibilities in the nation's polar-orbiting satellite programs and ballistic missile launches from the Navy's Pacific Missile Range.

They are employes of Federal Electric Corp. charged with operation and maintenance of electronic facilities at PMR's Naval Missile Facility, Point Arguello, Calif. (NMFPA).

Range support task was awarded to FEC, the service organization of International Telephone and Telegraph Corp., with a $1.4-million Navy contract in April, 1959.

• **Assignments**—The initial contract covers Phase I of FEC operations at NMFPA. This includes maintenance and operation of ground-to-missile telemetry; communications, including automatic and manual telephone equipment and four types of radio equipment—HF, VHF, UHF and microwave data link.

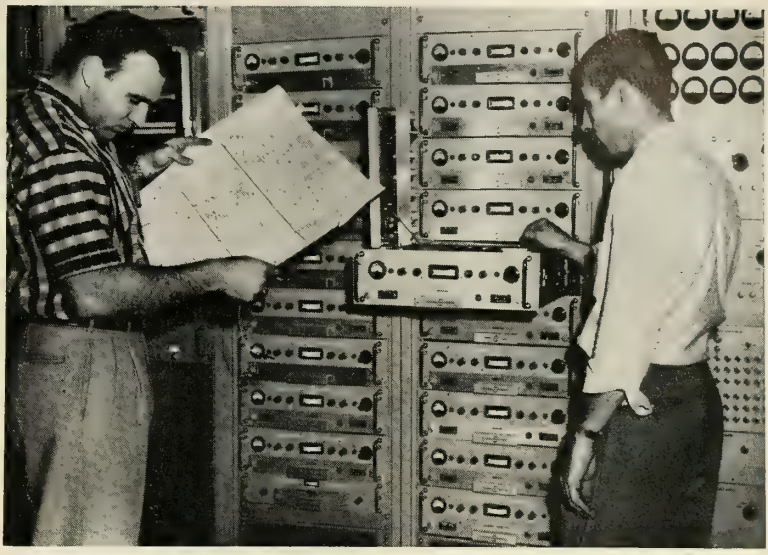
FEC is charged also with the critical job of monitoring daily all radio frequencies within the NMFPA area. Frequency interference control (FIC) detects and locates sources of radio frequency interference before, during and after a launch; assists PMR headquarters at Pt. Mugu in monitoring responsibilities assigned by the Federal Communications Commission; and provides needed information on satellite orbits as an additional monitoring function.

Instrumentation and range safety radar is operated and maintained by FEC personnel for missile tracking and impact prediction; air and surface surveillance and height finding of objects which might interfere with or be endangered by a launch operation.

For range safety, FEC functions include the post of range safety coordinator who must monitor all radar and range safety systems and select the best of available data for display to the missile flight safety officer. The latter uses the information to determine whether or not a destruct is required.

FEC personnel are responsible also for photo-optical equipment—fixed, calibrated-position cinetheodolites, mobile optical tracking units and related types.

Still another critical function charged to FEC is maintenance and operation of display equipment—radar indicators, manual and automatic plotting boards and status boards.



BIG GSE JOB is performed by employes of Federal Electric Corp., which has responsibility for maintenance and operation of electronic facilities at PMR's Naval Missile Facility, Point Arguello. Here two technicians check out telemetry equipment.

• **Three-ring circus**—First step in FEC action for a launch is receipt of instrumentation plans from PMR headquarters designating types and quantities required. Various FEC groups responsible for equipment to be used check it out and put it in the "ready" category.

FEC then receives an operation schedule and countdown procedure. When operations reach the countdown phase, three things happen. Or, as a FEC representative puts it: "All hell breaks loose in three ways at one time!"

The three functions line up as follows: range areas are cleared by surveillance radar and with Navy ships, aircraft and helicopters; the range user checks out the missile or vehicle and FEC's telemetry group reports to the user on the status of the signal; and all instrumentation is rechecked according to a prescribed countdown procedure.

When the missile or vehicle is fired, FEC personnel are about as busy as the proverbial paper hanger.

Telemetry groups record signals from the missile. Photo optics men track and photograph the launch and flight. Instrumentation radar crews track and record missile position. The range safety coordinator monitors and selects data to assist the missile flight safety officer. Operations and display personnel man radar indicators, plotting and status boards.

After the launch, crews collect data from each section, identify it, and transmit it to the Navy's data reduction center at Pt. Mugu.

• **Navy's chores**—What, then, does the Navy do? The answer is "Plenty!" as far as PMR is concerned.

As operators of PMR, the Navy retains overall responsibility for all missile operations over the range whether they be fired from nearby Vandenberg AFB or NMFPA. This includes range safety, impact prediction and tracking. On certain Vandenberg shots, however, "destruct" decisions may rest in the hands of an Air Force officer.

Navy personnel hold supervisory positions such as Range Operations Supervisor (ROS) who is assigned on a program or project basis in overall charge (less in-flight range safety) of operational phases of range support; Range Facilities Control Officer (RFCO) who is assigned to coordinate and report to all concerned on readiness of all facilities required for an operation; Missile Flight Safety Officer (MFSO) who represents the Range Safety Officer (RSO) and is responsible for execution of the "Range Safety Operational Plan" for a particular op-

eration; Surveillance Officer (SO) with functional responsibility in a particular geographic area of the range for a specific period of time or individual operation to exercise control of assigned aircraft, boats, air and surface radars display equipment and communications facilities.

Other positions with overall Navy responsibility include: Ground Safety Officer (GSO) who is charged with controlling the hazard areas during operations, including pad safety, movement of personnel and traffic evacuation of nonessential personnel from the ground hazard area, and surveillance of the Southern Pacific Railroad's right-of-way which extends the length of both Vandenberg and NMFPA; Pad Safety Officer (PSO) who monitors missile or vehicle preparation work involving use of hazardous materials or systems; Launch Control Officer (LSO) with responsibility for supervising accomplishment of all functions necessary in the preparation and countdown; and the Operations Conductor (OC) who represents the range user and is responsible for informing the RFCO and ROS of his time schedule and countdown progress, hold, cancellings, or incompleting the operation if objectives of the range user cannot be satisfied.

• **Expansion due**—FEC is heavily involved in all NMFPA projects other than tracking of *Thor, Discoverer* and *Atlas* launchings from Vandenberg. Among the more exotic support areas are the Atomic Energy Commission's HAS (High Altitude Sampler), *Sunflare,* a Naval Research Laboratory project to study solar flare phenomena; *Tumbleweed,* an AEC/Sandia Corp. project; *Tepee,* Office of Naval Research study of an aircraft and missile detection system. Future support operations will include *Titan, Samos, Midas* and Project *Mercury,* man-in-space.

FEC expects to add about 25% more personnel within the next few months as operations step up at PMR, and as FEC moves into Phase II of its NMFPA responsibilities.

The second phase will get under way in about 90 days. This will place all toxic fuel handling, ordnance handling and ground clearance facilities in the lap of FEC.

The ITT service organization does not fit in the same organizational spot as Pan American Airways in the Atlantic Missile Range. It might be described as a "little further down the line."

On the record, Navy Capt. William J. Sarcipno, commander of NMFPA, has praised FEC as a "fine example of military/industry teamwork." Off-the-record conversations with responsible Navy personnel at the facility also produced high praise for FEC's operations.

RCA Calls Transistorized EDP System 'World's Fastest'

LOS ANGELES—An electronic data processing system billed as "the world's fastest" has been introduced by the Radio Corporation of America. Dubbed RCA 601, the transistorized system is applicable to either business or scientific uses.

Unveiled simultaneously with the company's smaller EDP system, Model 301, the unit is designed to augment the year-old Model 501. RCA feels it has thus made available "the first total concept of computer service." All three are fully transistorized and modularly constructed.

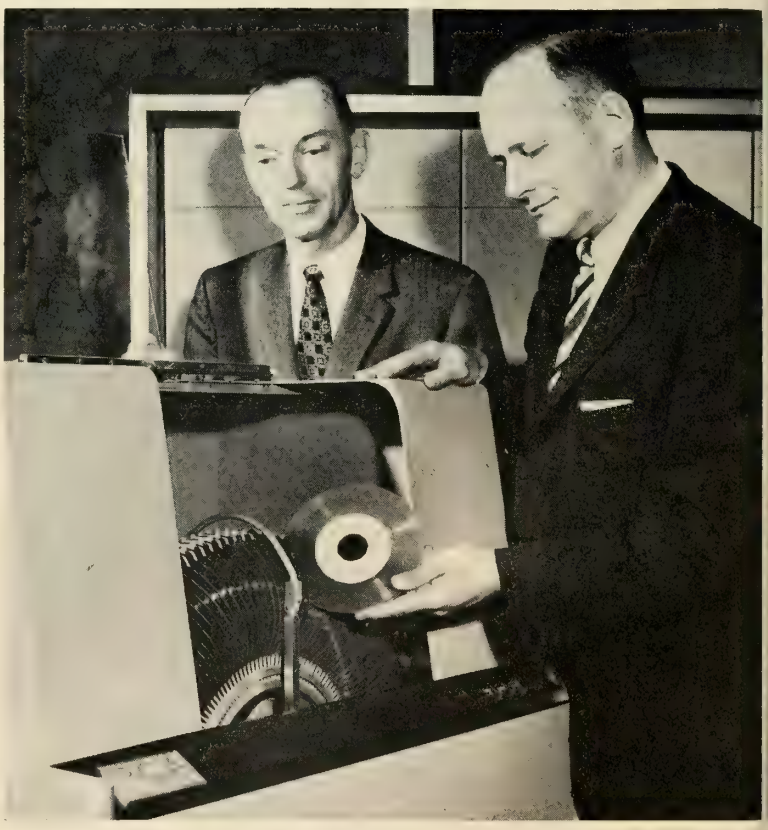
Expected to cost more than $20,000 monthly on a rental basis, the new 601 system incorporates a high-speed memory unit with a character capacity of 262,000 numbers, letters or symbols.

Up to 64 tape stations can be linked to the 601 for memory storage, each tape station having a capacity of 20 million data characters and a memory cycle of 1.5 millionths of a second. Tape speed is 120,000 characters/sec., and decisions can be made at the rate of 666,667/sec.

The "open-end" system design enables the user to expand capacity, increase functions or speed.

Its multi-programing provision has been designed to permit the automatic running of any number of independently written programs simultaneously, limited only by the system's total memory. In parallel processing or control operations, the system will operate on a job priority basis, as well as handling changeable priorities.

• **'Little brother'**—The "little brother" of the 601 is a computer designated model 301 and intended primarily for business applications. This unit rents for up to $9000/-month and can serve either as a com-



MAGNETIC MEMORY discs of the RCA 301 data processing system are examined by two RCA vice presidents, T. A. Smith, Industrial Electronic Products Div., and D. H. Kunsman, Electronic Data Processing Div. This is the first data processing system to use magnetic discs—similar to 45-rpm records—for its memory "storehouse"; it also can use magnetic tape on reels.

plete system or as an auxiliary to one of the larger models.

The basic processor of the 301 incorporates two sizes of core memory—either 10,000 or 20,000 individually addressable alpha-numeric characters—the program control, and a simplified control panel.

Other modules available for use with the basic system include card punch control, paper tape control, reader control, printer control, and simultaniety control. The last of these enables the computer to perform other functions while a memory search is being conducted.

The memory unit of the 301 contains 128 discs with magnetic recordings on both sides having a storage capacity of 4½ million data characters. As many as five of these can be utilized with the 301; discs can be interchanged rapidly or erased for re-recording.

Twelve magnetic tape memory units can be included in the 301 complex, each of which has a storage capacity of 4 million data characters. The unit can read tapes either forward or backward with equal speed.

The printer used with the 301 reads out data at the rate of 72,000 characters/minute. Variations in format and existing capabilities are under control of the stored program.

M-H Computer Within Price Range of Small Businesses

LOS ANGELES—A "new generation" computer billed as the most powerful available in the moderate-price field has been unveiled by the Datamatic Division of Minneapolis-Honeywell. The Honeywell 400 is expected to make high-speed electronic data processing feasible for most of the 10,000 top firms in the country.

Designed as a business computer rather than a scientific tool, the 400 performs up to 6000 operations per second, a rate as much as tenfold that of other computers in the same price range. Expected to rent for $8660 per month, the 400 is well below the $10,000-monthly rental figure generally considered to be the upper limit for small businesses, or subsidiary operations of large businesses.

The basic unit consists of a central processor, four high-speed magnetic tape units, a high-speed printer, and a card reader. Two additional tape units and a card punch can also be added as optional equipment.

• **High compatibility**—The new system, available for delivery in mid-1961, will be compatible with the larger data processing system, the Honeywell 800, enabling a firm to use it in conjunction with the 800 or to graduate from the 400 to the 800 with maximum ease and minimum disruption of processing.

High performance in the fields of storage and high-speed manipulation of large volumes of data make the 400 most efficient at sorting and maintaining files.

The 400 and 800 models use identical tape systems, printers and card readers. Information compatibility of the two models will also be complete, so that each system can read the data obtained and recorded by the other.

Core memory capacity of the 400 will be 1024 words of 48 bits each; this may be doubled, however, at customer option. Reading and writing operations may be performed simultaneously, and high-speed printing may be performed simultaneously with any other operation.

• **No 'baby'**—Transfer rate of information to or from the tape will be 64,000 characters or 96,000 decimal digits per second. Orthotronic control, a feature used on Honeywell's data processing systems, will detect and correct any errors in, or damage to, information recorded on the tapes.

The printer operates at 900 lines per minute, and the card reader handles 650 cards per minute.

The company emphasized that the 400 is not a "baby" machine. "Although not as powerful as the 800, this later system is nevertheless a complete and powerful system," according to Samuel D. Harper, Director of Sales Engineering for the Datamatic Division.

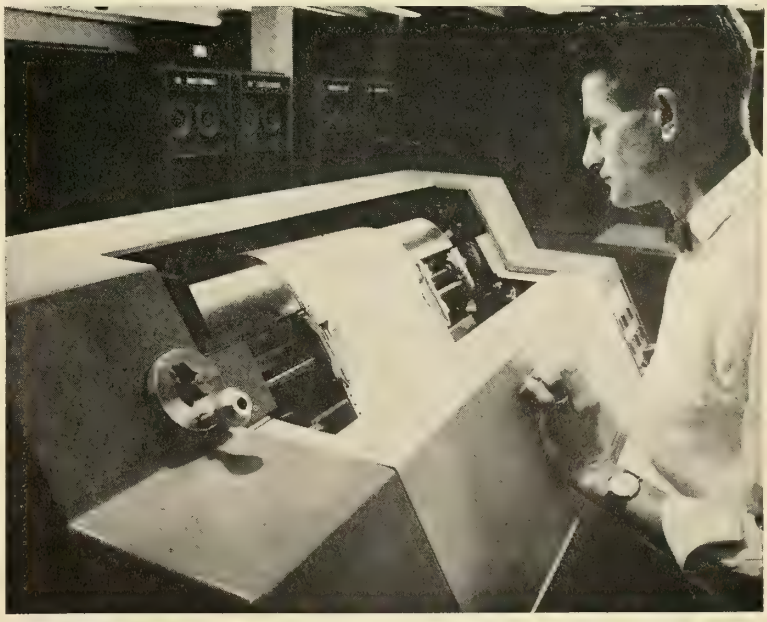
Minitrack Calibration Will Use Star Reference

Accuracy of Minitrack—worldwide satellite tracking network—will be checked by a new calibration technique using the stars as reference. The work is being done by Bendix Radio under a just-announced contract with NASA.

Calibration of the satellite tracker uses an aircraft in flight on a starlit night. A blinker light on the aircraft—actuated by a timed radio signal from the Minitrack station under test—is tracked by a precision camera on the ground. The aircraft's position in space is determined by its photograph against the background stars.

Simultaneously, a 108 mc radio signal is transmitted from the aircraft and recorded by the Minitrack station. The position of the plane as fixed by the radio signal received is compared against the starlit photographs and any errors of calibration are exposed.

Each Minitrack site is calibrated three times a year.



900 LINES a minute is the speed of the printer included in the Minneapolis-Honeywell Regulator Co. 400 high-speed electronic data processing system.





Honeycomb, a critical assembly device, is one of many research tools developed through the cooperation of Los Alamos scientists and engineers to enhance the Laboratory's constant quest for knowledge.

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Super-Accurate

NBS Uses Cesium Clock To Measure Frequency

Transmission of the world's most accurate radio frequency standard began last week at the National Bureau of Standards. Using the Bureau's new cesium atomic clock, the VLF (20 kc) broadcasts originate at Sunset Canyon, 20 miles west of Boulder, Colo.

Signals from the Sunset Canyon station—WWVL—may reach as far as Hawaii or even to New Zealand, but are not strong enough to provide good coverage over the entire globe. The Sunset station will serve as the pilot for eventual establishment of worldwide transmissions. The original signal will be used for research necessary before such service can be established.

The low-frequency waves from Sunset Canyon will follow the curvature of the earth with the ionosphere and the ground acting as upper and lower limits of a gigantic duct to guide the signals over the globe. Since the ionosphere will thus serve only as a boundary and not a direct reflector, it will have almost no effect on the speed of the waves. For this reason, the 20 kc frequency will provide a much more stable transmission than the presently used high frequencies of WWV and WWVH. Accuracies will be on the order of 100 times better.

Such ultra-precise standards, unknown a short time ago, are becoming increasingly necessary in the missile/-space age. Some uses: time coordination of missile and satellites tracking station recording; measurement of minute quantities of electrical and radio energy in basic research; as vital aid to progress in electronics.

The International Consultative Radio Committee (CCIR) adopted the proposed 20 kc frequency band in April 1959. Last December, the frequency was adopted by the International Radio Conference in Geneva for the International Telecommunications Union.

Guardite Co. Unveils New Space Simulation Chamber

LOS ANGELES—A hyper-environmental space simulation test chamber was unveiled at the recent Institute of Environmental Sciences conference here by the Guardite Co., a division of American-Marietta Co.

The spherical test facility permits simulation of altitudes up to 1.5 million ft. It is intended to test materials and components under space extremes of altitude, temperature and radiation.

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Thiokol Presses On-Site Loading

Lack of reliability and scale-up capacity make segmented solid rockets a 'dead end,' Wilhite maintains

by Jay Holmes

Reliability and scale-up capability are overwhelming considerations in favor of loading very large solid-propellant rockets at the launch site, a Thiokol Chemical Corp. official declared last week.

Bryce Wilhite, technical director at Thiokol's Utah Rocket Operations Center, maintained in an interview that logistic considerations would limit the growth of segmented rockets—making the concept a technological "dead end."

Wilhite did not specifically mention the current Air Force competition on a contract to study the feasibility of building a solid booster with 100-million-lb.-seconds total impulse. But his remarks had obvious bearing on the competition.

The six solid-propellant companies bidding are divided on how to fabricate and cast so large a rocket. Everyone agrees it is impractical to manufacture a whole rocket and transport it to a distant launch site. The reason is that the motor is simply too large for transportation by air, rail or truck. Although no one has given exact dimensions, it is generally assumed that the motor would be about 12 ft. in outside diameter and about 60 ft. long.

Thiokol and Rocketdyne Division of North American Aviation have proposed on-site mixing and loading. Aerojet-General Corp., Grand Central Rocket Co. and United Technology Corp., a recently formed subsidiary of United Aircraft, prefer building rocket segments at their plants and putting the segments together at the launch site. It is not known which approach is favored by the sixth competitor, Hercules Powder Co.

• **Reliability hurt?**—Wilhite contended that segmented construction automatically reduces system reliability by increasing the number of components. For instance, he said, if a rocket is made of six segments, each with a 95% reliability, the system reliability is the 6th power of 0.95—about 74%.

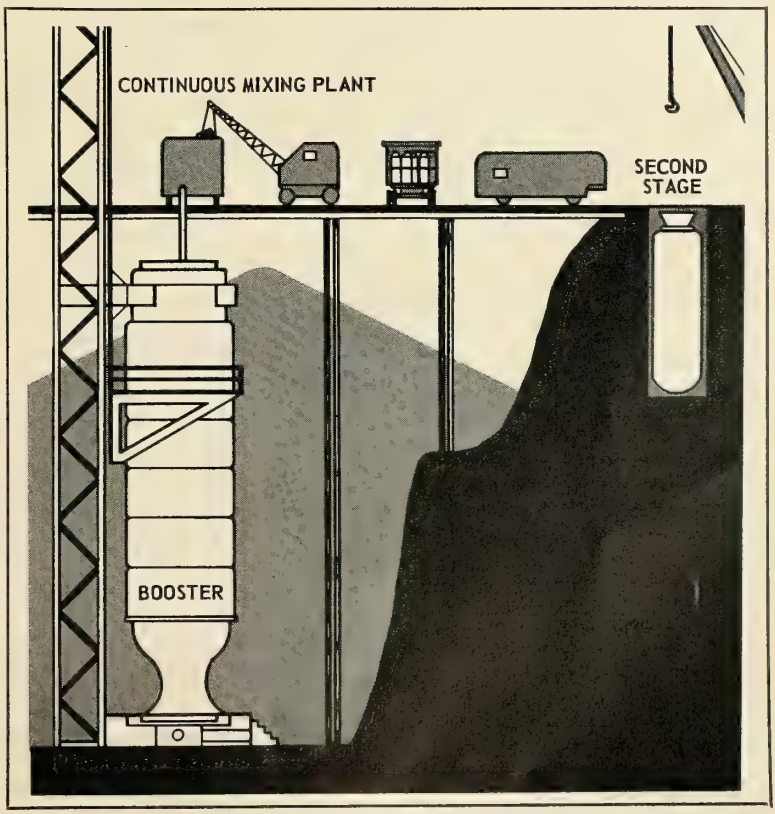
Further, he argued, reliability is reduced further by the impossibility of hydrotesting the rocket case. The propellant segment is cast into the cylindrical case segment at the plant and the segments are bolted or screwed together at the launch site. There obviously is no way to hydrotest the case with propellant in it.

The Thiokol official asserted that there are only two reasons for considering segmented rockets: ease of fabrication and logistics. So far as logistics is concerned, he said, the segmented approach is a technological dead end. It may be possible to transport segments and put together a motor one generation larger than those that can be transported by rail or truck, he said. But for the scale-up after this one, he asserted, it will be necessary to switch of on-site loading.

"The segmented rocket has absolutely no growth potential," Wilhite declared.

• **Experience**—Wilhite said Thiokol's Huntsville, Ala., division first worked on segmented rockets in 1952, when it was working on the *Loki* missile, which had a rocket 3 in. in diameter and 5 ft. long. The *Loki* motor had two segments, a cylindrical portion and a forward head. The head, filled with propellant, was fitted inside the cylinder.

In 1956, Wilhite continued, Thiokol built and fired a segmented motor 6 ft. in diameter. The rocket, called



BIG BOOSTER is loaded as it stands in firing position in this artist's conception, while the second stage waits in the pit to the right. Thiokol's continuous mixing plant was described in detail in the April 18 M/R (p. 28).

NASA to Be in Solid Booster Project

The Air Force will coordinate its Project 3059 big solid booster with the National Aeronautics and Space Administration, it was learned on high authority this last week.

Because of NASA's prime responsibility for developing big boosters, there has been considerable internal Air Force discussion about the appropriateness of sponsoring the development. The decision was positive—that there is a legitimate military requirement for supporting this advance in rocket technology and that the Air Force can take the first step without obtaining approval at the Department of Defense level or higher.

If a large solid rocket is proved feasible under the one-year study planned, the Air Force will go to higher authority before authorizing the next phase—a full-scale development program. During the first year, the Air Force will ask a NASA propulsion official to serve on a committee supervising the project.

Although no decision will be made until after the feasibility study, Air Force officials consider Dyna-Soar *a likely application. A solid booster has the usual advantage of rapid reaction and simplicity—important in any military weapon system.*

the "Big B," consisted of a head section, a main segment 4½ ft. long and a nozzle section.

It makes sense to fabricate the rocket case in segments and put the pieces together at the launch site, he said. Thiokol is convinced that the case should be built up from cylindrical segments, he added. This is because cylindrical weld seams introduce only half as much weakness as longitudinal seams.

Wilhite said he does not consider propellant physical properties a serious problem in design. He said he sees no need for internally reinforcing the grain, particularly when the booster is cast in a vertical, ready-to-launch position.

"The worst condition occurs when a rocket is lying on its side and cold flow of the plastic propellant puts the bond in tension. We ran slump with rocket engines 31 in. in diameter lying on their side for five or six years without ill effects," he said.

• **Loading**—On-site loading is best accomplished with the use of a mobile continuous mixing and loading plant. Wilhite noted that Thiokol has developed a pilot facility for a continuous mixing process at the Army's Longhorn Ordnance Works at Marshall, Tex.

Premixed fractions of the propellant would be delivered to the site in self-discharging transfer containers. The fractions would be in the form of pastes or slurries with very long shelf life, since oxidizer and fuel elements would be kept separate.

The mixing machine would feed directly into the rocket case. Wilhite said it might be wise to launch from near a steep hill or cliff, so as to simplify the layout as shown in the accompanying artist's conception.

He made no estimate of the cost of such an installation. But he said the expense for the continuous mixing and loading plant would be small in comparison with the overall cost of the launching facility.

• **Curing**—After loading, the propellant can be cured by piping hot air through or by wrapping the case with electric blankets. Thiokol studies indicate that the most practical method of curing is a controlled-zone approach —under which the mass would be cured in relatively small sections. If such a large mass were cured at once, it would develop excessive stresses and strains during contraction on cooling, which would probably produce propellant faults.

After curing, the core and casting fixtures are removed and the grain is trimmed to the desired size. Since propellant is poured from the forward end, the head must be attached after curing. This attachment will have to be made with bolts or screws, since it is obviously impossible to weld.

For materials handling, the principal items required are self-discharging transfer containers to feed the propellant ingredients to the mixing equipment. Thiokol said several types of pressure feed tanks on the market can be modified for this purpose.

Special mobile cranes or elevators and miscellaneous feeding and transfer equipment will also be needed for propellant handling. The operation can be made mobile and self-sufficient by installing everything on tractor-trailers, lowboys, refrigerated vans or trucks.

Some additional minor pieces of equipment will be required, Thiokol said, but it cannot be described until after completion of a detailed design project.

Secrecy, Fierce Competition Mark Rocket Case Making

Solid propellant rocket cases, a market that may approach a billion dollars in the next half-decade, make up one of the most fiercely competitive and secretive areas in the missile-space business.

The competition is wide open because there are thousands of companies in the metal and metal-parts trade who are qualified or who think they are qualified. And, with the recent interest in plastic rockets, hundreds of plastics manufacturers are potential new competitors.

These are the findings of a special M/R survey of companies in the field.

The rocket-case business is secretive for many reasons. Military security plays a prime role, of course. The desire to protect companies' proprietary secrets is another factor. A third is the reluctance of propulsion contractors to identify their suppliers.

The rocket-case business is lucrative because, in the missile age, it is a piece of hardware that still can be manufactured by mass production methods. If you can meet the tolerances and deliver in quantity, you can earn a nice piece of change.

However, there is a great deal more to the "ifs" than meets the eye. A few large companies suffered very bloody noses in the early stages of the rocket-case business. Some smaller ones lost their shirts.

• **Confinement**—The engineering problem—steering between the Scylla of too much dead weight and the Charybdis of too little strength—leaves little room for maneuver.

For in the solid rocket, the rocket itself is the combustion chamber. The entire case—not just the throat area as in a liquid rocket—must withstand the tremendous pressures of the expanding gases. Thus, the solid rocket has more dead weight than the liquid engine.

As solid rockets have grown bigger, the problems have gotten worse. Currently, the most headaches—and consequently the most money—are in the cases for the Air Force *Minuteman* ICBM, the Navy's *Polaris* fleet ballistic missile and the Army's *Pershing*.

Polaris cases have been in production for several months. The Navy plans to bring the submarine-launched weapon to operational status by the

end of this year. Next in line will be the Army's *Pershing*, which may go into production before the end of the year. *Minuteman* still has at least another year to go.

A fourth big solid missile, whose status is still unclear, is the Army's antimissile *Nike-Zeus*. It will be at least a year before the *Zeus* goes into production.

• **Those involved**—Five companies are involved with the production of *Polaris* cases. They are Aerojet-General Corp., Norris-Thermador Corp., Kaiser Metal Products Inc., A. O. Smith Corp. and Excelco Developments Inc.

Excelco—together with its companion company, Newbrook Machine Corp.—manufactured most of the cases while *Polaris* was in the development stage. Shortly before the missile went into production last year, Aerojet-General, the propulsion system contractor, acquired the Rheem Manufacturing Co. of Downey, Calif.

Aerojet centered its case manufacturing in the Downey plant. However, to meet the Navy's requirements, Norris-Thermador, Kaiser and Smith, which had been making development cases, were given production contracts.

The amount of money involved and the production rate are classified. The Navy declines even to disclose just how much of the current year's $876 million *Polaris* budget is going for cases.

Pershing cases are being made by Pratt & Whitney Division, United Aircraft, and Young Development Division of Hercules Powder Co. Douglas Aircraft Co. makes *Nike-Zeus* cases.

The *Minuteman* situation is complicated by the competition for propulsion contracts. Thiokol Chemical Corp., sole source on the big first stage, has at least four sources for cases: Allison Division of General Motors, Solar Aircraft Division of International Harvester, Pratt & Whitney, and Curtiss-Wright.

On the second stage, Aerojet has been chosen as primary source and Thiokol is providing a limited technical backup. Aerojet's Downey Division and Lycoming Division, Avco Corp., are providing Aerojet's cases. Thiokol obtains cases from Allison and the Rocket Engine Section of the General Electric Co. It is understood that Allison plans a proposal to Aerojet on the second stage too.

Aerojet and Hercules Powder Co. are in competition for the third-stage contract. Both are making their own cases. Aerojet is also obtaining development cases from Lycoming, Pratt & Whitney, General Electric, Allison, Solar and Curtiss-Wright.

• **Techniques**—Manufacturing techniques will probably vary widely on the large missiles, depending on the time the production run begins and the urgency of the program. The earliest method was "roll and weld" as in the production of aircraft bodies. It was a natural method to be adopted, since many rocket contracts have been awarded to aircraft manufacturers.

Some development companies achieved outstanding results with this method. Industry spokesmen often express amazement at Excelco's success.

According to metallurgical theory, the roll and weld method introduces a weakness in the longitudinal weld seam. The theory is that the crystal structure of the metal is disturbed by the welding, which heats the metal unequally.

Spokesmen for Excelco dispute the theory vigorously. A. J. Newman, Excelco vice president, shows visitors welded cases hydrostatically tested to failure. In every case, the burst is away from the seam. It is a question of getting welders who know their business, Newman says.

To avoid the problem of the longitudinal seam, manufacturers are experimenting with several processes involving seamless cylinders. Some are starting from forged rings and spinning or flow-turning the rings into cylindrical shape. The head is welded on. This does not introduce as much weakness because there is only half as much strain across a circular weld as across a longitudinal weld. *Pershing* cases will probably be made without a longitudinal seam.

But the use of forged rings and spinning equipment is expensive, parthe *Minuteman* first stage. Thiokol is investigating many approaches in an effort to find a manufacturing method that will provide cases of the necessary strength at minimum cost.

• **Downhold**—Keeping costs down is especially important in the *Minuteman* program because the low cost of solid rockets was one of the main factors involved in the Air Force decision to develop a third ICBM.

In *Polaris* manufacture, a longitudinal seam is used but it is reinforced. The case, 54 in. in diameter, is .220 in. thick. Across the weld, this is reinforced to a thickness of .280 in. to insure complete reliability.

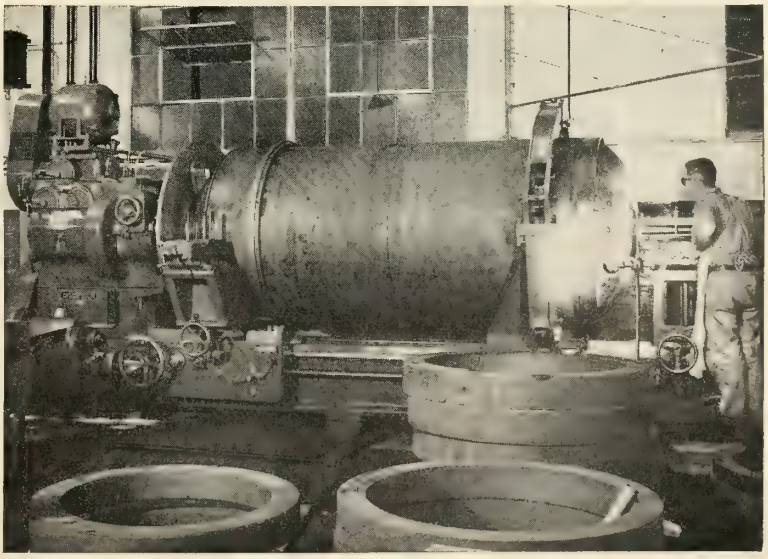
A. O. Smith Corp. reports it has manufactured more than 80 first-stage *Polaris* cases with only one hydrostatic test failure on the longitudinal seam. The failure, in a case without weld reinforcement, was attributed to a human error in reading a radiograph.

In manned aircraft, welding design normally calls for a 15% decrease in strength across a weld. The reinforcement adds enough metal to increase strength by about 25%.

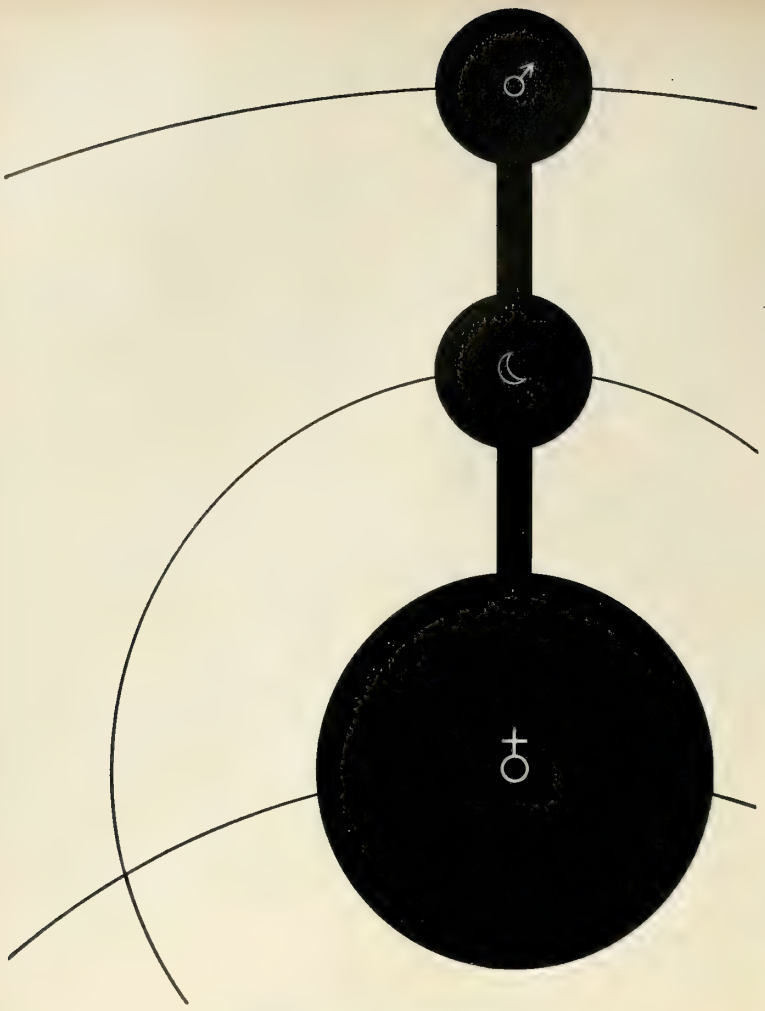
• **Conservatism**—The steel used for *Polaris* cases is a slight modification of AMS 6434, designated by Aerojet as M255. It is heat-treated to a 0.2% offset yield strength of 190,000 psi.

This is a very conservative design, since AMS 6434 steels are considered capable of heat-treating up to 210,000 or 220,000 psi yield. The cases are tested at 1150 psi proof pressure, which imposes a stress of 145,000 psi.

The *Polaris* chamber pressure is classified. However, it can be assumed it is lower than the 1150 psi proof



POLARIS **CASE is shown in production at the Vernon, Calif., plant of Norris-Thermador Corp. A horizontal lathe is machining the outer surface.**



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pressure. This adds another level to the conservative design: The chamber pressure is lower then the proof pressure; the proof pressure stress is lower than the heat-treated strength of the metal; the heat-treated strength is less than the maximum.

The production methods at Norris-Thermador are typical of the methods used for making *Polaris* cases. At its Vernon, Calif., plant, Norris-Thermador uses rolled sheet, plate and rough forgings in producing first and second stage cases. Welding is performed with the use of a tungsten inert gas head to protect the steel from oxidation.

Case heads are formed on a 6000-ton Lake Erie hydraulic press, welded to the sub-assembly and machined to final critical dimensions. The units are delivered to Aerojet separately, but with closures attached.

The case is heat-treated after the head and closure are welded to the body sub-assembly. This is done in a gantry-type furnace featuring a vertical, drop-bottom construction and an oil-quench pit. At A. O. Smith's Milwaukee plant, the heat-treat quench is in molten salt.

Another machining follows the heat-treat. Then the case is hydrotested. Complete final machining and final inspection wind up the production.

The *Polaris* specification calls for machining welds before and after reinforcement. Some engineers have questioned this requirement on the ground that the machining introduces weakness into the weld area. As far as is known, *Polaris* is the only major missile program that requires machined welds. The reason is classified.

Chutes, Solid Rockets To Help Recover *Saturn*

A combination of parachutes and solid-propellant retro rockets will be used to recover the *Saturn* booster, Dr. Wernher von Braun says.

After a 200-mile trajectory from Cape Canaveral, the booster will enter the atmosphere at about Mach 5, Von Braun has told the House Appropriations Subcommittee.

The recovery equipment and the operation for recovering one booster will cost about $250,000, Von Braun said, and the value of engines and other hardware recovered will be much greater.

The booster will go through a cluster of parachutes to bring it down to the water at low speed, he explained. At the end of a 100-ft. line will be a fuze that will be ignited on contact with the water. The fuze then fires eight rockets to counteract the remaining downward velocity and the booster eases into the ocean.

Ocean Research to Get $60 Million

Government plans to build ships and laboratories, develop research tools and recruit scientists

by William Beller

For the past two weeks the problems of oceanography have been gone over in congressional hearings relative to bills pending in both the Senate and the House. What these hearings mean is that the government is thinking of spending about $60 million a year for oceanographic research.

Late last month the Senate's Committee on Interstate and Foreign Commerce held hearings on the bill, the "Marine Sciences and Research Act of 1959," which drew heavily for recommendations from a report by the National Academy of Sciences-National Research Council's Committee on Oceanography. The Senate committee seemed favorably disposed towards the bill and there is a chance that it will be brought to the floor during the present session of Congress.

On the House side, an oceanographic bill identical with the Senate's is resting in the Merchant Marine and Fisheries' Subcommittee on Oceanography. There is little chance that this one will see the floor of the House this session. There were also oceanographic hearings last week before the House Space Committee, which were pegged to an Overton Brooks bill, but few people believe that this particular work has any significance.

• **What's important**—Whether or not legislative action is taken on any of the oceanographic bills during this session of Congress is not believed to be too important. What is important, according to a member of the Subcommittee on Oceanography, is that congress realize the importance of oceanography, that soon the body will be appropriating money for the work, and that meanwhile various government agencies already have the power to increase the tempo of their oceanographic studies and will be doing so as fast as they can.

The purposes of the identical Senate and House bill is "to advance the marine sciences; to establish a comprehensive ten-year program of oceanographic research and surveys; to promote commerce and navigation; to secure the national defense; to expand ocean resources; to authorize the construction of research and survey ships and facilities; to assure systematic studies of effects of radioactive materials in marine environments; to enhance the general welfare; and for other purposes."

The organizations listed in the bill to help in this work and to receive appropriations for their help are the National Science Foundation, Division of Marine Sciences; various activities in the Department of Commerce; the Department of Health, Education, and Welfare—Office of Education; the

Summary of Recommended Budget for New Oceanographic Activity by Agency

(Report of Nat. Acad. of Sc.-Nat. Res. Council)

(millions of 1958 dollars)

ar	Navy	Coast and Geodetic Survey	Bureau of Commercial Fisheries	Maritime Administration	Nat. Sc. Foundation	Office of Education	Atomic Energy Comm.	Bureau of Mines	Total
60	28.78	5.83	7.97	5.45	6.40	0.50	3.08	0.35	58.36
61	28.83	6.09	13.86	3.80	8.35	0.50	2.95	0.25	64.63
62	30.40	9.75	12.83	1.65	12.65	0.50	4.35	0.25	72.38
63	33.80	8.70	12.42	....	11.60	0.50	2.95	0.25	70.62
64	35.22	9.30	11.75	....	11.98	0.50	2.95	0.25	71.95
65	32.68	9.20	15.03	....	13.32	0.50	2.95	0.25	73.93
66	27.45	9.88	12.38	....	14.08	0.50	4.35	0.25	68.89
67	20.36	6.43	12.20	....	14.22	0.50	2.95	0.25	56.91
68	20.36	6.43	12.37	....	14.22	0.50	2.95	0.25	57.08
69	20.36	6.43	12.35	....	14.22	0.50	2.95	0.25	57.06
tal	278.24	78.04	123.16	10.90	121.04	5.00	32.43	2.60	651.41

Summary of Recommended Budgets for New Oceanographic Activity

(Report of Nat. Acad. of Sc.-Nat. Res. Council)

(millions of 1958 dollars)

ar	Education and Manpower	Ships	Shore Facilities (Research)	Shore Facilities (Surveys)	New Devices	Radioactivity in Oceans	Resources	Total
60	0.80	39.80	1.50	0.76	7.40	3.08	5.02	58.36
61	0.80	40.45	2.70	1.52	9.50	2.95	6.71	64.63
62	0.80	45.30	3.90	3.00	9.60	4.35	5.43	72.38
63	0.80	35.95	6.60	4.50	10.90	2.95	8.52	70.22
64	0.80	33.65	10.50	6.00	10.50	2.95	7.55	71.95
65	0.80	29.00	12.60	7.50	10.50	2.95	10.58	73.93
66	0.80	20.55	13.50	8.26	10.50	4.39	10.93	68.89
67	0.80	10.45	13.20	8.26	10.50	2.95	10.75	56.91
68	0.80	10.45	13.20	8.26	10.50	2.95	10.92	57.08
69	0.80	10.45	13.20	8.26	10.50	2.95	10.90	57.06
tal	8.00	276.05	90.90	56.32	100.40	32.43	87.31	651.41

Atomic Energy Commission; and the Navy.

The bill asks for a coordinated, long-range program of oceanographic research similar to that recommended as a minimal program by the Committee on Oceanography of the National Academy of Sciences-National Research Council. This program lists the following needs:

• Building modern, oceangoing ships for scientific research, surveys, fisheries exploration and marine development.

• Building laboratory and shore facilities adequate to service and supplement the research and survey fleets.

• Developing new and improved research tools, instruments, and techniques including bathyscaphs and other manned submersibles, manned and unmanned deep ocean buoys, modified icebreakers, acoustical equipment and telemetering devices, current meters, direct density, turbulence and radioactivity measuring devices, biological sampling instruments, precision salinometers and echo sounders, magnetometers, and deep sea underwater cameras.

• Recruiting prospective oceanographers from among undergraduate students of science, and facilitating their advanced education through a fellowship program.

• Getting more knowledge about the habits and use of marine life.

Establishing a national oceanographic records center to disseminate oceanographic and related data.

• Developing international cooperation in the marine sciences.

• **Ships & planes**—The engineering needs for ocean exploration were brought out in the National Academy of Sciences-National Research Council's "Oceanography 1960 to 1970," as well as by witnesses at the Senate hearings. Such needs were in large part based on ASW requirements.

More oceanographic research ships were asked for, ones uniquely designed for their missions. It was said that those that the country does have are makeshift, obsolete and uneconomical to operate.

A vigorous program aimed at developing manned submersibles was asked for. These craft should be able to get down to the bottom of most of the ocean and make whatever measurements and studies are needed there.

There is need for open-ocean manned research platforms which are stable and can remain in place so that time studies can be made.

A major program is needed to develop anchored and drifting buoys for getting space and time coverage of ocean characteristics.

The Academy says that it seems likely that aircraft can be used effectively for some research and surveys on the open ocean, particularly for studies involving the joint problems of oceanography and meteorology. Nearly all laboratories will need single-engine planes; several will need twin-engined amphibians; some will need four-engined commercial-type aircraft.

• **Further suggestions**—Here are other recommendations made:

Instruments should be developed for survey work, which are more accurate, effective and trouble-free than those now in use. Specialized devices such as Loran C, inertial navigation equipment, gravity meters and stable platforms should be made available for research as well as surveys as soon as possible.

A major program aimed at developing new high-seas engineering techniques should be started. Restricting our work are our limited abilities to handle heavy equipment at sea and to conduct operations such as drilling and bottom sampling of the ocean floor.

Machine aids to computation and data storage have much to offer and should be looked into for oceanographic applications.

High-pressure facilities to permit controlled physical and biological experiments in the laboratory are needed.

Efforts should be made to secure the active participation of private industry in the development and manufacture of new devices and instruments for oceanographic research and surveying.

Navy's Morris Dam Spotlights Undersea Guidance, Control

Underwater antics of missiles and torpedoes are under close Navy study.

Special facilities at Morris Dam near Azusa, Calif., may provide solutions to difficult problems of guidance and control of missile after water impact and entry. The research and development program is looking also for improved torpedo vehicles and techniques.

The site is equipped with a one-of-a-kind variable angle launcher (VAL) to simulate almost every possible water entry angle. Missile nose cones and system components are fired into the 160-ft.-deep lake by a compressed air system through 300-ft.-long tubes. Small subsystems and components are usually mounted in Mark 25 torpedos left over from World War II.

Principal use of the VAL system is to determine what happens when a missile hits the water's surface. If the test involves components only, effects of g forces during water entry are evaluated. Considerable time is devoted to studies of the minimum angle at which a missile can hit the water and follow through on its mission without "skipping" across the surface like a flat rock.

A second area of investigation involves research in water entry velocity. This approach varies considerably between test missiles, but prime purpose is to achieve configurations with optimum velocity and without danger of structural damage.

Third main study area at Morris Dam is verification of model-based computations as to underwater trajectory and the relationship of the trajectory to structural demonstrations.

Data are recorded by high-speed motion picture cameras and hydrophones. Evaluation of test results is made at the Naval Ordnance Test Station, Pasadena Annex, with optical, audio and computer equipment. The Pasadena Annex, like Morris Dam, is an adjunct of the Naval Ordnance Test Station at China Lake, Calif.

Test vehicles may be designed to float after launch. This provides ease of recovery. If the vehicle sinks, however, electronic "queening" search gear is used to locate the test object. Ten Navy divers are on hand to aid recovery which can take days if the vehicle sinks into the deep silt of this typical foothill lake.

Other test facilities include a nose cone water entry device. This unit, using huge shock cords as propulsion, operates exactly like a giant slingshot—slamming the nose cones into the water from about 200 ft. over the surface.

The Morris Dam site also has a propulsion research area for static firings of both solid and liquid propellants.

About 50 scientists and technicians, in addition to the divers, are assigned to the site on a permanent basis.

Hydrofoils Entice Navy, Maritime Administration

Succumbing to the lure of 100-knot surface skimming, the Navy has sent out requests for bids on an operational 115-ton hydrofoil boat and the Maritime Administration has awarded a contract for a 60-knot, 80-ton craft to Dynamics Developments Inc., an affiliate of the Grumman Aircraft Engineering Corp.

IRE-ARS Conference Has Good Panels, Poor Exhibits

CINCINNATI—Graced by the presence of some of America's top scientists, the 14th Annual Joint IRE and ARS Spring Technical Conference on electronic data processing and space technology drew an undeservedly small attendance here.

Although its dull and unimaginative exhibit hall warranted (and received) slight attention, the panels drew interested and active audiences during the two-day meeting.

Chaired by such stalwarts as Avco-Crosley's Dr. George Bruck and J. C. Elms (vice president and general manager), IBM's R. G. Connihan, University of California's Dr. Joseph Kaplan, M.I.T.'s Dr. Charles S. Draper, Sperry Rand's T. H. Bonn and Maj. Gen. M. C. Demler and Col. J. Paul Stapp of the Air Force, the eight panel sessions were informative and well directed.

Rocketdyne Uses Dry Ice To Cool Propellant Mix

Dry ice is being used to cool and speed the processing of solid propellant, Rocketdyne Division of North American Aviation reports.

At Rocketdyne's Solid Propulsion Operations in McGregor, Tex., the company disclosed recently, process engineers found that dumping dry ice into the propellant mix reduces mixing time by at least 30% and makes it possible to cut reject rates by as much as 20%.

Here is why: Propellants with a high burning rate must be mixed very slowly because heat buildup in the mix necessitates periodic stops for cooling. Previously, water was circulated through the mixer jacket at a temperature of 40°F. Despite this, the mix temperature would climb above 155°F.

By dumping 50-lb. batches of crushed dry ice directly into the mix, Rocketdyne engineers reduced the temperature of a 450-lb. mix to about 80° each time. A total of 200 lbs. of dry ice was used with each batch.

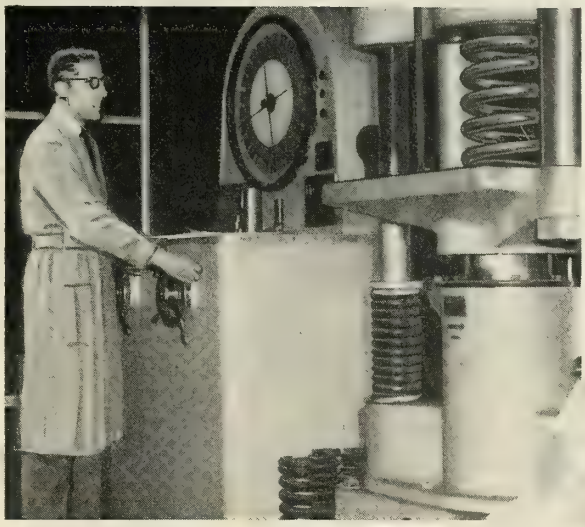
There was no contamination of the propellant—the dry ice all bubbled away harmlessly as carbon dioxide gas.

Stauffer Produces New High-Energy Oxidizers

Stauffer Chemical Co. has begun pilot-plant production of two new high-energy oxidizers, nitrogen trifluoride and tetrafluoro-hydrazine. The compounds are useful by themselves or as building blocks for more complex compounds, Stauffer said.

Reliability in SPRINGS

for Shock-Mitigation Problems

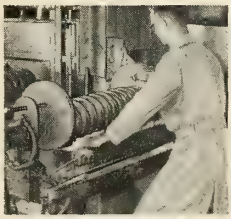


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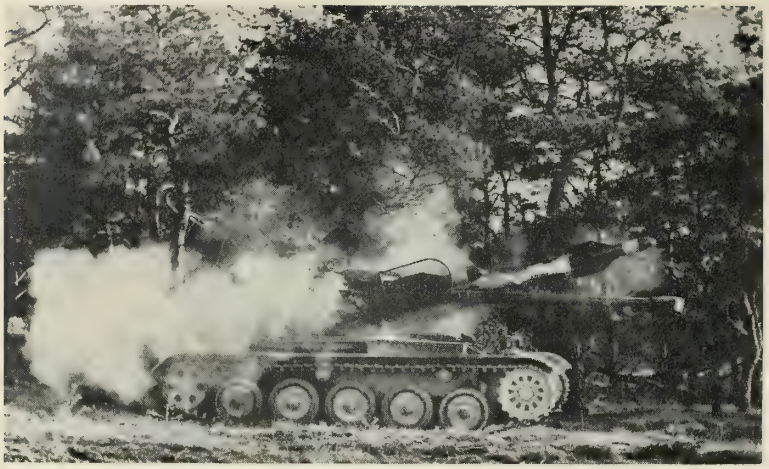
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GE May Get License for Nord's *SS-11B*

General Electric Co. is expected to be awarded a license shortly to manufacture the Nord *SS-11B* antitank missile.

Details of the licensing arrangement were still being worked out last week, M/R was informed. The *SS-11B*, which closely resembles the *SS-11* shown being fired from a tank above, is aimed by remote control and eliminates the wire guidance of the *SS-11*.

In a development Nord calls "human sense control," the missile operator employs a pair of binoculars containing infrared cells sensitive to the heat impulses emitted by the exhaust of a jet tracer in the missile. Trajectory is automatically calculated in a transistorized fire control box worn on the operator's belt and fed to the missile's guidance. The flight path duplicates the line of sight course in the cross hairs of the binoculars.

The *SS-11B* has a minimum range of 100 yards compared to 550 yards for the *SS-11*. Effective maximum range is 2.2 miles for both versions of the missile.

If the license agreement goes through, it will be the third Nord missile to be produced under license in the United States. The French company recently licensed Bell Aircraft to produce *CT-20* and *CT-41* drones.

British Report On R&D Funding Trend

The British Government's Department of Scientific and Industrial Research estimates that of the $830.7 million spent during 1958 on research and development by British manufacturing industry, $280 million was spent by the missile and aircraft industry. In fact, about 80% of the defense contracts for research and development were awarded to the missile, aircraft and electrical engineering industries.

The Department lists the "cost per qualified worker in research and development" in various industries. The missile and aircraft industry worker heads the list at $86,136, with the automobile industry second, a good way behind, at $55,378.

An interesting table compiled by the Department of Scientific and Industrial Research is one showing "research and development expenditure compared with net output" (defined as "the value added to materials by the process of production, including the gross margin of any merchanted or factored goods sold"). The missile and aircraft industry's net output is given as $783.7 million: the research and development expenditure, $280 million, represents 35.7% of this figure. The next industry on the list, electrical engineering, shows a percentage of 11.9.

• **R&D doubles**—The Department of Scientific and Industrial Research states in its report: "In 1955 it was estimated that nearly two-thirds of expenditure on research and development in manufacturing industry's own establishments was provided out of defense contracts. In 1958, the proportion was less than half, so that expenditure on civil research and development has approximately doubled between 1955 and 1958."

The British budget for 1960-6 provides for an increase in the amoun of money allocated to the Ministry o Aviation for research and developmen during 1960-61 of $23.8 million, o about 4%. Of the total ($566,020,000) "research and development work b industry" will account for $434,170, 800, an increase of $14 million, o 3½%. Most of the balance is mad up by allotments to British Govern ment research establishments, payment to Australia in respect of the Woomer range and "assistance to the develop ment and proving of transport aircraft.

More French Vessels To Be Armed With Missile

The last of eighteen 2700-ton escorters launched for the French Navy will be equipped with *Malafon* an 11-mile range anti-submarine mis sile, instead of the antiaircraft missile previously indicated by the French.

Spokesmen for the French Navy have announced that it will reques in the Defense program law now be ing prepared, the construction of fou or five missile cruisers (5-ton) an of the prototype of new escorters whic also will be armed with missiles.

RAF Medical Research Has 100,000-ft. Ceiling

LONDON—Although Great Britai is putting a great deal of money int new equipment and expansion at th RAF Institute of Aviation Medicin research facilities for space medicin are not included in the program, even contemplated.

Equipment at the Institute is d signed for experiments in human ascen up to altitudes of 100,000 feet—bu not beyond. Present facilities include human centrifuge with two rotor arm each outfitted with gondola and axi observer station; large climatic chan bers and several high-altitude chan bers.

Among sections in the Institute a Acceleration, Flight Selection and Ps chology, Applied Physiology, Climat Testing, Comparative Physiology, Hi Altitude Physiology, Training, Bi metry, Biophysics, Biochemistry, Tec nical and Equipment.

Problems peculiar to Naval avi tion are included in the experiment program. Cmdr. F. Burgess, MS USN, is stationed at the Institute und an exchange arrangement with t U.S. Navy.

Polaris-Subroc?

Joint Fire Control Is Proposed by Librascope

The Librascope Division of General Precision Equipment Corp. is proposing development of a combined fire control system for *Polaris* and *Subroc* missiles for use aboard *Polaris*-launching submarines.

J. J. Murray, General Precision chairman, says Librascope is "currently negotiating" the proposal.

Librascope developed the fire control system for the *Subroc* antisubmarine missiles soon to be operational in nuclear-powered fleet submarines. General Electric developed the fire control system for *Polaris*.

General Precision also has announced its entry into the transistor field. Murray said. A new company, The Kearfott Semiconductor Corp. with facilities in West Newton, Mass., has been formed for development and production of transistors and other advanced semiconductor devices.

The new company will operate under the Kearfott division of General Precision. Robert N. Brown, VP and general manager of the Kearfott division is chairman of the new company, and Stephen Cudlitz, formerly of the Instrumentation Laboratory of MIT, has been elected president. Robert S. Henderson, also formerly of MIT, has been named executive VP.

Tiros I Pictures Give New View of World Cloud Forms

U.S. Weather Bureau meteorologists reported last week that *Tiros I's* pictures have revealed an unexpected large degree of organization in the earth's cloud systems.

By the end of last week the weather satellite had completed some 300 orbits around the earth and had taken over 7000 pictures.

The most striking revelation, according to Dr. F. W. Reichelderfer, Chief of the U.S. Weather Bureau, came in pictures taken of the spiral cloud formations associated with large storms. Some of these spiral formations viewed by *Tiros I's* cameras were more than 1500 miles in diameter.

The cameras gave meteorologists, according to the Weather Bureau's Director of Meteorological Research Dr. Harry Wexler, "the first definite proof that a large percentage of such storms (spiral) . . . have a banded structure."

Radar during World War II, Dr. Wexler related, observed that tropical storms consisted of bands of clouds spiraling around a center rather than "a solid cloud mass rotating around the center." *Tiros* proved for the first time that clouds outside of the tropics have the same type of structure.

Weather satellites, according to Dr. Reichelderfer, will not replace current operations in predicting weather one or two days in advance, but will greatly increase the meteorologists' capability to make long-range forecasts by showing them the comprehensive world cloud picture.

Pioneer V 'Repaired' from Over 5,000,000 Miles Away

Pioneer V was "repaired" last week from a distance of over 5 million miles.

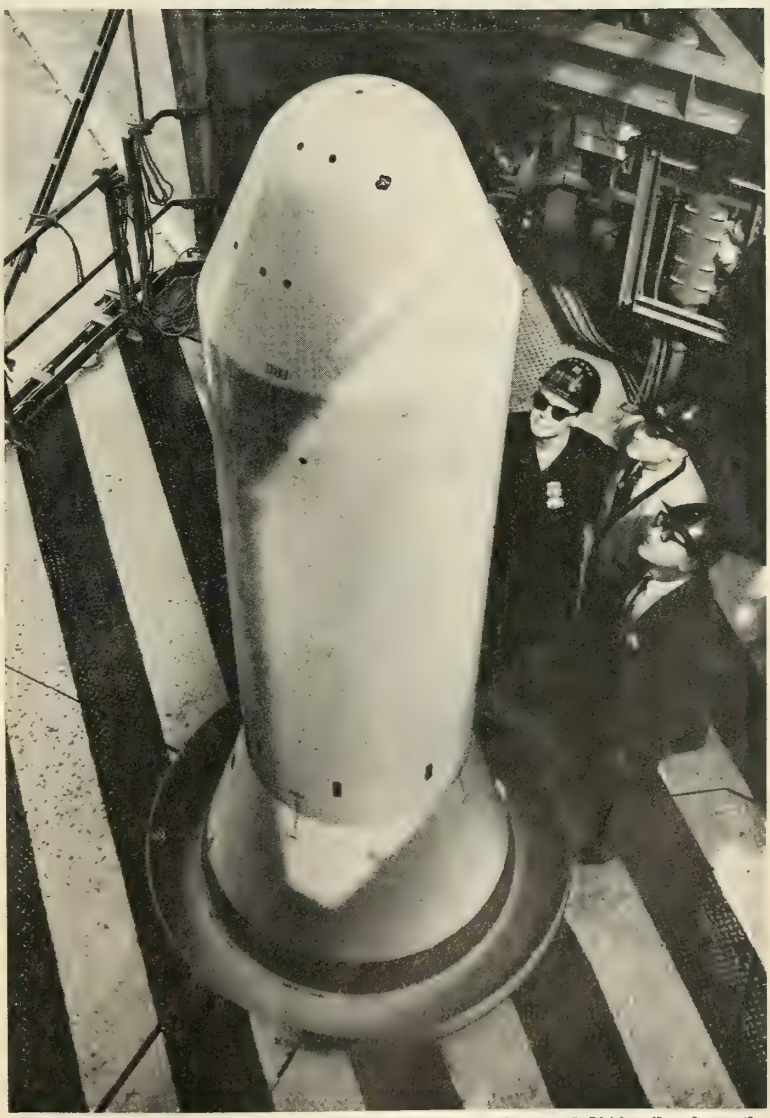
The source of trouble was the sun satellite's "telebit" unit which collects data before it is transmitted to earth.

Robert Gottfried of Space Technology Laboratories, Inc., who was instrumental in the design of the "telebit" unit, traced the trouble to a diode the size of a pinhead. He then worked out a new translation code for the channel taking the bad diode into account.

Gottfried's feat was extremely difficult, considering that the 10 lb. "telebit" unit contains some 450 transistors, 1500 diodes, 1600 resistors, 1000 capacitors, and several thousand soldered connections.

Before the "repair," values coming from the telebit channel which handles battery voltage levels, battery temperature readings and solar-cell paddle temperatures were obviously wrong.

Just One More Look



LAST INSPECTION is made of Avco nose cone before it soared 5000 miles down the Atlantic Missile Range aboard successfully fired Martin *Titan* on April 21.

Direct Reading Goniometer

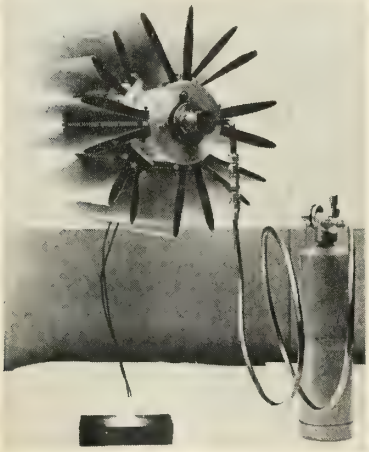
Calibration of divided circles, polygons and angle gages with direct reading to 0.1 second of arc is possible with the new Microptic Precision Goniometer developed by the Engis Equipment Co.

The bearing for the worktable carries a glass-divided circle, and the auto-collimating telescope unit also contains an optical system for determining the mean value of the opposite-side circle readings. Thus the measurement of the auto-collimator rotation and the measurement of the table rotation may be obtained separately with equal precision. The table may also be rotated relative to the divided circle about an auxiliary center by means of a micrometer spindle engaging a wormwheel. A second auto-collimating telescope is mounted on a column carried by the base casting.

Circle No. 225 on Subscriber Service Card.

Thermoelectric Generator

The General Instrument Corp. has produced a small (one-foot-high), lightweight (10 pounds) automatic thermoelectric generator than can produce electricity for a year on $10 worth of ordinary propane gas and will keep running as long as the fuel supply lasts.



Believed by the company to be "the first practical thermoelectric generator actually to be made commercially available in the United States," the unit is designed as an "ultrareliable and unmanned source of power" for radio communications, sea and air navigational aids, and industrial and scientific instrumentation in remote areas where other sources of electricity are not available or have a short life span and must be replaced or recharged.

The generator is expected to be priced at $500 or less in large-scale production quantities. Single "evaluation samples" are avalaible at a price of approximately $5000.

The generator, which employs "thermopiles" semiconductor elements to convert the heat of the burning propane into electricity, produces five watts of power, for as long as the fuel supply lasts. It has been designed to run for approximately a year on a 200-lb. tank (50 gallons) of propane gas, which sells commercially for about five cents a pound. By storing 1000 pounds of propane gas with the generator, it could run unattended for five years, according to the company.

Circle No. 226 on Subscriber Service Card.

Position Transducer

Small angular measurements can now be taken while maintaining all of the advantages of a precision potentiometer, with a new angular position transducer produced by Bourns, Inc.

Sensitive to a rotation of 0.012° and with a range of ±3° to ±5°, the instrument is currently being used on the gimbals of a rocket motor to provide a telemetering signal proportional to its angular movement. The magnified input of a small angular movement actuates a wiper which moves across a precision potentiometer producing a high-level DC output that can be used without amplification. Completely sealed against environmental conditions, the unit is oil-filled to further increase its life, eliminate noise and damp all resonant frequencies.

Flat frequency response to 30 cps has been observed without discontinuities or excessive wear. Life expectancy of the model is over 100,000 cycles.

Circle No. 227 on Subscriber Service Card.

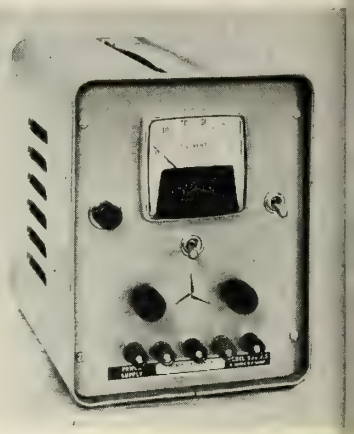
Transistor Power Supply

Trygon Electronics has introduced the new Trylab series of transistorized power supplies designed specifically for laboratory applications.

The units furnish 0-36 Volts DC at 0-600 ma and 0-18 Volts DC at O-1 Amp, with 0.05% line and load regulation and less than lmv. ripple. Automatic short circuit protection is provided with variable current limiting provisions to enable the user to draw only the required amount of power, thus protecting the load from overcurrent conditions. Turn-on and turn-off transients have been eliminated even for light loads, protecting the load from overvoltage conditions.

Remote sensing circuits have been incorporated in the units to maintain the required regulation at the load; remote programing over the entire voltage range is available as an optional feature.

The series regulator network, featuring a by-pass resistor technique, allows the power transistors to operate



at a lower temperature by dissipating the excess electrical energy in power resistors. Since the junction temperature of the transistors is thus reduced, a longer operating life results for these solid-state components.

Circle No. 228 on Subscriber Service Card.

Component Coating

A silicone base varnish, water thin and transparent, is being marketed by Melpar Inc., for the protective coating of electronic components.

The varnish, Melvar A-100, has a low curing temperature, a high operating temperature (400°F), and satisfactory fungicidal properties under tests specified in MIL-V-173A. The coating protects against electrical leakage caused by contaminants and breakdowns at high altitudes, and reduces moisture absorption.

The varnish can be applied by dipping, brushing, spraying or vacuum-impregnating without obliterating component markings.

Circle No. 229 on Subscriber Service Card.

'Blind' Welder Announced

An electronic seam weld-tracing device has been placed on the market by Welsma Co. The instrument automatically causes the electrode of the torch to follow the seam regardless of any mismatch in the workpiece.

When the electrode deviates from the seam an error signal is produced.

Amplification of this signal causes a servo motor to move the torch in a direction that nullifies the signal—in effect, guiding the torch back to the seam.

The instrument permits blind welding. The torch can be initially placed some distance from the seam, but as soon as a small arc is struck, the torch will move toward the seam and stay with it until the welding cycle is complete. Sample tests have shown that the deviation of the torch from the seam does not exceed 0.003 in. regardless of any mismatch and is negligible when passing over a small tack.

Circle No. 230 on Subscriber Service Card.

Alloy Junction Material

Indium precision spheres, for forming alloy junctions in germanium transistors with purity up to 99.9995% are available from Accurate Specialties Co., Inc. This ultrapure indium sphere assures reproducible results in forming the junction to the germanium crystal, according to the firm.

The spheres can be had in diameters ranging from 0.001 in. to 0.250 in. with the diameters held down to plus or minus 0.0001 in. precision and sphericity to plus or minus 0.0001 in.

In addition to pure indium, a number of alloys are available in spheres using the 99.9995% pure element. These include indium-gallium, indium-zinc, indium-gallium-gold, indium-gallium-zinc, indium-gallium-aluminum, indium-germanium and indium-germanium-gallium.

Production sphere lots of 1,000,000 pieces or more can be delivered within 10 days of receipt of order.

Circle No. 231 on Subscriber Service Card.

Read-out Oscilloscope

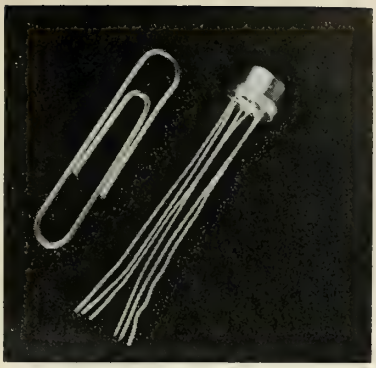
The indeterminate patterns of wave forms on an oscilloscope have been related to direct numerical reading and these readings have been automatically transferred to key punch machines for permanent record and statistical analysis in the DuMont Laboratories' new 425 Oscilloscope.

This direct tie-in of an oscilloscope with key punch equipment brings automatic tabulation of statistical test data to the laboratory or plant floor. The 425 scope can feed its data directly into analog and digital computers. If a variety of tests are contemplated, information from a battery of scopes can be printed on a single card.

Circle No. 232 on Subscriber Service Card.

Multiheaded Transistors

The Electronic Transistors Corp. has developed and is currently manufacturing multiheaded transistors to effect a further subminiaturization in transistorized circuits to a much greater degree than is now in use.



The multiheaded transistor is a combination of any type or types of transistors presently in use. These combinations, for example, may include PNP, NPN, Audio Frequency, Amplifier, Computer, Converter, General Purpose, High Frequency, Low Frequency, Intermediate Frequency, Low Noise, Matched Pair, Medium Frequency, Mixer, Oscillator, Radio Frequency, Subminiature and Switching. These applications may be combined in every variation and combination desired as each multiheaded transistor contains the individual transistor as per specifications in the multiheaded package.

The combination of these individual transistors within the multiheaded package creates no interference and has absolutely no contact with any other transistor within the package inasmuch as they remain individual as if they were not in the same package.

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Germanium Tunnel Diodes

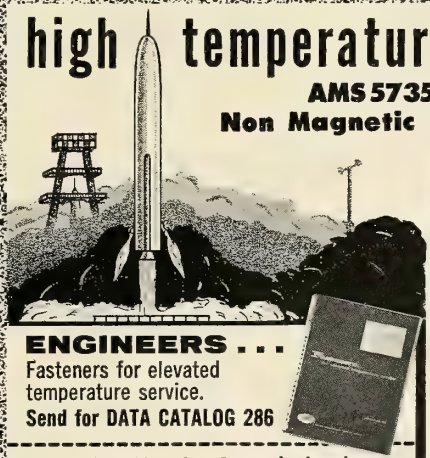
Sperry Semiconductor has announced immediate availability of germanium tunnel diodes covering the widest range of typical peak currents being offered to the industry. Sample quantities of types T101-T105, with peak currents ranging from 0.8 ma to 20.0 ma are available through all Sperry sales offices for engineering investigation and application.

Peak to valley current ratios on all types are in excess of 5.0 to 1, typically 8.0 to 1. Offering many inherent design advantages, including small size, reliability, radiation-resistance, wide temperature range and high cutoff frequency, they have a typical peak point voltage of 50 millivolts and typical valley point voltage of 250 millivolts. Op-

high temperature fasteners

AMS 5735 — A 286

Non Magnetic — Heat Resistant



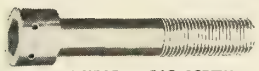
ENGINEERS . . .

Fasteners for elevated temperature service.

Send for DATA CATALOG 286



HEX HEAD BOLT MHH 3001



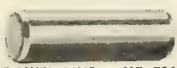
SOCKET HEAD — CAP SCREW MSH 441



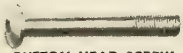
SCREW, FLAT HEAD 100° MFH 715



SOCKET DRIVE SET SCREWS MSS 1801



DOWEL PINS MD 706



BUTTON HEAD SCREW MRH 822



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erating and storage temperature range is from —55 to +100°C. The units have a 100 milliwatt dissipation rating at 25°C.

Preliminary specifications have been established on five types for use. Typical peak currents for the five types now in production are as follows: T101—0.8 ma; T102—1.5 ma; T103—3.5 ma; T104—7.0 ma; T105—15.0 ma.

Circle No. 234 on Subscriber Service Card.

Hi-Speed Torque Meter

B & F Instruments has added to its line of products a new high-speed torque meter, Model F2C2A, capable of accurate transmission of torque signals through 50,000 RPM.

The model is being manufactured in ranges from 0 to 100 in./lb. full-scale through 0 to 1000 in./lb. full-scale with 0.6pd male spline shaft ends.

Larger versions of this model with 0.8pd male spline shaft ends will transmit torque through 2500 in./lb. full-scale; a still larger version with 1.2pd splines will cover ranges up to 10,000 in./lb. full-scale.

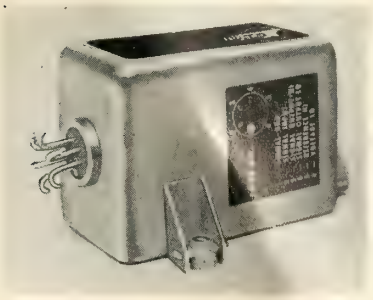
The instrument is usually furnished with coupling halves on the shaft assembly.

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Rejection Circuit

Kearfott Division of General Precision Inc., has announced availability of the D4816-01 quadrature rejection circuit designed to operate from a preamplifier or gain controlled amplifier into a transistor servo amplifier.

Small and lightweight, this device



rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to the load and the magnitude of the in-phase signal.

The unit is designed to operate in an ambient temperature range of −55°C to +115°C at altitude from 0 to 100,000 feet.

Circle No. 236 on Subscriber Service Card.

Flush Circuit Laminate

A copper-clad industrial laminate for flush-printed circuits has been developed by General Electric. Designated Textolite 11585, the glass-reinforced epoxy laminate is designed to make printed circuits that take 30 minutes in boiling trichloroethylene, over 30 minutes in gold cyanide solution, or 2 minutes in a 500°F solder bath without blistering or bond failure.

The new grade has high insulation resistance, low water absorption, stability in humidity and superior bonding strength, according to G.E. Engineers.

Textolite 11585 is available in sheets measuring 36 x 48 in. as well as in the standard sheet sizes of 36 x 36 and 36 x 72 in.

Circle No. 237 on Subscriber Service Card.

new literature

ENCODERS. A 12-page brochure, "Shaft Position Digital Encoders With Magnetic Readout," is available from the ASCOP Division of Electro-Mechanical Research, Inc. The literature gives complete specifications for the company's 13-bit, 8-bit, and incremental encoders. In addition, operating principle of the new type of magnetic readout is described in detail with illustrations. Recommended simplified transistor circuitry is given for interrogation playback, detection, and amplification of the new magnetic encoders. A conversion table is included for conversion from binary code to decimal or Gray codes.

Circle No. 200 on Subscriber Service Card.

HIGH TEMPERATURE APPLICATIONS—Bulletin #120, the first in a series of high-temperature applications bulletins offering industry detailed information on the use of ceramic tooling materials at elevated temperatures, is now available at no charge to production engineers faced with high temperature processing problems. Bulletin 120 shows the typical application of a Duramic 2000°F material in an RF soldering application, where the material offers unique characteristics required in this type of high temperature process: high heat resistance, low thermal expansion rate, and non-wettability by molten solder alloys. A photo depicts a fixture arrangement for soldering a magnet assembly giving details on RF coil design, fastening and locating methods used.

Circle No. 201 on Subscriber Service Card.

FLIGHT LABORATORY SERVICES. A 16-page illustrated color brochure describing full services for testing airborne equipment quantitatively and qualitatively in flight is available from the RCA Flight Laboratory, Radio Corporation of America. Services include flight-test instrumentation, data reduction and analysis, and aircraft installation, maintenance and modification.

Circle No. 202 on Subscriber Service Card.

ALUMINUM JOINING—A complete survey of aluminum welding, brazing and soldering is included in a comprehensive, practical, 40 page illustrated manual by All-State Welding Alloys Company, Inc. Among subjects covered are welding aluminum and its alloys by inert gas shielded metal arc with a consumable electrode, inert gas shielded metal arc with a tungsten electrode and the latest arc and gas welding processes. Chapters are also devoted to aluminum brazing with an introduction and detailed description of aluminum brazing alloys, brazing by torch, cleaning and finishing after brazing and charts of brazeable aluminum alloys. The soldering section includes melt and flow charts, how to solder aluminum to other metals and instructions on aluminum soldering with torch or iron—with or without flux.

Circle No. 203 on Subscriber Service Card.

MINIATURE CHOPPERS. An 8-page general instrument catalog which gives a complete set of technical definitions and specifications on new miniature chopper models as well as "standard" instrument chopper models is now available without cost from James Electronics Inc.

Circle No. 204 on Subscriber Service Card.

COOLING CRYOGENIC ELECTRONICS. A variety of miniature and compact refrigeration systems for cooling electronic devices to temperatures ranging from 3.5°K. to 200°K. is described in a new brochure published by Air Products, Inc.

Circle No. 205 on Subscriber Service Card.

contracts

NASA

$37,812—**Kaiser Fleetwings, Inc.**, Bristol, Pa., for services and materials 6-100 foot inflatable satellite container assemblies. (Erroneously listed under Air Force in our April 18 issue)

MISCELLANEOUS

$2,600,000—**Westinghouse Electric Corp.**, for tactical scatter communication equipment.

$50,500—**Hanley Industries, Inc.**, St. Louis, for loading of propellant-actuated, gas generating cartridges for *GAM-72* missiles. Subcontract from **Essex Manufacturing Co.**

NAVY

$21,000,000—**Bendix Aviation Corp.**, Detroit, for continued development and evaluation of the *Eagle* missile system.

$12,384,000—**Westinghouse Electric Corp.**, Pittsburgh, for design, development and production of nuclear propulsion components for three submarines.

$1,600,000—**Yardney Electric Corp.**, New York City, for manufacture of silvercell silver-zinc batteries to power propulsion and homing devices in the Mark 37 torpedo.

$800,000—**Cook Technological Center, Cook Electric Co.**, Chicago, for classified work.

$750,000—**Pacific Car and Foundry Co.**, Renton, Wash., for job orders in connection with the overhaul and modification of government furnished truck guided missile transporting—*Terrier*.

$600,000—**Packard Bell Electronic Corp.**, for classified airborne recorder-computer equipment to be used in antisubmarine warfare.

$124,970—**Camin Laboratories, Inc.**, Brooklyn, N.Y., for conducting a production improvement study of electro-formed rocket nozzles.

$32,000—**General Electric Co.**, Utica, N.Y., for providing field services of engineers in connection with installation, repair, modification and/or servicing of *Sidewinder* missiles, their components and/or associated equipments.

AIR FORCE

The Perkin-Elmer Corp., Norwalk, Conn., for developing an electronic-optical system for the *Titan*. Subcontract from **AC Spark Plug Div., General Motors Corp.** Amount not disclosed.

Melpar, Inc., Falls Church, Va., for design and construction of an antenna assembly for the 609A ballistic missile. Amount not disclosed.

$2,640,000—**Westinghouse Electric Corp.**, for six mobile radio sets for use in support of the air weapons control system.

$175,000—**J. C. Carter Co.**, Costa Mesa, Calif., for supplying all fuel and cryogenic pumps for the *Titan* missile sites. (Three contracts).

$140,000—**Avien, Inc.**, Woodside, N.Y., for production of a reference junction compensator for use on the *Minuteman*.

$38,940—**General Electric Co.**, Scranton, Pa., for electron tubes.

$33,114—**Wiancko Engineering Co.**, Pasadena, for digital instrumentation system.

$29,260—**Bendix Aviation Corp.**, Eatontown, N.J., for electron tubes.

$27,779—**Leeds and Northrup Co.**, Atlanta, for recorders and indicators.

ARMY

Horkey-Moore Associates, Torrance, Calif., for production of ten ammonia servicing trailers used in connection with GAM-77 *Hound Dog*. Amount not disclosed.

$5,500,000—**General Dynamics Corp., Convair Div.**, Pomona, for development of the *Mauler* guided missile system.

$1,962,900—**Western Electric Co.**, New York City, for development of local communication and range instrumentation plant at Kwajalein Island test site in support of *Nike-Zeus*.

$595,194—**Raytheon Co.**, Andover, Mass., for modification kits, *Hawk* launcher and concurrent repair parts and line items. (Three contracts).

$272,931—**Western Electric Co.**, New York City, for *Nike* spare parts and components. (Two contracts).

$268,582—**Firestone Tire and Rubber Co.**, Los Angeles, for decontamination kits and shop sets, engineering services and repair parts for the *Corporal* missile. (Three contracts).

$248,346—**General Dynamics Corp., Convair Div.**, San Diego, for engineering services and the supplies required for proto-proofing installation and flight test of *GAR-11* missile capabilities in F-102A type aircraft.

$110,129—**Douglas Aircraft Co.**, Santa Monica, for repair parts for the *Nike* system. (Three contracts).

$83,715—**Bendix Aviation Corp., Computer Div.**, Los Angeles, for dimensional flight simulator and auxiliary equipment.

$83,559—**Garrett Corp., AiResearch Mfg. Co.**, Los Angeles, for *Nike* repair parts.

$75,000—**California Institute of Technology**, Pasadena, for research on hypersonic wind tunnel program.

$55,000—**The Martin Co.**, Orlando, for plastic frame shields and jet vane assemblies for the *Pershing*.

$46,790—**RCA, Electron Tube Div.**, Harrison, N.J., for electron tubes.

$43,933—**Southwest Research Institute**, San Antonio, Tex., for investigation of current state-of-the-art technology relating to tracking mechanisms and couplings and the construction of scale engineering model.

$32,334—**R. E. Clarson, Inc.**, St. Petersburg, Fla., for additions and changes complex 30 and missile assembly building D, Cape Canaveral.

reviews

POTENTIAL NONNUCLEAR USES FOR DEPLETED URANIUM, published by the Atomic Energy Commission. Order TID 8203 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $.75.

The report discusses: past industrial uses and markets for uranium and its products; physical and chemical properties of depleted uranium and its principal compounds; potential industrial uses of depleted uranium and its compounds; health and safety hazards involved in industrial usage of depleted uranium; and a summary of comments relating to potential markets.

when and where

MAY

American Physical Society, Conference on Reactions Between Complex Nuclei, Gatlinburg, Tenn., May 2-3.

Instrument Society of America, Symposium on Electrical Safety Instrumentation, DuPont Country Club, Wilmington, Del., May 2-3.

American Institute of Electrical Engineers, National Aeronautical Electronics Conference, Dayton, Ohio, May 2-4.

Instrument Society of America, National Flight Test Symposium, San Diego, May 2-5.

Society of Aerospace Materials and Process Engineers, (SAMPE) Eastern Division, Spring Meeting, Massachusetts Institute of Technology, Cambridge, May 3.

Western Joint Computer Conference, Jack Tar Hotel, San Francisco, May 3-5.

National Association of Relay Manufacturers, Eighth Annual Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, May 3-5.

Materials Handling Exhibition and Convention, "Mechanical Handling" sponsored by Associated Iliffe Press, Dorset House, London, May 3-13.

Properties and Application of Materials in Aerospace Vehicle Design, sponsored by Martin Co.-Denver, Park Lane Hotel, Denver, May 4-6.

National Machine Tool Builders Association, 58th Spring Meeting, The Roosevelt Hotel, New York City, May 5-6.

Radiation Research Society, Annual Meeting, San Francisco, May 8-12.

Aerospace Medical Association, 31st Annual Scientific Meeting, Americana Hotel, Miami Beach, May 9-11.

1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego, May 9-11.

Instrument Society of America, National Power Instrumentation Symposium, Drake Hotel, San Francisco, May 9-11.

National Rocket Society, Semiannual Meeting and Astronautical Exposition, Ambassador Hotel, Los Angeles, May 9-12.

Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel, and State Fair Park, Dallas, May 9-13.

1960 Electronic Components Conference, sponsored by IRE Professional Group on Component Parts; AIEE, EIA, and Western Electronic Manufacturers Association, Hotel Washington, Washington, D.C., May 10-12.

American Institute of Chemists, Annual Meeting, Radisson Hotel, Minneapolis, May 11-13.

New York University Conference, "The Critical Million—How to Talk to the Nation's Scientists and Engineers . . ." New York City, May 17.

ASME Production Engineering Conference, Shroeder Hotel, Milwaukee, May 17-19.

names in the news

W. O. Chamberlin, Jr.: Appointed to the newly created post of director of Advanced Planning for Cook Electric Co.'s Technological Center. Previous posts: Dayton representative for Hughes Tool Co.; assistant manager, missile contracts department, Hughes Aircraft Corp., and staff assistant to the vice president of Ryan Aeronautical Co.


CHAMBERLIN

Michael A. Moscarello: Appointed chief engineer for the Ford Instrument Co., division of Sperry Rand. Was formerly assistant chief engineer.

Dr. Emil Onaca: Who joined Leach Corp. in 1958, named marketing analyst for the firm.

Richard M. Hultberg: Elected director of Radiation, Inc.'s Systems Development Division-Melbourne. Was previously with International Telephone & Telegraph Corp.

John Pink: Named products marketing manager for The CompuDyne Corp. Was formerly senior sales engineer at Southwestern Industrial Electronics Co.

Robert M. DeHaven: Former associate director named manager of the flight test division of Hughes Aircraft Co., replacing **Clarence A. Shoop,** who will devote his efforts entirely to Hughes International.

Robert E. Kinter: Replaces **Roy E. Campbell,** retiring, as director of advertising and sales promotion for Joy Manufacturing Co.

Robert G. Butterwick: Appointed advertising and sales promotion manager of Minneapolis-Honeywell Regulator Co.'s Industrial Systems Division, formerly known as Davies Laboratories.

Gordon A. McAlpine: Named market manager, Industrial and Automation Products, Radio Corporation of America. Prior to joining the firm was for 13 years associated with the Industrial Sales Division of Ex-Cell-O Corp.


McALPINE

Douglas T. Egbert and **Wilbur A. Taylor:** Appointed director of astronautics and research marketing and director of missile marketing, respectively, at Northrop's Norair Division. Prior to joining the firm in 1951, Egbert was head of structural dynamics with the U.S. Navy's Bureau of Aeronautics and dynamics engineer with North American Aviation, Inc. Taylor joined the firm in 1955, serving successively as an engineering specialist and supervisor of air defense systems in weapon systems analysis.

Herman E. Goodman: Resigns as vice president and director of advertising and public relations at Textron, Inc.

Frederick A. Henry (USAF-ret.): Appointed manager of long-range planning for Summers Gyroscope Co. Previous posts: Director of planning, Associated Missile Products Corp.; Assistant to the vice president and general manager of A. O. Smith Corp., and executive contract officer for Fletcher Aviation Corp.

E. Floyd Sherman: Named director of program development for the Systems Laboratories Division of Electronic Specialty Co.

Jack H. Kent: Formerly with Landau Metal Products, Inc., appointed general manager of Telemetal Products, Inc., a subsidiary of Polarad Electronics Corp. He will be responsible for the overall operation of the organization.


KENT

Ray D. Gardner: Named chief engineer of Horkey-Moore Associates, wholly-owned subsidiary of Houston Fearless Corp., replacing **John N. Kerr,** vice president engineering. Previous posts: System project engineer with Northrop Corp.; Vultee Aircraft Co.; Douglas Aircraft Co. and Andrew Higgins Aircraft Co.


GARDNER

C. L. Hewitt: Manager of Republic Aviation Corp.'s customer relations department, named manager of sales in the Missile Systems Division.

Stanley M. Smolensky: Appointed executive director of marketing at Thiokol Chemical Corp.'s Reaction Motors Division.

Orval W. Rahn: Former associate design engineer, appointed vice-president-design and engineering for Luminator, Inc.

Walter R. Lamb: Former supervisory physicist at the U.S. Naval Radiological Defense Laboratory, joins Rheem Semiconductor Corp., where he will work on development of new types of transistors.

Peter L. Lindley: Former manager of special products section at Electro-Data Corp., appointed manager of technical services at Endevco Corp.

David I. Shapiro: Joins the customer relations staff of the Fruehauf Missile Products Division of Fruehauf Trailer Co. Was formerly Western representative for Vertol Aircraft Corp. and Allied Associates.


SHAPIRO

Logan J. Hines: Named head of The National Cash Register Co. Electronics Dept.'s newly formed military engineering department. **Everett A. Emerson,** formerly in charge of preliminary design, will direct the department's systems engineering activities.

Richard T. Barrett and **John Agnitch:** Join the Newport Beach, Calif., Aeronutronic division of Ford Motor Co. Barrett, formerly advanced systems sales manager for Lockheed Electronics Co. will be manager of systems marketing, Range Systems Operations. Agnitch, previously in charge of military space systems marketing in the advanced program development department of Hughes Aircraft Co., will be on the marketing staff of Space Technology Operations.

Dr. Thomas T. Omori: Chief project manager of Aerojet-General's Space Technology Division since last September, appointed European manager of the NATO-Aerojet Propulsion Program for production of motors for the *Hawk* with headquarters in Paris.

B. A. Kvist: Former assistant director of contracts, named director of contracts at Aerojet.

Dr. Richard B. Nelson: Formerly manager of Klystron Development, elected manager of Tube Division Research and Development at Varian Associates. Prior to joining the firm in 1951 was associated with Litton Industries, General Electric Co., the National Research Council of Canada and RCA.

Dr. Howard S. Seifert: Former special assistant for professional development at Space Technology Laboratories, joins the technical staff of United Technology Corp.

John R. O'Brien: Promoted to vice president-government relations in the military products division of Hoffman Electronics Corp. Was manager of the firm's Washington, D.C., office and will continue to make his headquarters there.

MISSILE
SYSTEMS
ANALYSIS

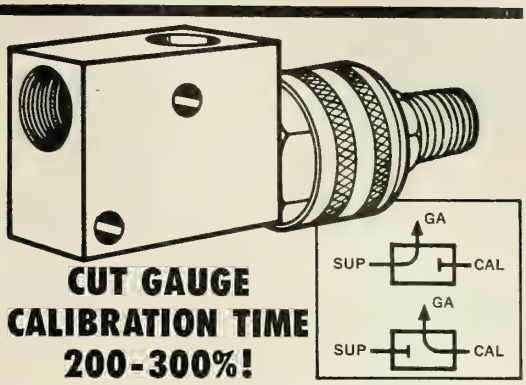
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New York 17, N.Y.—20 East 46 Street; YUkon 6-3900
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Paul N. Anderson
Raymond G. Quirk

Los Angeles, California—8929 Wilshire Blvd.; OLeander 5-9161
James W. Claar, Western Advertising Manager
Charles R. Martz, Jr.

Detroit 2, Michigan—201 Stephenson Building; TRinity 5-2555
Kenneth J. Wells

Chicago 2, Illinois—139 N. Clark St.; CEntral 6-5804
George E. Yonan

Miami, Florida—208 Almeria Ave., Coral Gables
Richard C. Hager

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'Q' Awards for Quality and Quantity

Addressing the employees of Packard Bell Electronics, President Robert S. Bell declared:

"Today our ability to grow through profit is threatened by inflation and by foreign competition. We are individually and collectively at war. It is a war against foreign ideology and technology—and against our own complacency. Aside from preparedness, it is not a war of missiles and nuclear weapons but one of philosophy and production. It is economic and psychological war covering almost every area of our lives."

President Bell noted that the United States today stands almost at the bottom of the list of major nations in terms of annual rate of economic growth—while the Soviet industrial growth persists at 8 or 9 per cent a year; that the gap between our two economies will be dangerously narrowed by 1970 unless our own industrial growth is increased.

Bell has a device for at least helping to solve the problem—a device which might well be adopted by every manufacturer of any size.

It is the "Q" award—"Q" for quality and for quantity. It is a monthly recognition of the employee, section, department or division at Packard Bell for improvement in production quality or quantity "beyond the expected."

President Bell says: "Only through quantity can we fight inflation and compete in foreign markets; only through quality can we prevail in any market."

For details write Packard Bell.

Snyder Tries to Muzzle Manufacturers

On the wall back of the desk occupied by Murray Snyder in the Pentagon are two large framed photographs. A visitor sitting facing the Assistant Secretary of Defense for Public Affairs can hardly fail to be impressed by this aspect of Mr. Eisenhower looking over Murray's right shoulder and Mr. Nixon over his left.

This indeed is the impression which the former White House assistant press officer has tried to create; that while he may be occupying a Defense Department position, he really represents the White House and takes his direction from there.

It may be true. During Murray's tenure he has done more to gag the normal commonsense flow of information from the military than any predecessor. He has permitted himself to be surrounded in his immediate office with some of the rankest incompetents Pentagon newsmen have ever tried to work with. With their help he has withheld news on whimsical orders, muzzled high-ranking officers and civilians, devised the "not classified but not releasable" security regulation. Most present-day Pentagon news comes not from releases but from leaks.

His latest dictatorial move—and possibly his greatest—has just come to light. It was a move to place all defense contractor advertising under the regulation of his office for policy clearance.

Rep. John E. Moss (D-Calif.), chairman of the House Government Information Subcommittee, calls the proposed directive an attempt to make Snyder an "advertising czar"; to give him the power to censor advertising, speeches and press releases by manufacturers. The three services are opposing the directive.

The very manner in which this story has come to light—by surreptitious leak—demonstrates the flaws in Snyder's gag rule system and in his own sincerity. If there is a need to checkrein the advertising and speeches of defense contractors, there are a dozen methods whereby the matter could be taken up with those primarily concerned —and not imposed by a secretly contrived order which violates every American concept of free press and free speech.

Clarke Newlon



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SM/I PRESENTS

A HISTORY OF RELIABILITY



THE QUESTION ARISES, "HOW FAR CAN RELIABILITY BE CARRIED?" ACCORDING TO L'AVIACON ITALIANO, CO-DESIGNERS SALVATORI-BONSIGNORI AND BARTOLOMEO SAVONI REMAINED ALOFT 6 YEARS IN THEIR UNIQUE "FRESH AIR MACHINE." THEY EVENTUALLY WERE SAFELY SHOT DOWN BY A GOVERNMENT AIRCRAFT TO PREVENT THE CONTINUATION OF THEIR EXTREME HUNGER."



WALTHER VIPPER UNICOPTER. THE VIPPER "SCHNAPP" ADDED TO THE G RELIABILITY OF T WORTHY STEEPLE



THE DISTRESSING EVENT ON THE RIGHT WAS THE RESULT OF A RELIABLE CREW FLYING A QUITE UNRELIABLE AIRCRAFT THE ILL-FATED "GROSSE HILDA" FLOUNDERING HOPELESSLY OVER THE BALTIC. HER AILERONS AWRY, HER NAVIGATING OFFICER TRYING DESPERATELY FOR A FIX, AND THE REST OF THE CREW TRYING DESPERATELY TO FIX THE AIRCRAFT, — TO QUOTE COUNT BAUMER, IN HIS MEMOIRS... (WELL, MAYBE WE HAD BETTER NOT.)

FOR THOSE INTERESTED, THE MACHINE BELOW CAME EQUIPPED WITH WHITEWALL TIRES, A SPARE PROPELLER, AND GENUINE IMITATION LEATHER SEATS, 1915.00 F.O.B. G



SIR WIMBLEDON ROOKE, NOTED RACONTEUR, BON VIVANT, AND PRESIDENT OF ROOKE ENTERPRISES, GAVE HIGH PRAISE TO HIS "WHALE" CLASS FLYING-BOAT, IN HIS BOOK, "THE LABRADOR SWYNDLE." BUT HASTENS TO EXPLAIN IN CHAPTER 5 THAT AS TO THE QUESTION OF RELIABILITY, IT WAS HIS EXCELLENT REFRIGERATORS TO WHICH HE WAS REFERRING.



THE NOTED INVENTOR WAG GATES AND HIS FEARLESS WI MINNIE, IN THEIR "AIR MOBILE," WHI AFTER EXTENSIVE TESTS, PROVED A MO EXCELLENT MACHINE, FOR HUSKING C

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missiles and rockets

THE MISSILE/SPACE WEEKLY

HOUSTON PUBLIC
Houston, Texas



FIRST STATIC FIRING OF CLUSTERED *SATURN*

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Minuteman Speed-up: Story and Photos . 44

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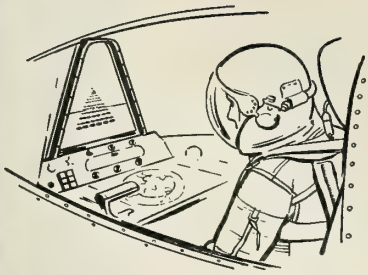
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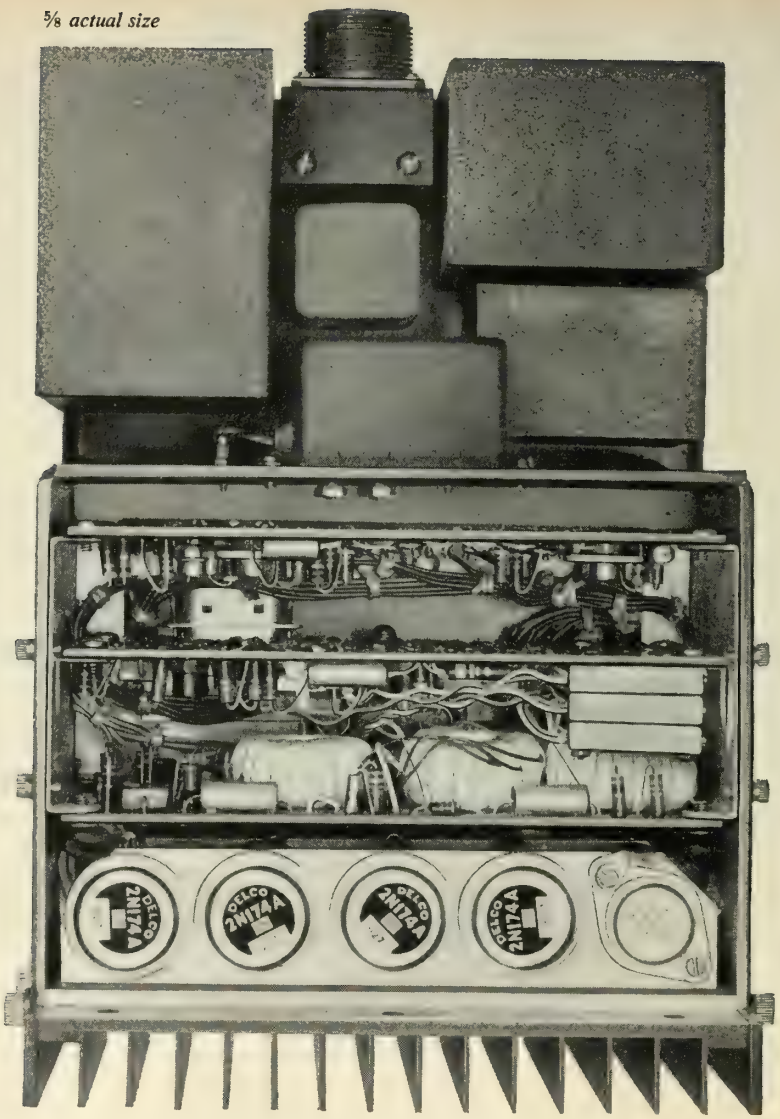
Civilian application of this new concept could well extend to ships, airliners and even trucks and cars which will *drive themselves* down this "electronic road."

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THE MISSILE / SPACE WEEKLY

missiles and rockets

May 9. 1960 Volume 6, No. 19

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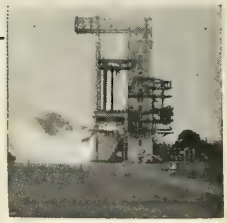
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THE COVER

First static firing of eight-engine Saturn *cluster at Huntsville May 2 was called a "complete success," developing 1.3 million lbs. of thrust for about 10 sec. duration.*

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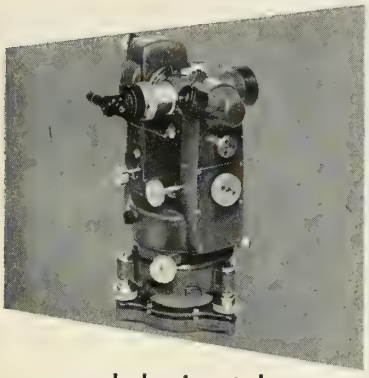
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Memo from the Publisher

The 12 months lying just ahead—Fiscal 1961—should be the most vital in the short but dramatic history of the missile/space market. They will see the first launching of *Saturn* and a dozen space vehicles. *Atlas* will go into new bases, *Titan* will become operational, *Polaris* and *Minuteman* will be well on their way. The nation will have a new president and a new administration, giving us fresh vision in both peaceful and military space exploration.

During the forthcoming year, M/R will put forth its finest editorial effort: a series of special issues and special reports backing up our weekly coverage in depth of the missile/space market by the strongest group of editorial specialists ever gathered to cover this market . . . 14 editors who, in 15 months of working together under the direction of Executive Editor Clarke Newlon, have grown into a tightly knit team with solid capabilities over a very broad field.

Look for the following over the next twelve months:

June 27, 1960: Special report on drones, under the direction of Engineering Editor Bill Beller.

July 18, 1960: 4th Annual Engineering Progress Issue, featuring the Missile/Space Encyclopedia, which in turn will feature for the first time a special section on "Rocket Engines of the World," under the direction of Defense Editor Jim Baar.

Sept. 19, 1960: 3rd Annual Ground Support Equipment Issue, under the direction of M/R GSE specialists Bill Howard and Hal Gettings.

Nov. 28, 1960: 2nd Annual Advanced Materials Issue, under the direction of Materials Editor John Judge and Propulsion Editor Jay Holmes.

Feb. 27, 1961: 4th Annual Missile Electronics Issue, under the direction of M/R electronics Editor Charley LaFond.

May 29, 1961: 4th Annual Missile Market and Product Guide. (Company listings for the 1960 Guide have passed the 4,000 mark . . . a 100% increase over our first effort in 1958).

Every month: Special reports on the fascinating subject of ASW Engineering under the direction of M/R Industry Editor Don Perry.

During the past several months, with the help of expert consultants on typography and layout, we've made several changes in the traditional format of M/R. We've departmentalized it, condensed the news and industry Countdown, added the Technical Countdown, blossomed forth with a new cover and a new contents page. These improvements make M/R easier to read, easier to clip and give it better visibility.

The number of new subscriptions flowing in each week, and the marked increase in the number of renewals over the past three months, together with the gratifying number of letters of approval from all over the market, prove the acceptance of M/Rs' "new look."

And we look for your continued approval, as we continue to publish the world's most complete and comprehensive weekly report on missiles, space systems and their developing markets.

Edward D. Muhlfeld

—letters—

New ASW Section Noted

To the Editor:

My congratulations to MISSILES and ROCKETS for the new ASW Engineering section introduced in the April 11 issue. The editorial content is an excellent presentation in the field of antisubmarine warfare. The editors are to be commended for broadening the scope and content of your outstanding publication.

William B. Bergen
President
The Martin Company, Baltimore

To the Editor:

I wish to commend you and your staff for an excellent initial article (M/R, April 11) summarizing the ASW field and some of its most challenging problems. Your future success in this area will, in my opinion, depend largely upon your follow-through in isolating, and keeping readers current (within security limits) on, the problem solutions or "breakthroughs" most needed in achieving major advances in ASW capabilities. This, of course, concurrent with reporting general ASW activities and business opportunities.

I wish you success.

H. O. Hauck, Technical Director
Fairchild Astrionics Division
Wyandanch, L.I., N.Y.

U.S. Controls Warheads

To the Editor:

In regard to the article on the "Luftwaffe" in your March 7 issue, in which it is stated that the *Mace-B* missile that the Germans will receive will be atomic-tipped, I should like to raise the following questions:

Is this poor reporting? or

Has the Atomic Energy Act of 1954, which was amended by Public Law 85-479 in 1958, since been again amended to allow U.S. atomic weapons in the hands of foreign powers? or

Is there a high-level conspiracy between the executive branch of the government, the State Department, and the Defense Department working with the Atomic Energy Commission to violate, circumvent, or change the law of the land?

It seems that a clarification of the article in question is in order.

At the same time, can you kindly explain the "News Brief" in your March 21 issue regarding the turning over of two 15-missile squadrons of *Jupiter* IRBM's to the Italians? Presumably these missiles would be atomic-tipped and thus be covered by the atomic energy laws.

John Savas
Canton 8, Ohio

M/R did not mean to imply that the Mace-B's *which the Germans will purchase will be delivered with nuclear tips. Actually, of course, the atomic warheads will remain under U.S. control, just as are the warheads for the* Thors *in Britain and the* Jupiters *in Italy.—Ed.*

(continued on page 48)

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This is typical of the many successful design and manufacturing applications which Electro-Tec performs for leading manufacturers of radar, gyros, inertial guidance, instruments, and switching.

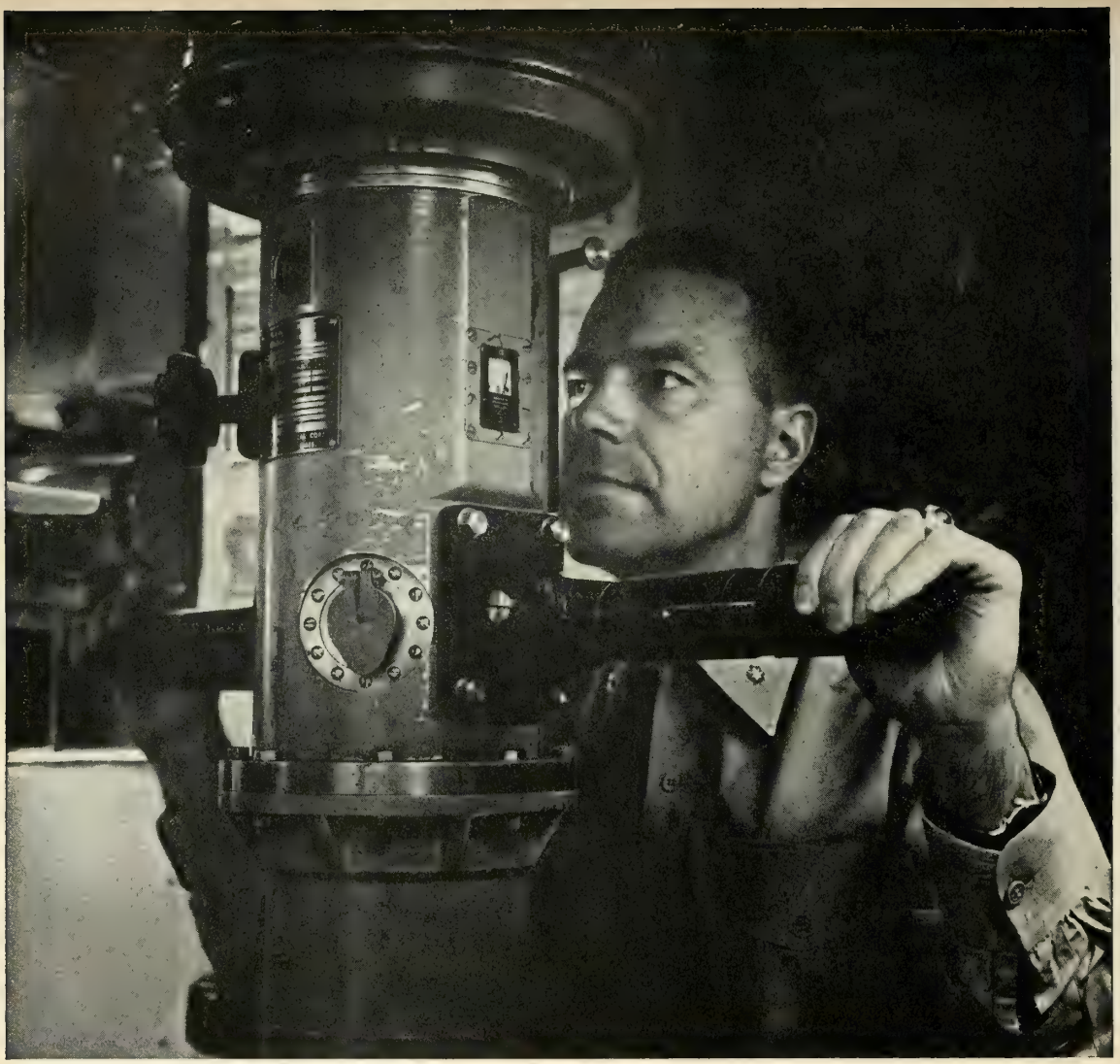
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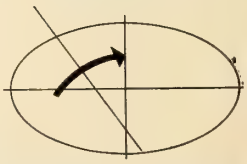
One day, a new fleet weapon system will be *on-station* beneath the ocean surface—ready to hurl retaliatory missiles toward strategic inland targets with pinpoint accuracy. This new weapon system will be part of the Navy's Polaris Fleet Ballistic Missile Program.

Though new in concept, the Polaris program makes full use of the precision Shipboard Inertial Navigation Systems (SINS) developed and produced by Autonetics for the United States Navy.

System design and components of earlier autonavigators have proved reliable in an Air Force supersonic missile, aboard the Navy's surface ship *USS Compass Island*, and on the *USS Nautilus* and *Skate*.

Advanced Autonetics' Shipboard Inertial Navigation Systems—like those to be used by the *USS George Washington*, the first Polaris-carrying submarine—will provide the critical missile alignment data to insure effective missile launching. SINS emits no tell-tale signals ... requires no receipt of external transmission at any time.

DID YOU KNOW?



The flattening of the earth at the poles can result in a navigational error of almost eleven nautical miles if not taken into account.

Inertial navigation by Autonetics

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WASHINGTON

Subroc Scrapping Denied

Contrary to a report in COUNTDOWN (M/R April 25) the Navy says it has no intention of scrapping the Goodyear *Subroc* 25-50 mile underwater or surface-to-underwater missile. There have been no changes in the plan to put it aboard the nuclear-powered Thresher attack submarine due to be launched in a few weeks, and development is proceeding on schedule.

DOD Eyes Satellite Bomb System

Despite Eisenhower Administration statements that space has little military potential, DOD is continuing to entertain proposals for satellite bombing systems which could be released from orbit on command. Some contracts may be let once the *Discoverer* capsule recovery is perfected.

NASA Under Fire

Expect the House Space Committee to open up a full dress investigation of the *Vega-Agena* space vehicle case. Insiders are quoting officials close to the programs as saying "someone was awfully careless with the taxpayers' money" when NASA's *Vega* was dropped for the Air Force *Agena* after several million dollars had been spent on it. Another case under scrutiny is the recent award of a *Saturn* upper-stage fabrication contract to Douglas.

Ride on Underwater Jet Stream?

The Navy may deny it, but consideration is being given to sending a nuclear submarine on an underwater speed run to dramatize the advantages in sea-going missile mobility. The sub would attempt to ride the Cromwell current which flows eastward across the Pacific near the equator, at an average depth of 600 to 700 feet and speed of 3.5 m.p.h. for a distance of 3500 miles or more.

Cheyenne Bids for Missile Railhead

ICBM's apparently aren't giving Cheyenne, Wyo., the jitters, although it is now a primary target as the center of the first AF *Atlas* base. City fathers are bidding to make it a hub for deployment of railroad-launched *Minuteman*, pointing out that the city is a junction for east-west and north-south railroads.

Minuteman Guidance Limitation

Look for critics of the mobile *Minuteman* to point out that the first ones will be limited to firing from preselected sidings using pre-computed target data. Follow-on missiles after it becomes operational in 1962 will have capability of computing data to fire almost instantaneously from any position.

Hiatus Coming in NASA Shots

There will be no major NASA shots until July, when the first *Atlas-Mercury* capsule combination is fired down the Atlantic Missile Range on a re-entry test.

INDUSTRY

Secret Steel for Deeper Subs

U.S. Steel is reported to have developed a tough new steel which will increase the strength of the pressure hulls of *Polaris* submarines an average of 30%. Details are secret, but the steel is expected to be used in follow-on subs after the *Ethan Allen* class and add greatly to their operable depth.

GAO Hits Cost-Reimbursement Practice

The Government Accounting Office is urging DOD to abandon a policy under Directive 7800.6 which requires defense contractors to obtain private financing for 20% of pre-delivery costs under certain cost-reimbursement contracts. GAO contends the three-year-old directive has cost the government $8.7 million more on 26 Air Force contracts than if the military had financed the costs.

More *Regulus II* for AF

Chance Vought and the Air Force are dickering on a contract for delivery of about 10 Mach 2 *Regulus II's* for *Bomarc A* target drones. The contract has to go through Navy, which developed the missile.

New Pinch on *Bomarc B*

Negotiations for sale of the *Bomarc B* to foreign countries have been jolted by the announced cutbacks in the program. However, Marquardt Corp.'s Roy Marquardt says the company is discussing with the AF a stretchout of *Bomarc* ramjet engine production at the firm's Ogden, Utah, plant. The House Appropriations Committee has voted to kill *Bomarc B* altogether (see p. 14.)

INTERNATIONAL

Red Espionage Reported

Soviet agents are said to be causing alarm in northern Norway and Sweden where there have been reports of several arrests. The spy activity is believed connected with the protection of several Soviet IRBM launching sites in Russia just across the Finnish border.

Nord AS-30 to be Nuclear-tipped

First French missile to get a nuclear warhead probably will be the *Nord AS-30*. It will give stand-off capability to the Vautour and Mirage III bombers.

For Technical Countdown, See Page 21

To assure a new order of reliability

MICRO-MODULE

EQUIPMENT



The micro-module is a new dimension in military electronics. It offers answers to the urgent and growing need for equipment which is smaller, lighter, more reliable and easier to maintain. Large scale automatic assembly will bring down the high cost of complex, military electronic equipment. Looking into the immediate future, we see a tactical digital computer occupying a space of less than two cubic feet. It will be capable of translating range, wind velocity, target position, barometric pressure, and other data into information for surface to surface missile firings. The soldier-technician monitoring the exchange of computer data will have modularized communications with the other elements of his tactical organization. RCA is the leader contractor of this important United States Army Signal Corps program and is working in close harmony with the electronic components industry.

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Circle No. 10 on Subscriber Service Card.

Army Fears Tactical Missile Gap

Service warns it may lack firepower to stop Red swarms; praise from President gives hope of more funds

by James Baar

FT. BENNING, GA.—Army officials are warning that within the next few years the United States will face a tactical missile gap as critical as the coming missile gap involving city-busting ICBM's.

The blame is placed directly on the Administration's budget-pinching procurement policies that are preventing the Army from buying sufficient quantities of its newest tactical missiles.

Officials warn that as a result the Army will not have sufficient firepower to stop masses of missile-armed communist troops in a limited war—the kind of war the Army considers more and more likely in the 1960's.

The Red Army alone has some 175 divisions compared to the barely 20 NATO divisions that face them in Europe across the Iron Curtain. The Russians are fully equipped with a vast array of tactical missile power. On the other hand, the U.S. Army's starved 14 divisions—of which only about 10 are full and combat ready—are being equipped with relatively few of such powerful field weapons as *Pershing* and *Sergeant* missiles under present procurement plans.

Warnings of the coming tactical missile gap came this last week as the Army paraded its latest weapons before President Eisenhower and hundreds of industry, military and government officials at Project MAN—a three-day exhibition here of modern Army needs.

The exhibition included:

- First unveiling of the launching tubes of the Army's potent *Davy Crockett* system. One, constructed like a mortar on a tripod, can be carried and operated by a team of two or three men. The larger is mounted on a jeep or an armored personnel carrier. Both tubes fire a *Crockett* with a fractional-yield nuclear warhead or a conventional warhead. The secret *Crockett* itself was not displayed for security reasons.
- Disclosure of a radically modified Western Electric-Douglas *Nike-Zeus*. A wooden mock-up of the 65-ft. bird with much smaller fins and a trimmer configuration was displayed. The new version is scheduled to be fired soon. (At Los Angeles, the Army said this last week the *Zeus* could go into limited production right now because tests have been so successful.)
- Disclosure that Martin Co. and the Army are working on a follow-on *Pershing* that could have variable ranges from under the present 300 miles up to about 1000 miles. Development beyond the study depends on the scrapping of the present range limit on the Army by the Pentagon.
- Disclosure that 15% of the Red Army's munitions in the field are chemical agents. Much of the Soviet poison gas can be delivered by missiles.
- The launching of two *Honest Johns* and one *Little John* under simulated battle conditions. One of the *Honest Johns* was launched during a blazing night exercise that also included the firing of salvoes of 4.5-in. rockets. The second *Honest John* and the *Little John* were fired during a daylight attack exercise that also included the launching of *Nord SS-10's* from helicopters and salvoes of twenty-five 4.5-in. rockets from mobile multiple-tube launchers.

The *Honest John* launched during the night exercise thundered across the battlefield, trailing behind it its blazing tail. Moments later a simulated nuclear blast roared from the woods in the distance of a mushroom cloud loomed against the sky.

Tracers crisscrossed again across the field and the battle continued.

President Eisenhower said after witnessing the daytime exercise:

"A day like this makes a man quite ready to call all those people mistaken—if not worse—who say that America has become soft and is not capable of defending itself. In other words, gentlemen, I am so proud of you that I really have no words in which to express it."

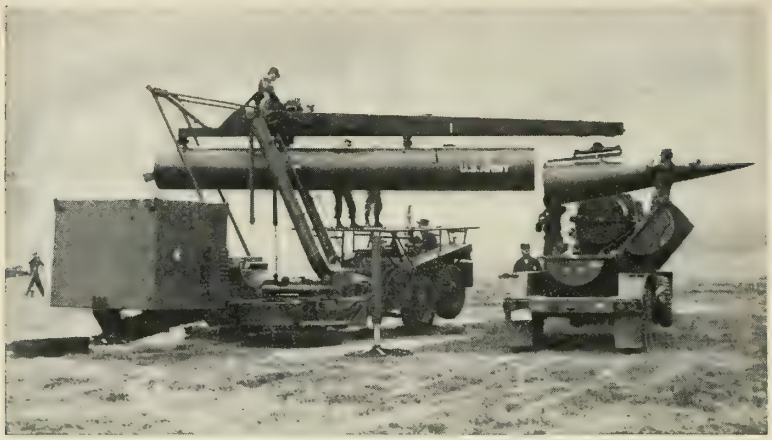


ARMY UNVEILS *Davy Crockett* mortar-launched tactical missile with nuclear or HE warhead. New defense bill calls for production of more than 6000 of this new missile.



LAUNCHER FOR *Davy Crockett* can be jeeped or carried by two men.

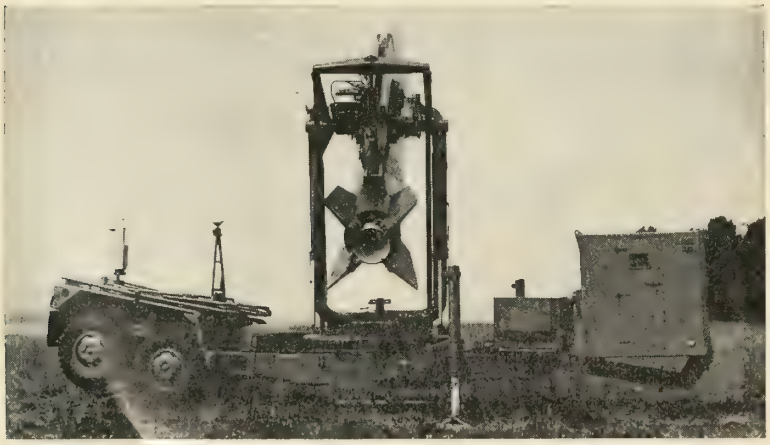
Where money is needed . . .



NOSE SECTION of Army's new *Sergeant* missile is unloaded from its transport trailer and assembled on its erector-launcher rig at Fort Benning.



MINUTES IS ALL it takes to assemble *Sergeant* on its mobile launcher. *Sergeant* vehicles mark first use of U.S. Steel's newly developed thin sections of T-1 steel.



READY FOR FIRING, the *Sergeant*, for which Sperry Utah is prime contractor, owes much of its mobility to T-1 alloy, which cut erector launcher weight by 7000 lbs.

• **Money ills**—Army officers beamed and hoped for a loosening of funds.

The Army is looking to Congress this year to give it more money to purchase missiles and other tactical battlefield equipment.

It has told Congress it should have $180.7 million more in the 1961 budget for the purchase of missiles. This would include 50 *Sergeants*, 600 *Little Johns*, 701 *Honest Johns*, 1200 *Redeyes*, 4 *Lacrosse* battalions and 6247 *Davy Crocketts*. Funds also would be used to expedite the *Pershing* and *Hawk* programs.

Congress is expected to approve much of the extra funding. How much of it will be released by the Administration remains in doubt.

To have many of these weapons in sufficient quantities, by 1963—the beginning of what most military men agree will be a time of great peril—procurement has to begin in the next year. This is particularly true of advanced models of *Pershing* and *Sergeant*.

Lt. Gen. Arthur G. Trudeau, Army chief of Research and Development, told observers at Project MAN that his job was to provide a variety of weapons "to deter or to fight an all-out nuclear war or local aggression with non-nuclear weapons."

Project MAN showed that these weapons are being developed—but are of little use unless they are in the hands of troops in quantity.

SAC Starts Rail Tests of Mobile Minuteman in June

Strategic Air Command will begin tests this summer of the mobile *Minuteman* deployment system over civilian railroads in the Far and Midwest regions.

In cooperation with the Association of American Railroads and officials of 13 railroads, a series of six tests will be made to determine how a missile-carrying railcar could be coordinated with regular route traffic. No missile hardware will be on board during early trials.

The first test run will begin June 20 from Hill AFB, Utah, and last about a week. The special train is expected to have 14 cars, including a control and command car equipped with a single sideband radio and UHF link to Hill AFB and the SAC Command post at Offutt AFB, Neb. Other cars making up the train will be used for fuel and supplies, and Pullman cars will house the missile crew.

The AF said a mobile *Minuteman* will cost $3 million, against $1.5 million for one in a silo and $35 million for an *Atlas* in a hardened launcher.

would rely on U.S. . . .

Britain May Drop Nuclear Arms Role

Shakeup in NATO deterrent forces seen if government decides against buying Polaris and Skybolt

by G. V. E. Thompson

LONDON—Although government leaders have made no announcement of the fact and may not for some time, it is reliably said here that England will not purchase American-made *Polaris* and *Skybolt* missiles to supplant their own abandoned *Blue Streak* IRBM program.

While the final choice rests with the politicians, not the military, many competent observers think the Government have already decided against both *Polaris* and *Skybolt* and merely mention them so as to keep Britain's place in the international poker game.

Sooner or later, they believe, Britain will have to chuck its hand in, abandon its policy of having an independent nuclear deterrent, and withdraw from participation in the overall Western or NATO deterrent plan.

Such a withdrawal would bring up the question of public opinion permitting nuclear-armed U.S. fighter and bomber planes to occupy British soil.

It would also probably necessitate a realignment of NATO forces to compensate for the loss in deterrent power of the RAF V-bomber force and the British-based *Thor* missiles.

The United Kingdom in becoming non-nuclear would rely on the U.S. deterrent. Such a decision presumably would be acceptable to America. (U.S. military experts are reported to have said "it may be best for you to stop being a target, which is all you ever could be"). It is also likely to meet with approval in Britain. Support for the Campaign for Nuclear Disarmament has been growing. A crowd of over 100,000 assembled in London's Trafalgar Square on Easter Monday for a "ban-the-bomb" demonstration.

• **Target worries**—When the British government announced the cancellation of *Blue Streak,* officials stated they were considering the purchase of *Polaris* and/or *Skybolt* missiles.

Polaris is, of course, the Lockheed submarine-launched 1200-mile missile which could be launched equally well from surface ship or a land base. *Skybolt* is the Douglas "stand-off bomb," a 1000-mile or better missile to be launched from an aircraft. Both are solid-fueled.

In the ensuing discussion, however, the point repeatedly was made that these are subject to the same, or just as serious, objections as the land-based rocket. The reason given for abandoning the fixed-base *Blue Streak* was that it was too vulnerable to sudden attack by Russian missiles.

This applies equally to the airfields from which Britain's V-bombers carrying *Skybolt* would take off. It also applies to *Thor* missiles, four squadrons of which are already on station in England.

Even when the Fylingdales Moor BMEWS station is completed, there will be only three minutes warning of missiles launched from East Germany. This is not enough to get either bombers or missiles off.

To avoid having the bombers destroyed on the ground Britain would have to maintain a perpetual airborne deterrent and this would seem too expensive. It would also provoke considerable political opposition. There is no present solution to the slow reaction time of present-day missiles.

• **Lost purpose**—Britain is not interested in the use of *Polaris* as a land-based missile, and considers that surface ships carrying it would be too easily detectable. However, the U.S. is pressing for the adoption of a land-based *Polaris* by NATO. If Britain did decide to go in for *Polaris* or *Skybolt,* these might be made here under license. It is understood that the R.A.F. have already been cooperating with the USAF in the development of *Skybolt,* and Bristol-Aerojet may be working on the propulsion system.

If Britain does abandon the nuclear deterrent, it will mean that much of Britain's work in the atomic energy field will have lost its purpose. Thus the Atomic Weapons Research Establishment at Aldermaston would become superfluous and the stockpile of plutonium would be available for other purposes. Presumably, the staff engaged on weapons research would be transferred to the nuclear power programme, which would then be greatly accelerated. The plutonium would be written off and made available for power purposes at a very low cost.

Britain would not drop all work on missiles, however. Short-range rockets would still be required for "police actions" in colonial trouble spots, and for anti-aircraft defense. Work on the *Blue Steel* stand-off bomb is still continuing, though Avro is not inviting publicity about the missile, as it does not want to see it follow *Blue Streak.* As yet, *Blue Steel* has kept outside the political arena.

No decision has yet been taken on whether *Blue Streak* shall be used in a British spaceflight program. The rocket would be ready for flight tests in two or three months. More time would be required to convert it for satellite launching. Detailed cost estimates are being hurriedly prepared and it is expected that the Government will reach a final decision about the middle of May. One proposal which is being put forward is that the U.K., British Commonwealth and Europe should join together in partnership in a space research programme, initially using the *Blue Streak.*

— news briefs —

AF PUSHES SPACE ROLE—One of the strongest statements yet for a bigger role in space was given to the Aviation Writers Association meeting in Los Angeles last week by Col. Richard D. Curtin of the AFBMD. He stressed need for "comprehensive deterrence" in space.

ARMY LETS BIG CONTRACTS—A $6.3 million contract for continued *Redeye* development was awarded to Convair this past week. Army also awarded Western Electric a $4-million contract for *Nike-Zeus* R&D and a second contract for *Nike-Hercules* missiles exceeding $5.7 million.

INCENTIVE CONTRACTS HIT—Testimony before a special House Armed Services Subcommittee shows DOD has been using incentive contracts almost exclusively with manufacturers who already have the advantage of government-owned facilities. Renegotiation Board studies showed these contractors realizing profits amounting to 71.3% on total net worth allocated to renegotiable production.

Bomarc Killed in Revamped DOD Budget

A major shift in defense spending which would buy more *Polaris* submarines and kill the *Bomarc B* interceptor missile program was sent to the House this past week.

The drastically revised FY 1961 defense bill totalling $39,337,867,000 —just $2,867,000 more than President Eisenhower asked in January—included a rejuggling of programs involving nearly $3 billion.

The revisions were made by the House Appropriations Committee, which said the bill reflected its support of the mixed force concept of hardened fixed-base ICBM's, mobile *Minuteman* and *Polaris* missiles and limited development of the B-70.

The mixed force is more expensive, the committee said, adding that it urged the "numbers of weapons systems be limited by avoiding duplicating operational characteristics.

Significantly, the revised bill added $321 million to antisubmarine warfare requests, including $100 million for R&D, bringing the total Navy appropriation in this category to $1,684,400,000. It pointed out at the same time that while the Navy said it was giving highest priority to ASW, "there is no indication of dramatic or dynamic leadership in this field."

The committee recommended that the Navy immediately establish for ASW a single manager system similar to the Special Projects Office which is developing *Polaris*.

The bill wiped out all funds for the *Bomarc B* that had not been previously committed, a reduction amounting to $675,100,000. This action, if approved by Congress, is expected to have repercussions in Canada which has an agreement with the United States for two squadrons of the missile. In place of the *Bomarc B*, the committee shifted $215 million to the procurement of 50 additional F-106 fighter planes.

"The *Bomarc B* . . . is a very questionable weapon system, and therefore a majority of the committee considered it inadvisable to place any reliance at this time upon such a weapon," the report said.

The committee agreed to the Navy's post-January request for six additional *Polaris* submarines, but it revamped the funding to speed up their development. It gave full financing to five instead of three submarines and provided long-lead time authority for seven instead of nine. The number of *Polaris* subs authorized would be 21, with 14 fully funded. To accomplish this, the committee added $241 million above the $153 million extra sought by the Navy.

Concern over missile mobility was apparent in the committee's decisions, although it approved the Air Force request to add three *Atlas* missiles to the last six of 13 authorized hardened squadrons, making them 12-missile squadrons. It added $20.7 million to accelerate the development of a railroad launch system for *Minuteman*.

The committee adroitly handled the controversy over the Strategic Air Command's request for a continuous airborne alert by recommending the President be given power to incur a deficiency in DOD funds to order an alert any time he feels it is necessary. It also raised the sum for this purpose from $85 million to $200 million.

In addition, the bill increased the *Midas, Samos* and *Discoverer* satellite projects of the Air Force by $54 million to effect their acceleration.

The committee disagreed with the Navy ASW shipbuilding plans. It chopped out $293 million for a conventionally-powered aircraft carrier and then approved funds for three, instead of two, nuclear-powered attack submarines.

• **Cutting the pie**—Of the total defense appropriation, the Air Force gets $16.8 billion; the Navy $11.9 billion and the Army $9.4 billion.

Air Force missile funds were set at $2,378,400,000, a $645-million reduction accounted for largely by dropping the *Bomarc B*. Its research, development, test and evaluation funds were increased $208.6 million to $1,542,-668,000 and included $100 million for the services of Rand Corp., Mitre Corp., Space Technology Laboratories, Lincoln Laboratories, Analytic Services Inc. and others.

Navy missile and aircraft procurement, which are lumped together, was boosted $28.8 million to $2,141,800,-000. Under RDT&E the $100 million for more ASW research increased total funds to $1,268,530,000. Navy missile research is being funded for $374 million—one-third for *Polaris* and the rest divided among *Eagle, Typhon, Corvus, Subroc* and an improvement in *Sidewinder*.

Procurement of Army missiles and aircraft was placed at $1,374,000,000, an increase of $37.1 million, while RDT&E funds were cutback $510 million to $1,041,190,000. Eighty percent of the $493.8 million for missile development is earmarked for R&D of the *Nike-Zeus* and *Pershing* systems.

• **Waste cited**—To compensate for some of the increases, the committee ordered an across-the-board slash of $400 million, or 3% in procurement funds.

Noting examples of waste and mismanagement reported by the General Accounting Office, the committee said it was serving "notice on all contracting officers in the military services that hereafter they personally can expect to be called upon to explain fully their actions in administering certain suspect contracts."

Senate Hikes NASA Money Bill

The question of how much money NASA will be able to spend during FY '61 became a little more confused last week when the Senate voted to authorize the agency to spend $970 million dollars in FY 1961—$50 million more than it had asked for.

The week before, the House voted to cut NASA's FY '61 budget by $38,-985,000 on the recommendation of the House Independent Offices Subcommittee of the House Appropriations Committee. (See M/R, April 21.) The subcommittee claimed that NASA didn't really need the extra money.

The Senate Space Committee, on the other hand, claimed that NASA erred in making up the budget by thinking it could make "unspecified savings," and that therefore the extra money is needed. The full Senate agreed, by a vote of 78-0.

There thus will be an $88 million difference between the House and Senate bills. A compromise will have to be ironed out in Conference.

Space Act

Military's New Role Positive in New Bill

The House Space Committee last week reported out the space program reorganizational bill (HR 9675) designed to placate military and industry critics of the present Space Act.

Basic features of the bill include:

- The substitution for the President's National Space Council of an aeronautics and astronautics liaison board co-chaired by DOD's Director of Research and Engineering and NASA's Deputy Administrator.
- A definition of the military's role in space with language stating that "DOD shall undertake such activities in space . . . as may be necessary for the defense of the U.S."
- A mandate giving NASA power to "formulate specific national objectives" for peaceful purposes in space and carry them out.
- A provision indemnifying contractors damages resulting from "unusually hazardous risks."
- A broadening of NASA's waiver of patent rights authority so that it more closely conforms to DOD patent regulations.

The final bill failed to include a proposal by Rep. B. F. Sisk (D-Calif.) requiring NASA to submit after-the-fact data on all negotiated contracts.

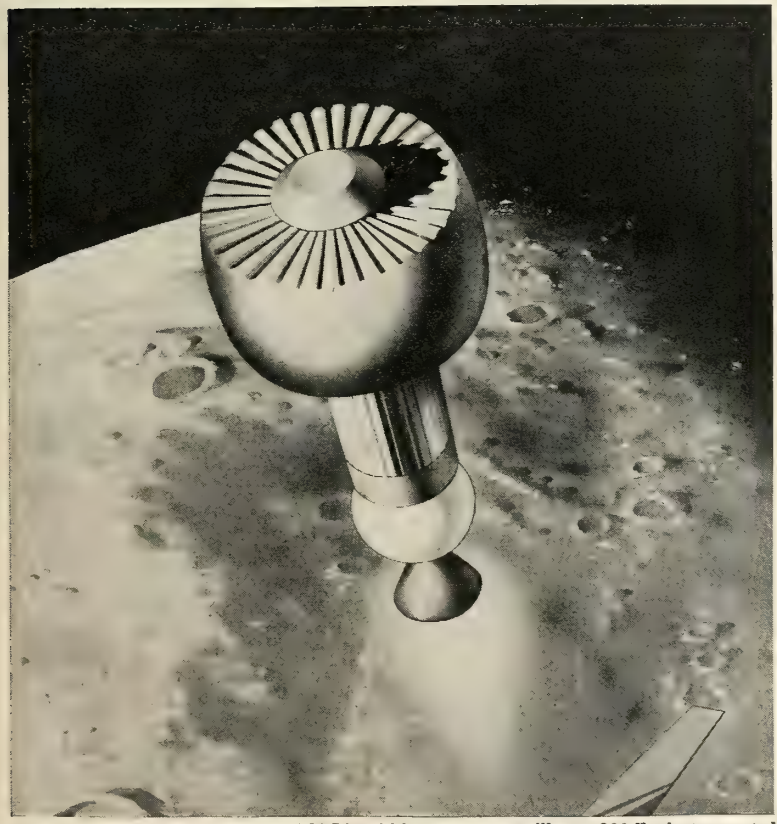
Major significance of the changes was to soften military and industry criticism that the original Space Act was detrimental to their interests.

The definition of the military's role in space was included because many military spokesmen felt that the language of the original act did not affirmatively state that the military had a role in space. The original act stated the military's role in a negative fashion, stating that "nothing in this act shall preclude" DOD from undertaking space activities.

The indemnification provision was included because industries contracting for space work have been worried about the potentially dangerous aspect of space research, and the possibility that they might have been held liable for injuries incurred.

Industry for some time has criticized the fact that NASA's patent provisions were much harsher than DOD's for the same type of research and development.

Lunar Impact Capsule



MOON LANDING attempt by NASA within two years will use 300-lb. instrumented capsule developed by Ford's Aeronautic Division. Retrorockets will lower capsule from 20 miles out. Drawing shows capsule after separation from vehicle.

Pioneer V Data Shows Threat of Solar Flare

An analysis of data obtained from *Pioneer V*—the first space vehicle to send back information from outside the earth's sphere of influence—has revealed that:

- The level of radiation from solar flares can become so intense as to produce a threat to manned space travel.
- The processes producing the outer Van Allen belt are not due directly to the injection of particles coming from the sun itself; the material caught by the earth's magnetic field is of much lower energy than most of the particles emitted by solar flares, and is accelerated by some unknown process after it is injected into the earth's field.
- Plasma caused by solar flares entering the earth's atmosphere disrupts the magnetic field so that trapped radiation is dumped into the earth's atmosphere, causing the low latitude auroras.
- The rate that plasma clouds caused by solar flares travels through the solar system can be ascertained, and it is possible that future space vehicles can give earth advanced warning of solar storms.
- The information obtained has allowed astrophysicists to divide the regions of space around the earth out to a distance of about five to seven radii.
- There is a steady field of radiation in space which may be a galactic field permeating the solar system.

These results and many others, were outlined at a NASA press conference from NASA *Pioneer V* technical reports and also from reports being made at the annual meeting of the American Geophysical Union.

The space agency also reported the possibility that Jodrell Bank may be able to command *Pioneer V's* larger 150-watt transmitter out to a distance of 100 million miles. This would mean that the sun satellite could be tracked while it speeds through over 1200 million miles of space.

NASA also reported that *Pioneer V* last week was 6.7 million miles from earth, had traveled 83 million miles through space, had been tracked for 94 hours, and that its command system has operated 227 times.

The scientists pointed out that the satellites transmitter had to be commanded regularly so that the batteries do not overcharge.

Rickover Tells Why U.S. Trails Russia

Says could not develop Nautilus today; harassment by a parade of bureaucrats hampers technical staff work

The following remarks by Vice Adm. Hyman G. Rickover, developer of the nuclear-powered submarine, were excerpted from recent testimony before the Senate Space Committee. They include a sharp analysis of what he believes to be the continuing problems facing the nation and the military in the contest with Russia—and the way to remedy them.

• **The contest**—In essence, the contest is really between two different systems of administration; between two different bureaucracies. If we place the issue on that basis, if we stop talking about a contest between democracy and totalitarianism, we can get at the root of the problem and find out why their rate of progress is greater than ours, why they are getting ahead of us.

In Russia, only the most determined and most competent people can get the best jobs. If they don't do a good job, if they botch a job, they are fired. And if they are fired, they don't have a private company to go to for a job. The Russians don't exercise too much favoritism, either.

One of Khruschev's closest friends was recently removed from the Presidium because he hadn't done a good job. He didn't even get a letter from Khruschev saying how much he regretted his leaving. He was just told to go . . .

The great mistake we make is to believe we are in competition with the Russian people. We are not in competition with the Russian people. We, the American people, are in competition with the Russian Government . . .

They have the advantage of speed in decision-making, the ability to concentrate on a few definite national objectives to which they apply the necessary energy and resources. They decide what is important technically and industrially, what is important for the political and military power of the state. These items they give national priority. They place a man in charge of a project, they hold him responsible and they let him alone.

If he fails, they get rid of him. They don't hound him day after day and literally prevent him from doing his work, which is the way we treat the men in charge of our large-scale governmental projects. This way of doing business we can no longer afford . . .

• **People, not money**—Over the last 10 years there has been a constant increase in difficulty in getting a job done in Government. In fact it has gotten to the point now where it is almost impossible to do a good job.

It isn't money. You don't get jobs done with money alone. In fact, you can slow jobs with too much money, because it takes time to spend money. Also, it takes lots of people to spend lots of money.



. . . too many fire alarms

The situation is comparable to a fire department with one fire station and many fire alarms. We have only the one fire station but we keep on adding more fire alarms, and more people are ringing alarms; the fire station can't take care of all the demands being made on it.

Similarly the few people doing the actual technical work are being overburdened by constant requests for information, justification, rejustfication, and so on . . .

For example, why don't we judge people by results? A man who is truly dedicated to a job will not want to take on work he doesn't believe in. If he doesn't believe in a job, he just won't do it.

Another thing, I have been urged numerous times to take on additional projects. I won't take them on because I don't believe they are worthwhile, or do believe they will interfere with what I am already doing.

I consider if I or somebody else has produced results, he certainly should be let alone to devote his time to his job.

There are many groups in Russia such as mine. They are not bothered. They are permitted to make some mistakes, but they are judged by results. They are not judged by the number or thickness of their reports, or by their methods.

Many things cannot be justified, in detail, particularly in research and development. Day after day people ask abstruse questions: "Why did you use this physics formula, why did you do that thing?" You can't explain those things. All you can do in scientific or technical matters, just as in politics, is to judge people and results. It is the only thing you can do. There is nothing else. In the final analysis you must judge people.

Let me recapitulate: If a man is doing a job, for God's sake, let him alone. This is not the case in our Government. That is the real issue. That is our real problem . . .

• **No Nautilus**—I don't think with the present climate, the way it has changed in the last 10 to 12 years, I could develop the Nautilus again. Now that is a statement for you to ponder.

You asked what we have gotten for the money spent in the naval program. For about $850 million we got all of our laboratories; we got five land prototypes of atomic powerplants that are now operating; we got all of the research and development over this entire period of time; and we also got the atomic powerplants for the Nautilus and the Seawolf. We got all of this for less than $1 billion . . .

• **Executive responsible**—In the broad sense it is not the legislative branch that is responsible for our shortcomings; it is the executive branch. The executive branch must see to it that the senior administrative people in the technical departments really understand the jobs they are supervising. Perhaps

the Senate should more thoroughly investigate before it confirms appointees to certain important jobs to assure that they are really qualified.

Edwin L. Weisl, committee counsel: Are there still many problems connected with nuclear propulsion plants?

Admiral Rickover: There are many problems, and we are not doing as much as we could or should. I finally got to the point of no return about two weeks ago. At 11 o'clock one night a serious technical problem arose. For the first time in my 12 years in charge of our project there were no technical people in my organization available to handle the job. The technical people were all off writing reports at 11 o'clock that night.

Now that is a fine way to use the rare technical talent we have in this country—to waste their time on nonproductive work. Whom are we fighting anyway? Are we fighting ourselves?

• **Brass parade**—A military organization is not geared to do research and development. It is an operating type of organization. Officers who have had command of ships and of fleets and have done a fine job come to Washington and are given authority over technical people. Those in line authority are frequently not competent to make the technical decisions, but they make them anyway.

Now that wouldn't be so bad if they stayed around long enough to learn their jobs. I will quote a few figures to illustrate the point.

During the time I have had my present job there have been seven Secretaries of Defense, seven Secretaries of the Navy, six Chiefs of Naval Operations, nine Directors of Atomic Energy in the Office of the Chief of Naval Operations, six Chiefs of the Bureau of Ships, four Chairmen of the Atomic Energy Commission and three Directors of the Reactor Development Division . . .

• **Schools behind**—Our children should know at least as much as those in Russia. But the educationists will say, "They will have to work too hard. It will be bad for their health."

Yet the records show that there is a smaller percentage of rejections for physical unfitness for military service in Western Europe and in Russia than there is in the United States. So that argument won't hold water.

Sen. Prescott Bush: They have a tighter discipline in the schools, do they not?

Adm. Rickover: Yes, sir.

Sen. Bush: Not only in Russia but also in Western European countries?

Admiral Rickover: Yes sir; and they go to school longer, too. For example, our children go to school 5 hours a day, 5 days a week for only 180 days a year. Their schoolday is 6 hours, with no study period, 6 days a week. In Denmark, they go to school 280 days a year. So they do in 9 years what we in 14. The average in Western Europe and in Russia is about 240 days a year . . .

• **On bureaucrats**—The Pentagon today is a big jungle, as you well know. No one could possibly control that outfit with its large number of people.

In fact, the Pentagon is the "fifth service." There are the Army, Navy, Air Force, and Marines. These are the four services. So the Pentagon has become the "fifth service . . ."

Nearly everybody in the Pentagon has the right to question me, but with no obligation and no responsibility to see that my job gets done. And every year the number of people with this right is increasing.

That is why it would help to arbitrarily reduce the number of people in the Pentagon by 20 or 30%. This could be one of the most significant steps that has ever been taken to improve efficiency. It is significant that one of the first steps Mr. Khrushchev took when he became premier was to reduce the Moscow bureaucracy by more than 100,000.

Sun Is Photographed by X-rays

First X-ray photograph ever taken of the sun shows it rimmed by a halo and several intense spots of X-ray emission. Photo was obtained with an *Aerobee-Hi* rocket fired from White Sands April 19 to an altitude of 130 miles.

The experiment, conducted by the Naval Research Laboratory, used a simple pinhole camera mounted on a biaxial pointing control which aimed it at the sun throughout the flight.

X-rays are generated by the sun's coronal gas which reaches temperatures of millions of degrees. The gas is completely ionized at these temperatures and collisions between electrons and heavy nuclei cause the X-ray emission. Since this radiation does not penetrate the earth's atmosphere below 60 miles, photos must be taken above this altitude.

The camera used had a 0.005-inch-diameter pinhole covered by an opaque aluminum coating. The metal blocked visible light but allowed the X-rays to pass through and record their image on photographic film. The resulting photograph was one-tenth inch in diameter.

The rocket's motion caused smearing of the image but did not obliterate features of interest to the participating scientists.



AF Forms Non-Profit Unit to Replace STL

by Clarke Newlon

As M/R went to press the Air Force was ready to announce plans for the formation of a non-profit corporation to take over the job of providing administrative services, fundamental laboratory research and advanced planning for the USAF's Ballistic Missile Division from Space Technology Laboratories.

The new organization planned after a study by a committee of scientists and engineers headed by Dr. Clark Millikan, California Institute of Technology, is known informally as "Corporation A." (See M/R April 4, Page 50).

According to best available information, the new corporation is expected to take over from STL some 25% or more of its present 4900 employes. It is also expected to occupy the present complex of offices at El Segundo and Aviation Boulevards, Los Angeles, now occupied by STL. These buildings were constructed for STL by its parent company, Thompson Ramo Wooldridge.

The Ballistic Missile Division of the Air Research and Development Command will, it was said, continue to occupy its present site adjacent to STL on Arbor Vitae Avenue, Los Angeles.

BMD, under whose direction the new non-profit corporation will work as did STL, had an on-site strength March 1 of 1403. Of these 737 were officers, 206 enlisted personnel and 460 civilians.

With the Ballistic Missile Division taking over the entire STL premises for its new corporation, this would seem to indicate that either the new organization would be greatly augmented by outside hirings (since only some 25% of STL personnel would be used) or that BMD intends to increase its own strength.

• **History of controversy**—Space Technology Laboratories was formed in 1954 when the Air Force was given the green light to produce the intercontinental ballistic missile in a top priority program. Its assignment under the direction of Simon Ramo and Dean Wooldridge was to manage the systems engineering which went into the production of *Thor, Atlas, Titan,* and later *Minuteman.*

Because of the dozens of new techniques, processes and materials required, literally hundreds of companies were called upon to contribute their scientific skills. It was the job of STL to integrate and manage the work of these companies, in conjunction with BMD and the prime contractors.

The overall job done enabled the Air Force to produce the ICBM almost 18 months ahead of the forecast schedule.

STL was, however, a profit-making institution. When its management decided on entering the production of hardware field, in addition to systems management, potential competitors objected to it as a "chosen instrument." The protests eventually reached Congress which saw a conflict of interest.

In seeking a solution the Air Force apparently has decided on the non-profit corporation as the most feasible.

J. D. Wright, chairman of the board of Thompson Ramo Wooldridge, recently announced in Los Angeles that STL, the "wholly owned but separate subsidiary corporation" would be integrated into the TRW family to continue in business as a private contractor in a conventional manner. STL would, he said, "be relieved of any requirements to furnish administrative facilities, advance planning or evaluation of contracts," presumably for the Air Force.

Moss Acts to Bar Snyder Censoring

Rep. John E. Moss, chairman of the House Government Information Subcommittee, moved last week to prevent any future attempts on the part of DOD Information Boss Murray Snyder to censor the speeches, press releases and advertising of defense contractors.

As reported in M/R (May 2, Page 16), Snyder's office attempted to get approval of a proposed directive which would give him the authority to require all military contractors to submit speeches, press releases and advertising to his office for policy review.

When the proposal was publicly exposed, Snyder withdrew it. Rep. Moss last week announced that he has asked DOD what its future plans are—that is, if Snyder intends to come up with another such proposal at a later date. Rep. Moss wrote:

"News reports resulting from the disclosure of a proposed Department of Defense directive controlling advertising by defense contractors stated that, as a result of the publicity, the directive would not be put into effect at this time.

Lockheed pays dividend despite drop in earnings

Lockheed Aircraft Corp., despite reduced first-quarter earnings, has declared a two percent stock dividend. The dividend is being paid in stock rather than cash, according to board chairman Robert E. Gross, "to conserve the company's cash for expansion and product improvement."

Gross stated that first quarter earnings of approximately $2.75 million were down about a third from the same period last year. Sales and backlog are both considerably above last year's figures.

Almost 90% of Lockheed's business is in missiles, satellites, and military aircraft. Their major missile program, the *Polaris,* is progressing well, Gross reported, and on schedule. Based on a long-term goal of 45 *Polaris* submarines, each carrying 16 missiles, the company anticipates a production run approximating "those we used to have for military aircraft." The Lockheed report also cited NASA's plans to buy 16 *Agena* satellite vehicles at a cost of $50 million.

United Consolidates Two Groups to Add Capability

United Aircraft Corporation's Missiles and Space division has been consolidated with its Hamilton Standard Division at Windsor Locks, Conn.

Hamilton Standard, already engaged in electronics, ground support equipment and Space Age activities, will provide the missiles operation with the facilities lacking in the previous setup, the company says.

Wright A. Parkins, United's vice president for engineering, will relinquish his additional assignment as general manager of the missiles and space division. Charles M. Kearns, Jr., general manager of Hamilton Standard, will direct the operation.

Two current military study contracts recently awarded the missiles and space division will be continued under Hamilton Standard. Two earlier hardware contracts will be transferred to United's Sikorsky Aircraft, where the work is being performed.



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This AMF engineer knows what it takes to shrug off megaton forces. He *had* to know because he designed the prototype atomic bomb shelter at Frenchman Flats, the only building that stood up under the force of the atomic bombs exploded there. Well, not altogether—a flange on the door *was* bent.

In order to design the shelter, he had to calculate the effect of the explosion on materials and structures. He had to know how the shock was transmitted through the earth's crust and what effect it would have on the shelter—from beneath as well as from above. And, after the dust of calculating had settled, he had the very practical problem of expressing the results in steel and concrete. He did so, successfully.

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- *Range Instrumentation*
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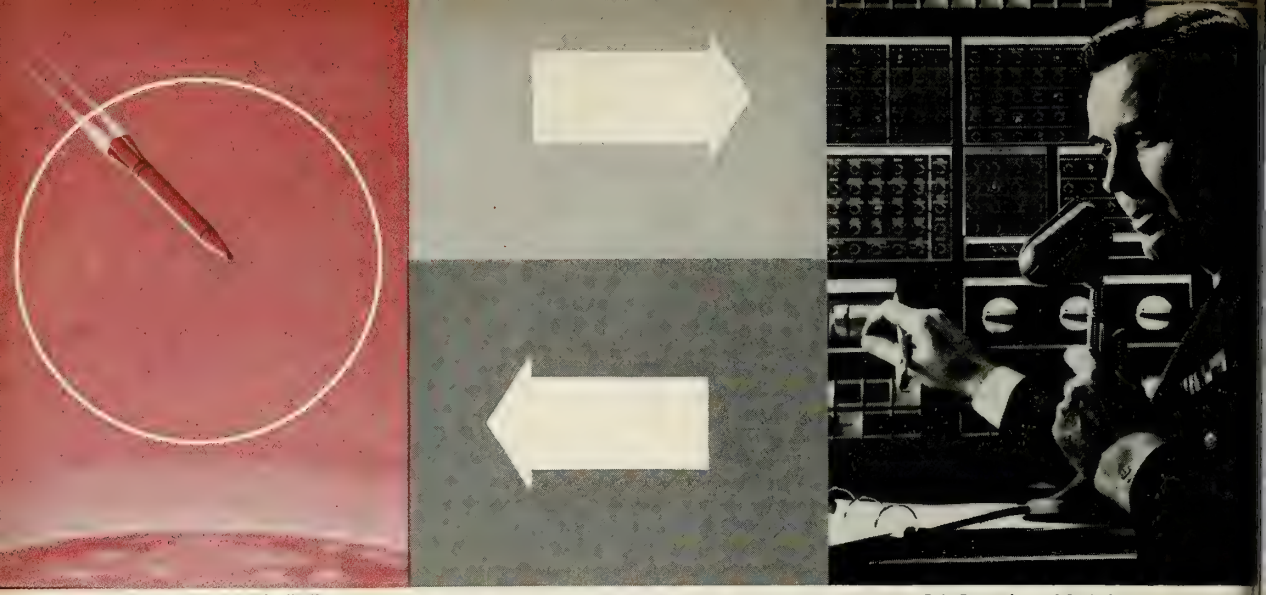
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Technical Countdown

PROPULSION

Nozzles Solid Stumbling Block

Big solid rockets will never be used for space missions, says Dr. W. J. Harris, executive secretary of the Materials Advisory Board, because the nozzles will never be developed in time to keep up with liquid rocket development. Lead time for a big solid nozzle is much too long, Harris says.

N_2O_4 Switch Seen for *Agena-B*

The Lockheed long-burning, restartable upper stage, *Agena-B,* will switch oxidizers in later versions—from inhibited red fuming nitric acid (IRFNA) to nitrogen tetroxide. The change will package higher energy in the hypergolic combination with UDMH. Farther down the road: a fluorine-hydrazine combination.

AF Buying *Scouts*

AFBMD and Chance Vought will sign a contract in the neighborhood of $2 million for several copies of the Air Force version of the NASA solid-propelled *Scout* satellite launcher. AF may put a new name on its version.

GCR-Marquardt Fire 32 Hybrid Motors

Grand Central and Marquardt have fired 32 hybrid motors in their joint, company-funded program. Grand Central makes the fuel grains; Marquardt provides the pressure-fed liquid oxidizer system. GCR says the hypergolic propellants are storable from –60° to 160°F. Thrust can be modulated between 0 and 100% by oxidizer flow controls.

Reliable Valve Introduced

A more reliable primary fuel valve has been developed by Clary Dynamics for the Lockheed *Discoverer* program. Duel squibs and dual wire leads insure that one functions even if the other fails.

ASW ENGINEERING

Killer Boat Launched

Killer submarine Tullibee launched last week at Electric Boat Co. has torpedo tubes amidship rather than in bow—devoted to sonar gear. Navy says she'll be the quietest running nuclear boat in the fleet. House Appropriations Committee is calling for four other attack-type subs.

'Task Force' Proposed

One leading oceanographer says it is possible to detect submarines by sampling disturbance of marine organisms. He calls for a research group composed of a marine biologist, a biochemist, a physiologist and a physicist.

New Market Opens for Small Business

Less than a dozen companies provided instrumentation for the Navy's bathyscaph Trieste. Now that improvements and advanced models are in the works, oceanic experts says the field was never better for small companies that can come up with improved lighting, TV, sonobuoys and instruments for measuring currents, salinity, etc.

GROUND SUPPORT EQUIPMENT

Bases in the Hole—Wired

Titan power house and control center "igloos" at Lowry AFB will be reinforced against thermonuclear blasts with up to 25 layers of prestressing steel wire—about 1600 miles of wire under tension of 150,000 psi for the 12 buildings.

Zeus Cell Passes First Test

Underground launching cell for *Nike-Zeus* underwent first successful test firing April 28 at White Sands, N.M. Thiokol's 450,000-lb.-thrust booster carried dummy sustainer and warhead. Underground cell for *Zeus* is an economy measure that reduces costs of temperature control and simplifies maintenance—rather than truly "harden" the base.

ELECTRONICS

SAGE Extends to Sea

Flying electronic detection stations will extend SAGE defense network over the sea. Lockheed Aircraft Service has received $3.5 million contract to assemble, install and flight-test the electronic systems in two RC-121 aircraft.

High-Temp Transistor Developed

The first gallium arsenide transistor—capable of withstanding the high temperatures in missiles and space vehicles—has been demonstrated by RCA. It is reported able to operate above 480°F. It is a diffused junction drift-field type.

Decoy Uncovering Sought

The best practical method of detecting ballistic missiles among decoys is sought by Raytheon under a $1.8 million ARPA study.

ADVANCED MATERIALS

Space Experiments Due

Capability of the earthbound environmental test chamber has about been reached, NASA materials specialists say. Now experiments must be held in space—to test the combined effect of vacuum, radiation and micrometeorite erosion. Most tests will be aboard *Scout* satellites.

Problem Solved

All nozzle and nozzle insert problems would be solved if just one material were developed, engineers reported at the Cincinnati materials symposium. What is needed is a rubbery refractory.

New Cryogenic Line Reported

AiResearch Manufacturing Co., a Garrett Corp. subsidiary, reports it has applied for patent on a method of transporting cryogenics such as liquid nitrogen in ordinary transfer lines, without vacuum jacketing, for more than 25 feet. Exterior remains frost-free. Flexible plastic lines can be used. AiResearch gave no hint as to how it is done.

Future of Ocean Research Is Vast

Lockheed tells Congress official estimate of time needed to double effort is 'conservative'; sub threat stressed

by Donald E. Perry

Lockheed Aircraft Corp. last week gave the House Science and Astronautics Committee an illuminating picture of the role American industry can perform in oceanic research if government draws on industry for critically needed scientists and engineers and provides the same kind of funding and priorities that have been given the nation's space program.

The corporation's presentation was made by Dr. James E. Lipp, Director of Development Planning, and undoubtedly represents Lockheed's advanced thinking toward opening new markets. Lipp spoke at the end of a session of hearings on oceanic research.

Lipp had been preceded by Dr. Harris S. Brown, noted professor of geochemistry at California Institute of Technology, who warned that "no matter how hard we might make a missile base on land, it is difficult to create it in such a way that people in neighboring communities are not going to be killed should there be an enemy attack."

Brown emphasized that "we are being pushed into the oceans" for a major answer to the problem of creating hardness in our missile bases, and said in another decade or so "warfare is going to be conducted primarily in the ocean." He pleaded that if we are going to fight a war there we must get more knowledge of the ocean—the victor in such a war will be the nation which knows the most about the sea.

Brown termed the long-range nuclear-powered missile-carrying submarine "the most serious military threat that the United States faces," and said learning how to find such submarines is perhaps the most serious and difficult technical problem which the nation faces in the military field.

On one point Lipp took issue with Brown, who is chairman of the National Academy of Sciences Committee on Oceanography. Lipp said the committee's estimate that the research effort can double in 10 years and reach a level about one-tenth of our present space effort "is very conservative." He said the estimate was based on the rate of training of new oceanographers, but he reminded the committee that the nation's space program in a few short years exploded from essentially no effort into a major profession simply by drawing on industry for scientists and engineers.

Lipp urged an accelerated basic research program as a foundation for future progress in the sea, but said that in addition the engineer and the scientist must become familiar with the new environment and thereby learn how to exploit it and behave in it.

He slid lightly over the Naval weapons aspects in the open hearing session, but said many developments indicate that the Navy is moving toward operation in the full depth of the ocean.

His emphasis was on the many peacetime commercial and industrial activities which will gain impetus from the Navy program. They included:

• **Devices for undersea research.** Lipp advocated a mid-depth type of vehicle, a "mesocaph," to operate at depths of 15 to 18,000 feet, which would have good maneuverability and a substantial payload. He said about a dozen of such craft are desirable, since roughly half the geographic area of the world will fall within their capabilities. He said also the Navy's bathyscaph Trieste should be improved as to payload and maneuverability, and that three or four such craft will be necessary within the next several years.

• **Cargo submarines.** Lipp said advances in structural materials, submarine hull design and power plants are steadily bringing closer an "economical" cargo submarine. Chief advantages would be low drag of a submerged hull and relative immunity to heavy weather or destruction by enemy submarines. Such a development would also give rise to new kinds of shore facilities for efficient loading and unloading. Lockheed recently acquired the Puget Sound Bridge and Dry Dock Co., Seattle, but neither it nor any other firm has a cargo submarine development project.

• **Undersea pipelines.** Lipp said a study is being made in Europe of a gas pipeline from North Africa to southeastern Spain, and the project is undoubtedly the forerunner of a network across narrow seas and straits all over the world.

• **Underwater communications.** He sees only uses on a modest scale and in special situations—for example, across the Arctic where the nuclear-powered submarine has the technical capability to lay a cable under the ice in a geographical area where magnetic disturbances seriously affect most other forms of communications.

• **Fresh water conversion.** Lipp believes areas of development are tremendous; the chief problem is to reduce operating costs of distillation plants to a level competitive with natural sources of fresh water.

• **Mining and chemical extraction of minerals.** Oil exploitation will continue on the upswing, with a next big step being recovery of manganese and cobalt from ocean deposits.

• **10-year program**—In separate testimony, James H. Wakelin, Jr., assistant secretary of the Navy for Research and Development and Chairman of the Interagency Committee on Oceanography of the Federal Council for Science and Technology, said his committee has estimated that total cost of oceanic research will approximate $1 billion in a planned 10-year program, if a goal to double present capability is realized.

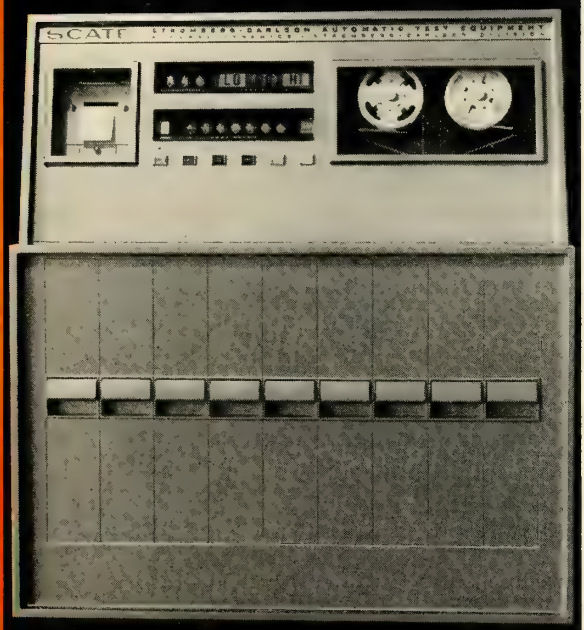
Total funding of the nation's oceanic research requested in FY 1961 totals about $56 million, an increase of almost 50% over FY 1960's level of $37 million (M/R, May 2, p. 41). This does not include approximately $14 million for military surveys and about $10 million for military research programs mainly funded by ONR.

The Interagency Committee, with representation from DOD, Commerce, Interior, Health, Education and Welfare, the National Science Foundation, and the AEC, gives these estimated major cost elements of the 10-year program:

Oceanographic research and ship operations . . . $490 million
Ocean surveys and ship operations . . . . $144 million
Construction of 78 new ships and facilities . . $405 million

The U.S. now operates about 52 ships, mostly of small size for oceanographic research and surveys. About 30 will be replaced during the next 10 years because of overage.

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GCR Boosts Segmented Solid Rockets

Company spokesmen claim big segmented birds will be feasible and reliable, countering arguments by advocates of on-site loading

by Frank G. McGuire

REDLANDS, CALIF.—A segmented very large solid-propellant rocket will be reliable, easily tested and capable of tremendous growth, Grand Central Rocket Co. officials declare.

Grand Central is one of six bidders on the Air Force's Project 3059, for developing a solid rocket of 100 million pound-seconds total impulse. The bidders are divided on how to go about building such a rocket. Thiokol and Rocketdyne favor a single unit loaded at the launch site. Grand Central, Aerojet-General and United Technology Corp. are following the "tootsie-roll" approach. Hercules Powder Corp. is not publicly committed.

In interviews last week, GCR officials pointedly countered the arguments put forth by Thiokol's Bryce Wilhite, technical director of the Utah Rocket Operations Center (M/R, May 2, p. 37). And they outlined what they contend are additional advantages of segmented construction.

Principal areas of differing opinion were reliability, testing capability, and growth potential. Other voices have been heard, questioning the risk of "disastrous results" occurring if combustion were to succeed in getting between the segments and causing end-burning of the grain. Some on-site loading proponents have maintained that a foolproof sealing and inspecting of these seams will be necessary.

• **Reliability and testing**—"When people refer to a 95% reliability factor in a rocket, they are talking about liquid propellant rockets, not solids," said Larry Thackwell, senior vice president-advanced concepts. "This approach will give us a reliability factor of .9999 for each segment—or a system reliability of .99," he said, pointing out that the *Mercury* escape rocket being produced by GCR has a reliability factor of .999.

The approach being followed by GCR is aimed at producing the "simplest rocket ever built," according to Thackwell, who pointed out that the company conducted thorough studies into both methods of building huge boosters, and has the capability of following either route now under consideration by industry.

The preparation of propellant grains in short sections that are open for inspection at both ends allows X-ray and other quality control methods to thoroughly check each segment. The grain can be inspected through the web thickness, as well as on the port surface.

Economic advantages exist if flaws are found in the grain of a segmented booster, contrasted with the single-grain booster. A flaw will cause only the affected segment to be replaced, compared with the required scrapping of the entire motor in event a fault is found in a single grain booster.

Additionally, dividing the booster motor into separate sections permits transverse expansion joints in the propellant grain, allowing grain freedom to expand or contract in the axial direction. This freedom from constraint greatly minimizes the tendency for the grain to crack in the hoop direction under conditions of suppressed hoop tension arising from grain shrinkage during cooling after curing, from low temperature conditioning, and from expansion of the case wall under internal pressure during motor firing.

"As for hydro-testing," said G. R. Makepeace, vice president-research and engineering, "we can hydro-test each casing segment before loading propellant, then use pressurized inert gas to accomplish the same purpose after the assembly is completed and ready to fire."

The quality control and testing capabilities presented by the segmented motor approach provide a level of quality in the final product that is far superior to any quality control possible with one huge motor, GCR feels.

• **Growth potential**—One Grand Central official termed the comment on "lack of growth potential" in segmented solid boosters as ". . . a remarkable statement." The very concept of using building blocks as a basis for constructing large boosters has "growth potential" written all over it, he said.

By use of standard segments, boosters may be built to a wide range of total impulse values and thus be used for any combination of upper stage and payload weights for a variety of end uses.

The thrust and corresponding burning time values can be varied to suit any particular trajectory by adjusting the combustion pressure and/or utilizing propellants with the desired burning rate.

The method of adding segments to attain greater total impulse has a limitation, based on the geometry of the motor. In the present design being proposed by GCR, this limitation is five segments, which would fulfill the thrust requirements laid down in the present competition.

In boosters requiring more thrust, a change in core design and nozzle configuration would probably be sufficient, but this solution is good only to a point.

When extremely large boosters are required, clusters of segmented motors will unquestionably be the only answer, in view of the overwhelming disadvantages—economic, technical and reliability-wise—faced by huge one-grain motors. Many of the arguments presented in favor of segmented boosters gain strength as the size of the proposed vehicle increases.

The segmented method, with its ready-made attach points at the juncture of each section, merely continues its building block concept.

• **Inert parts**—The increase in weight due to inert parts required by the segmented approach, in the form of bolts and flanges, has been calculated to be almost negligible. G. Daniel Brewer, assistant vice president-project management and marketing, said this increase in weight has been calculated to equal nine parts in 1000, ". . . an insignificant penalty to pay for all the advantages of the system."

Propellant mass fraction (ratio of propellant weight divided by motor

gross weight) is apparently almost unaffected by the slight additional weight, and will not affect performance appreciably.

• **Propellant geometry**—Considered by some to be the biggest drawback to the segmented approach, end-grain burning is all but ignored by Grand Central. The company says it has a foolproof solution to the situation, and doesn't even consider it a problem.

The grain, measuring ten feet in diameter by 13 feet, has a perfectly cylindrical hole down the center axis. The geometry of the case segments is such that when the exposed surfaces of the propellant are ignited, they will burn at an even rate. The amount of surface exposed to combustion at any instant is essentially constant.

Segments are joined, end-to-end, by a conventionally-designed bolted flange and sealed with an O-ring. A single case segment joined to an appropriate nozzle will provide the propulsive power equivalent to a *Thor* IRBM. Two case segments, forming a motor approximately 26 feet long, will provide the propulsive energy of an *Atlas* ICBM.

Five of the presently-conceived GCR segments incorporated into one motor would be capable of boosting the second and third stages of *Saturn* to a velocity of over 3100 ft./sec. Company spokesmen point out that thrust termination in the solid propellant motors now being produced is such that no vernier correction whatsoever is required for final velocity trimming.

Alleviation of the slump problem faced by propellant grains placed in long-term storage has been accomplished through the use of the short-section grain. The visco-elastic flow which takes place in the grain is a gravity effect that is accentuated by grain size. A short-length segment will slump much less than a full-length motor when stored in a vertical position.

Also, segmentation enables use of dummy cores, removable just before assembly, which would be centered from the girth joint flange at each end of the segment. These would completely eliminate grain slump during horizontal storage.

• **Other advantages**—GCR points out that numerous fringe benefits are to be found in the building block approach to large multi-million-pound boosters. One of these would enable the booster scheduled for a mission to be disassembled and returned to storage, in event the mission is cancelled or postponed. This is not as easily done when oversize vehicles are involved.

Every part of the big booster can be transported by truck, aircraft or ships. This includes the propellant sections (which would be open at both ends and present no propulsive problem in event of fire), the separate nozzles, head closures and igniters.

Combine Dust Reactor, Thermionic Converter?

A Martin Co. engineer has proposed the combination of a dust-fueled nuclear reactor and a shell of thermionic converters to generate from 100 kilowatts to 10 megawatts of electric power in space. Such a device could be developed by 1980, he said.

W. R. Corliss of Martin's Nuclear Division made the suggestion in a paper at last week's Symposium on Space Stations in Los Angeles.

The dust-fueled reactor, Corliss said, is a concept originated by the Armour Research Foundation. In it, the nuclear fuel is in the form of uranium carbide or plutonium carbide dust, so that the heat-transfer liquids or gases can be eliminated with the use of a flowing solid. Thus the possibility of leaks would be reduced.

The dust fuel would be pumped around a racetrack-shaped path, with its flow controlled electrostatically. Nuclear fission would occur only when the dust passes through a region surrounded by a neutron moderator. In other parts of the path, the heated dust would cool by radiation.

Most of the energy created by the fission would be converted to electricity by a shell of thermionic converters, walls of the ducts. The remainder would be re-radiated into space.

Record-Setting Rocket Run . . .



ATLAS VERNIER engines generate 1000 lbs. thrust for 1930 seconds at Rocketdyne's Propulsion Laboratory, Canoga Park, Calif., in the longest run ever made by a rocket engine. Hydromatics Inc., Livingston, N.J., manufactures Flo Ball valves, which control LOX and fuel flow. Hydromatics says its valves are used on all major liquid rocket projects, including *Thor, Titan, Jupiter, X-15, Nova* **and** *Centaur.*

Marquardt Advanced Nuclear Systems for Air and Space

MARQUARDT EXPANDS WORK ON "PLUTO"



Broadened team effort with University of California's Lawrence Radiation Laboratory aims toward early feasibility demonstration of a nuclear ramjet reactor (Project PLUTO).

A supersonic, low-altitude missile capable of weaving, feinting and dodging unobserved by conventional radar while seeking out selected targets — this is to be the mission of the Air Force's proposed nuclear ramjet-powered vehicle of virtually infinite range.

As an integral part of the team which is contributing to this country's all-out race for supremacy in weapons, Marquardt is working with the University of California's Lawrence Radiation Laboratory on the nuclear ramjet program, known as Project PLUTO.

Marquardt's basic PLUTO effort concerns preliminary design of the nuclear ramjet and development of airborne reactor controls and other components for severe temperature and radiation environments. The multi-million dollar program supports a multi-phase corporate effort headed by the Nuclear Systems Division.

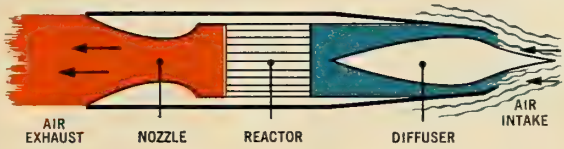
Other aspects of Marquardt's PLUTO effort include: support of LRL's feasibility tests on the non-flyable Tory IIA reactor; design and fabrication of significant portions of the reactor's control system, air ducts, flow instrumentation and remotely operated disconnects; fabrication and test of reactor core structural components; architect-engineering on the test air supply system; participation in a supporting program of environmental tests; and preliminary design of test facilities for full-scale power-plant development.

Highlights of the Corporation's other current nuclear programs include: exploration of both military and non-military applications for transportable reactors of advanced design, including their use for space power; development of the engine control system for the G-E nuclear turbojet; research studies of advanced space propulsion devices utilizing nuclear concepts; materials and processes work with molybdenum, other refractory metals and ceramics; and development of original nuclear instrumentation.

For a copy of Marquardt's new "Nuclear Systems" brochure, write to Mr. Aikman Armstrong, Chief Applications Engineer-Nuclear Systems, The Marquardt Corporation, Van Nuys, California.



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Variable Thrusts in Solids Achieved at Rocketdyne Div.

Variation in thrust levels in solid-propellant rockets—from 700 to 1200 lbs. thrust—has been achieved by Rocketdyne Division, North American Aviation, at its Solid Propulsion Operations in McGregor, Tex.

The variation was accomplished by the use of a mechanical device consisting of movable mild steel nozzle segments covered with pure molybdenum in high-temperature areas, such as the pintle. Thrust is controlled by changing the throat area.

The first results were attained with the use of ammonium nitrate oxidizer, burning the binder at a temperature of 2700°F. Rocketdyne feels it is feasible to adapt the variable-throat principle to the higher-performance ammonium perchlorate propellants, since it has developed nozzles that have successfully withstood temperatures of 5500°F. The use of such propellants would increase pressure sensitivity, and thus the controllability.

Four tests have been conducted in the program, which began in October. The most recent test took place about two weeks ago. Rocketdyne has used the principle in proposals given to the military, and hopes to get a contract based on it. So far, all work has been company-funded.

"The variable thrust nozzle, when combined with our experience in long-duration firings with new high performance propellants, would have specific applications in battlefield missiles, sled boosters, aerial target drones and air-to-ground missiles," said T. E. Myers, vice president of Solid Propulsion Operations.

Radiosonde Measurements Used in Saturn Safety Work

Army weather specialists are taking daily radiosonde measurements throughout the *Saturn* booster development program at Redstone Arsenal so as to predict what the sound intensity from static firings will be at any given location.

The weather data will help insure that firings of the clustered rocket at 1½ million lbs. thrust can be conducted with complete safety of people and property in neighboring Huntsville, Ala.

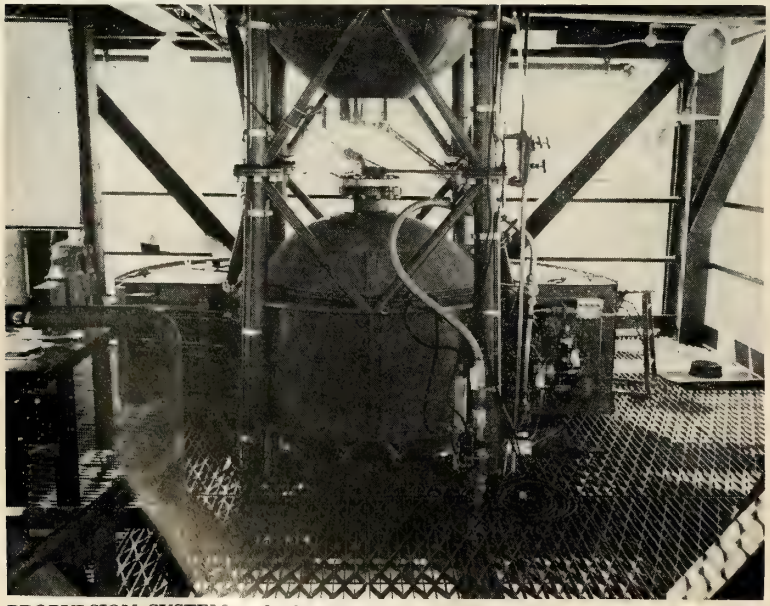
The Army Ballistic Missile Agency is developing *Saturn* for the National Aeronautics and Space Administration. On July 1, the ABMA Development Operations Division will become the George C. Marshall Space Flight Center, an integral part of NASA.

The radiosonde measurements are typical of support services provided for ABMA by the Army Rocket and Guided Missile Agency. Both are elements of the Army Ordnance Missile Command, headquartered at Redstone Arsenal. ARGMA will continue to provide this type of technical support as required after July 1.

The weather data is taken by sending small radio transmitters aloft in helium-filled balloons with instruments for measuring atmospheric pressure, temperature and humidity. On the ground, a radar-type tracking unit and a meteorological recorder transcribe the messages sent by a radiosonde transmitter-modulator. The balloon bursts at an average height of 90,000 ft. and a small parachute carries the radiosonde to earth.

Daily radiosonde measurements during the *Saturn* program will enable the weather specialists to build up a complete area weather history and make it possible to predict the most favorable firing times.

Storable Propellant



PROPULSION SYSTEM tanks installed in static test stand at Edwards AFB, Calif. The 6K system utilizes the same high-performance storable nitrogen-tetroxide and hydrazine planned for *Titan*. Tanks were made by Standard Steel Corp.

Slow-Burning Solid Fuel Developed for APU Use

A solid-propellant grain with the slow burning rate of about 0.042 in./sec. (1000 psi, 60°F) has been developed for use as an auxiliary power fuel source.

AiResearch Manufacturing Division of Garrett Corp., which developed the grain in cooperation with Amoco Chemical Corp., said the slowest-burning propellant previously in existence had a rate of 0.059 in./sec.

The propellant was used to operate a 30 KVA turbo alternator in a 32-minute hot gas run. AiResearch said this demonstrated that duration is no longer a particular limitation on the use of solids for auxiliary power.

The company said a former problem—degradation of turbine performance because of hot gas contamination—did not appear.

AEC Tentatively OK's Martin Reactor Facility

The Atomic Energy Commission plans to issue a permit to The Martin Co. to build and operate a fluidized bed critical reactor facility near Middle River, Md.

The AEC last week gave notice of intent to allow Martin, under an AEC contract, to test the criticality of slightly enriched uranium oxide fuel pellets. The facility, to be constructed by mid-1960, will operate at maximum power of about 10 watts.

The permit will be issued unless a request for a hearing is received by May 12, the commission said.

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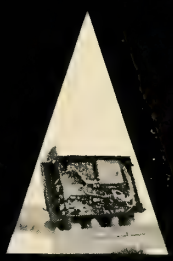
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SIE provides airborne telemetry, signal conditioning systems —using solid state electronics— for the U. S. Army's new Pershing Missile, recently successfully test-fired at Cape Canaveral. SIE measurement equipment delivers unexcelled reliability under extreme airborne environmental conditions—providing the Martin Company with advanced, precise electronic missile measurements.

or detailed information about SIE telemetry, signal conditioning systems, please contact IGHT MILITARY PRODUCT MANAGER.



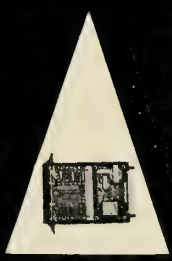
AC-3A
AC Amplifier



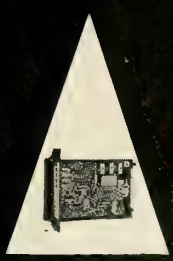
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High Temperature R&D Money-Starved

A survey of how a fundamental field is hurting from lack of adequate funding and a shortage of glamor

"But there can be no doubt that we can maintain an effective deterrent only by making certain that no other country will ever reach the next higher technological plateau before we do . . ."
General Thomas S. Power, USAF
Commander in Chief
Strategic Air Command

by John F. Judge

PHILADELPHIA—The U.S. is spending money at the rate of about $1.5 million per year in the field of basic high-temperature research—the fundamental source of progress in rocketry.

Dr. Aristed V. Grosse, president of the Research Institute of Temple University and one of the handful of men actively engaged in broadening our fundamental understanding and handling of high temperatures, estimates that over $30 million per year would just barely meet our needs.

There is little doubt that we have almost exhausted our fund of basic knowledge in the fields most critical to the advancement of the space effort. Various leaders in government and industry have pointed this out time and time again. The National Academy of Sciences has endorsed this viewpoint (M/R, April 4, 1960, p. 28). But little is actually done.

Five years ago the late Dr. Wendell Latimer of the University of California, upon receiving the Nichols Medal, said: ". . . high-temperature thermodynamics holds the key to the important problem of U.S. leadership in nuclear energy, jet engines and guided missiles." It still does. This is because there is a direct relationship between the maximum power generated and the temperatures involved.

Expenditures in this area, says Dr. Grosse, would pay off handsomely at least in the decreasing of the rate of military obsolescence.

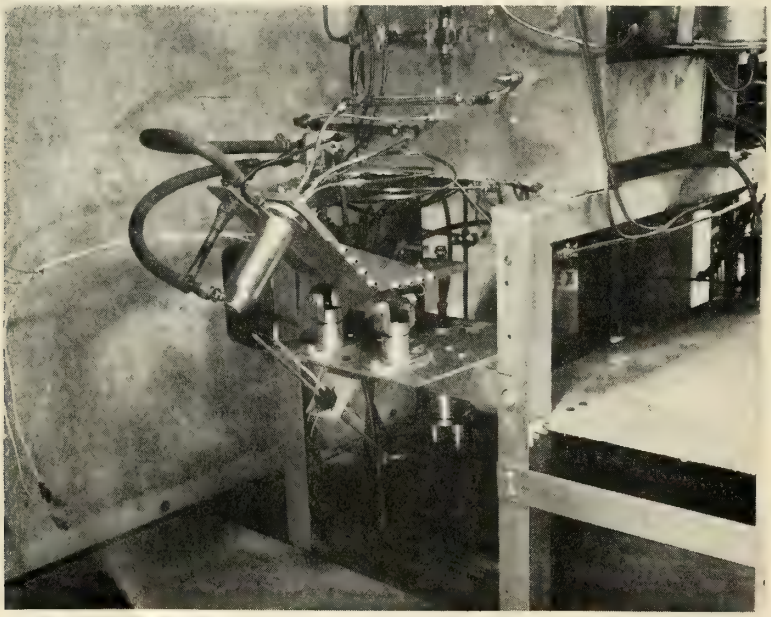
• **Glamor lacking**—The Temple scientist went on to another problem in high temperatures—manpower. This type of work is quite unromantic and lacks the glamor often attached to other aspects of the space business. Fewer and fewer young men are attracted to the field, he said. One of the most important aspects of high-temperature work, and one in which we are particularly weak in this country, is the discipline of an inorganic chemist. The reactions involved and their understanding are less likely to be achieved as quickly as in other more glamorous categories of pure science. To emphasize the manpower point, Dr. Grosse said that a single German University will turn out more PhD level men and women in inorganic chemistry in 1960 than all of the institutions in the U.S.

Under Dr. Grosse, the Institute has been specializing in high temperatures for twelve years. In terms of degrees Kelvin, the area of interest lies between 2000° and 50,000°. Regrettably, all of the current work is concentrated nearer the lower end of the scale. The primary aim of the Institute is the creation and control of high temperatures—and an understanding of their nature.

The main laboratories are located in a mansion formerly owned by Isaac D. Levy. An extension, a high temperature test site, is operated by the Institute in a small group of buildings on a farm in the vicinity of Valley Forge.

Most of the current projects are concerned with the generation of high temperatures, usually through chemical means. Fuels and oxidizers such as cyanogen, ozone, O_3F_2, O_2 and F_2 are a few of the more common ones in use. Temperatures around 5500°K have been investigated in this manner (M/R, Dec. 14, p. 17). The exhaust streams of these experimental rockets have been used to evaluate materials for nose cones and nozzles.

A major project rapidly nearing completion at the Institute is a microrocket propellant evaluator. Under development for the Army Ballistic Missile Agency, the instrument is designed to give an evaluation of labor-



PROPELLANT EVALUATOR being developed for ABMA. The microrocket is mounted on the V-shaped deflection unit and is designed to provide data on laboratory quantities of new propellants.

itory ideas in propellants wherein only a small amount of the substance is available. The device measures the thrust effects through use of a torsion type deflector attached to the motor. This is necessary because no known materials will exist in the exhaust stream long enough to give meaningful results in deflection-type measurements. Although the data obtained are limited, it provides a basis for deciding whether the test propellant holds any promise.

• **Powder metal torch**—Another interesting development is the construction of a powder metal-oxygen cutting torch. This device uses the burning of powdered aluminum and other metals to cut through construction materials such as concrete.

The Institute has built a small plasma jet to aid in the studies of the behavior of gases at high temperatures.

The field of high temperatures has been but minutely penetrated. Researchers at the Institute intend to go on in a number of divergent directions within the field. Some of the more promising areas include:

• Detonation—largely unexplored in the past. Quenching and slowing of detonation waves, and dead pressing (rendering explosives safe by reaching maximum density) are of particular interest to the Temple group.

• High energy propellants—liquids and solids.

• Plasma Jet—To be used in chemical studies as well as aerodynamic heating. The end of chemical temperatures has not yet been reached.

• Inorganic Chemistry—theoretical studies.

• Combustion of metals—the powder metal-oxygen cutting torch is an example in this area.

Dr. Grosse and his staff firmly believe that it is only through working with high temperatures that basic understanding can be achieved. For years it has been common knowledge that finely powdered aluminum and an open flame lead to disaster. The Institute has had little or no trouble in this area. Most professional scientists would be uncomfortable anywhere near ozone yet the Temple staffers work with it almost as a matter of course. There are many unknown factors yet to be discovered before the handling of high temperatures becomes practical; working with the environment instead of talking about it is the shortest route to success.

The next technological plateau in space will probably be attained through high temperatures. It is the fervent hope of Dr. Grosse and others in this field that the United States will get there first.

Ceramics Pushed

Metals being outstripped in space materials needs

Space Age materials requirements have all but exhausted the possibilities of metals and the trend is more and more toward ceramics for solutions to the high temperature problems.

John R. Townsend, Special Assistant to the Director of Defense Research and Engineering, told a recent meeting of the American Ceramic Society in Philadelphia that the Government was intensifying its effort in the field of ceramics to the point where it is considering establishing an information center on ceramic materials similar to those in existence at Battelle Memorial Institute.

In the same vein, Dr. Townsend pointed out that the usual time lag involved from discovery to application is eight years in materials research. If materials research processes cannot be speeded up, "we will be handicapped more and more in the technological race."

Looking to the future, Townsend outlined six major areas of interest in which the potential space uses of ceramics were enormous.

• Specific data on the rare earth oxides such as melting points, vapor pressures, density, ductility, thermal conductivity, thermal shock resistance and emissivity.

• Simplified processes for radomes, nose cones, insulation, coatings, adhesives and rocket nozzles.

• Effects of radiation on ceramics.

• Structural and semi-structural ceramics for use up to 3500°F.

• Bonding of ceramics to metals as coatings to withstand high temperatures, erosion and corrosion.

• An information center on ceramics with a broad familiarity of technical and patent literature.

• **Manpower**—Twice as many ceramic engineers, technologists and glass technologists are needed immediately to carry out various development programs necessary to the missile/space effort. Dr. John H. Koenig, Rutgers University, told the meeting that enrollments are not increasing despite the fact that the average ceramic graduate has as many as eight job offers on graduation. Since vehicles such as *Tiros I* carry nearly 10,000 separate ceramic components, and the new developments in nuclear and electronic fields are often tied to ceramics, a dearth of qualified men in this field will have far-reaching and disastrous effect.



ENGINEERS

SITE ACTIVATION

We're rolling up our sleeves for the next important step of activating bases throughout the United States. Design or liaison engineers with B.S. in M.E. or E.E. and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations.

Assignments are at Warren Air Force Base, Cheyenne, Wyoming; Offutt Air Force Base, Omaha, Nebraska; Fairchild Air Force Base, Spokane, Washington; and in San Diego.

Please send complete resume to Mr. R. Merwin, Engineering Personnel Administration, Dept. 130-90, 5652 Kearny Villa Road, San Diego, Calif.



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Silica Radomes Survive Force of Ballistic Re-entry

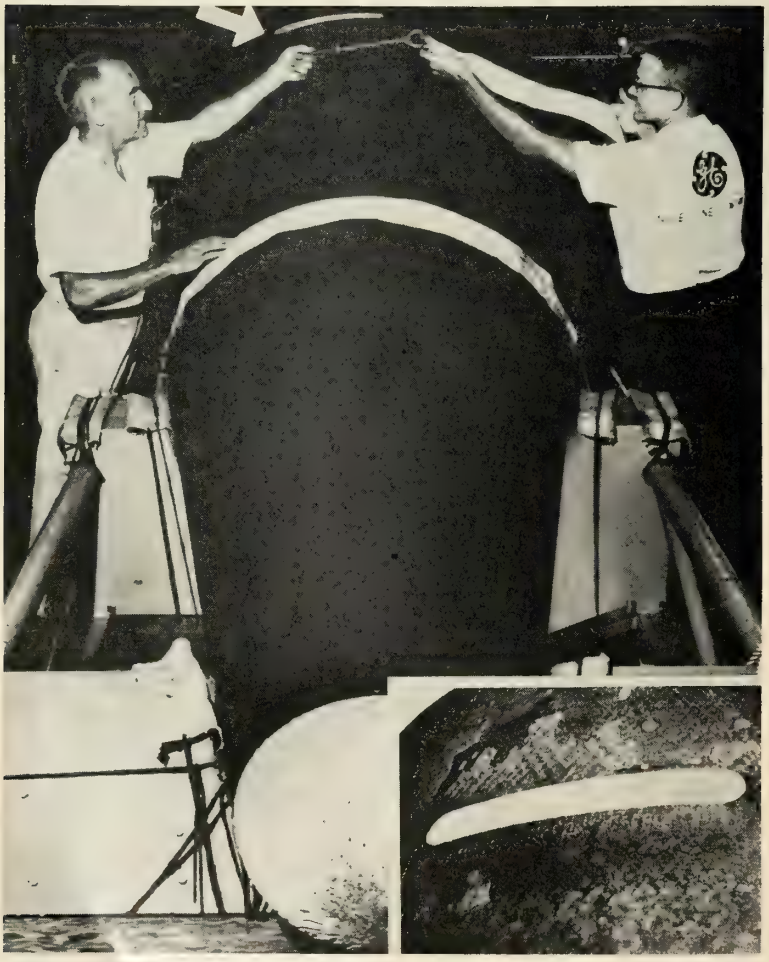
Fused silica antenna windows have survived ballistic re-entry in an experimental ablative nose cone.

The windows were in a General Electric Missile and Space Vehicle Department RVX-2 experimental nose cone flown 5500 miles down the Atlantic Missile Range on July 21, 1959, but data on these radomes was just released by the Air Force.

The windows were made by the Corning Glass Works, Corning, N.Y., from pure silica through their "Multiform" process. This method of manufacture, in which the gaseous silica is condensed into a solid slab, permits the fabrication of a wide variety of shapes—a feat not possible prior to the Corning development.

The pure silica, in its fused state, is extremely viscous at its softening point around 2880°F and tends to sublime before it can liquefy and flow. In addition, excellent thermal shock resistance (Coefficient of thermal expansion—3 x 10^{-7} per degree F), a stable dielectric constant and a low loss tangent over a broad temperature range contribute to the material's success as an ablative radome.

At a frequency of 8.6 x 10^{9} cps, the dielectric constant is 3.58 at 77°F and 3.57 at 750°F. At the same frequency, dielectric loss factor ranges from 0.00069 at 77°F to 0.00098 at 750°F.



ARROW POINTS to one of the two fused silica windows, produced by Corning Glass, that protected telemetry antennas in the experimental nose cone. The inset is a close-up view of one of the windows.

LOX Ground Transfer Lines Can Be Extended

Studies at the National Bureau of Standards indicate that the transferring of cryogenic fluids by pipelines can be done over distances much greater than are currently in vogue provided there is an awareness of the cool-down performance limitations.

The theoretical examination of such transfer problems have been completed and the Bureau is now in the process of experimentally verifying the paper conclusions.

The entire project has a twofold purpose—to determine the hardware and techniques needed; and to ascertain what losses will occur during these long-distance transfers.

The Bureau's conclusions are derived from a mathematical model based on the laws of conservation of mass, energy and momentum. These laws were used along with verified assumptions and empirical data to yield a complete model consisting of 12 equations which describe the flow characteristics of a transfer line. This flow model permits the design of a transfer system by relating all the pertinent parameters—flow rate, line length, line diameter, pumping pressure, heat leak and fluid properties.

Since economic and feasibility questions are unanswered in the equation, the Bureau computed relations involving all of the known loss factors and, together with equations for heat leak and fluid drag, included them in the total computation.

Thermocouples Measure Temperatures Up to 5000°F

Extensive investigations at Minneapolis-Honeywell's Research Center, Hopkins, Minn. have shown that two relatively new types of thermocouples have promise above 3000°F and as high as 5000°F.

Rhodium-iridium/iridium couples can be used in vacuum or inert atmospheres and in oxidizing environments up to 3600°F. This is 600° beyond the capabilities of platinum-based thermocouples.

The other thermocouple, tungsten-rhenium, is outstanding in stability and power for applications in other than oxidizing atmospheres up to 4000°F and potentially almost to 5000°F, according to John B. Moxness, Brown Instruments market manager. This is in contrast to the 2400°F limit for chrome-alumel thermocouples.

The studies were carried out by Honeywell in cooperation with the National Bureau of Standards and several other companies.



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"A Mathematical Model of an Air Defense Operation and a Method of Evaluation," a paper by SDC's staff, is available upon request. Please address inquiries to Mr. E. A. Shaw at SDC.

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NAA Cuts Costs with IBM Computers

Nation's 'largest' electronic data processing system links firm's divisions, boosts speed and accuracy

CANOGA PARK, CALIF.—Teamwork by International Business Machine Corp. and Rocketdyne Div. of North American Aviation, Inc., has paid off in a series of substantial benefits to the nation's rocket engine program, including speed, accuracy, efficiency and reduced costs.

Over 175 pieces of equipment in Rocketdyne's plants have made electronic data processing and control an indispensable aid to research, development and production of both solid and liquid propellant rockets.

What the two companies call "the largest electronic data processing complex in the nation" is due in part to a 30-mile microwave link connecting North American's two IBM 705's and two 709's at the Los Angeles Div. to the two 709's at Rocketdyne. The Autonetics and Missile Divisions of NAA soon will join the net for an even larger complex.

Developed at Rocketdyne's request by IBM and the Pacific Telephone and Telegraph Company, the network passes information back and forth at the rate of 75,000 words per minute.

Use of the link has eliminated the past problem of a peak work load at one computer installation simultaneous with a slow period at another computer installation. Work can now be distributed so that the divisions utilize the machines as a pool. Overall efficiency has increased measureably.

In addition to the main microwave link, Rocketdyne has secondary data links—leased wire cryptographic systems—connecting its operations at Neosho, Mo., McGregor, Tex., and the Santa Susana Mountains near Canoga Park. By fall, another link is expected to connect the division with the test stand for the F-1 million-and-a-half-pound-thrust rocket engine at Edwards AFB, Calif.

In addition to achieving better work distribution for its six big computers, North American also has gained the capability of programing each computer for the work it will perform most efficiently. The two 709 models at Rocketdyne are used mostly for scientific work, while the 705's at the LA division are occupied primarily with business matters.

However, even the two 709's at Rocketdyne may become tied up, and a job will be transmitted to a 709 at the LA division.

• **Typical operation**—In practice, engineers at Rocketdyne feed magnetic tapes into an IBM 9702 remote tape unit to the equipment maintained by the telephone company. The data is channeled through multiplexing gear which feeds it subsequently to the microwave transmitter.

A paraboloidal-reflector antenna atop the Canoga Park plant beams these signals at the relay station on Oat Mountain. (The dog-leg between Canoga Park and Los Angeles via Oat Mountain is made necessary by the Santa Monica Mountains, which prevent more direct line-of-sight transmission.)

At Los Angeles, the signal is reconverted to computer language and placed on tape by another 9702 unit, which feeds it to a model 760 control device. This unit examines the signals to insure that no errors have been introduced during transmission through interference. Then the tape is fed into the 709, the above procedure is reversed, and Rocketdyne gets the results.

APPLICATIONS

• **Production control**—One of the major fields in which Rocketdyne is applying its computers is mechanized production control (MPC), which is expected to yield savings of $50,000 monthly by October. Using a RAMAC 305 (random access method of accounting control) computer, MPC makes it possible to locate any part in the plant, including experimental project hardware, and determine its status within 15 minutes.

This time includes 0.6 sec. for the computer to locate the information, another second or two for the printer to display the data, and the remaining time for routing to the requester.

In full operation since January, MPC began as a study in 1958 and used a punched card system until last December, when the RAMAC was phased in. A 15% reduction in supporting labor costs has been made through use of the system. The method also has contributed to a 37% reduction in costs of *Thor* and *Atlas* engines for the Air Force.

MPC operation follows a flow pattern with few steps. An engineer's design, released for production, is assigned a seven-digit control number. This is supplemented by a code which tells management what "mix" of work (production programs, test programs and experimental programs) is currently in progress.

Information fed into the computer can be retrieved through use of many filing systems. Data can be filed according to part number, engine type, contract number, scheduled completion date, etc. Therefore, if management wants to know the status of all parts being produced under a particular contract, the RAMAC selects the information immediately.

Part numbers assigned to hardware can vary according to their interchangeability among several different engine modifications or engine types; hence the control number links all interchangeable parts.

Data regarding part number, contract number and other statistical information are entered on a color-coded production order, which is used as a basis for key-punching the programing cards to be fed into the RAMAC for future planning. (Plans are currently in the works to eliminate the need for this colored production order.)

The open order card, having been key-punched, is then fed into the RAMAC's storage discs, which whirl at 6000 rpm. The information is then available via a pickup arm that seeks out the proper disc, then extends until the proper bit of data is selected. Since the disc speed does not vary, the data must be picked up "on the fly."

As each job passes through various operations, production progress notifications (ppn) and inspection progress notifications (ipn) are filed with MPC by production control personnel. These reports are key-punched into progress cards which are fed into the RAMAC. The computer then changes all previous status information on that job,

and substitutes the latest data. If a job does not move or does not have its production status changed in any way, no card is filed.

At the end of each day, daily receival and completion reports are prepared by the RAMAC, and these are made available to every department head by 8 o'clock the next morning. The department chief is thus kept fully informed on every production order which moved in his department the previous day.

MPC personnel are currently handling approximately 500 to 600 requests for information (RFI) daily. Within a few months, Rocketdyne expects to have a series of teleprinter installations in operation about the Canoga plant which will allow remote RFI's to be handled.

In addition to the daily receival and inspection reports, a weekly analysis of all work in progress is supplied to management. About 20,000 work orders are in progress at any one time.

Company officials emphasize that the MPC system is utilized for all work in the division's Canoga Park facilities, not just for straight production. Experimental projects and test programs with numerous changes also are handled by the RAMAC system.

• **Budgetary Control**—Application of computer techniques for budget control has been initiated with the aid of a cathode ray tube and the IBM 709. The program covers cost factors affecting any given program: money spent through the prior month, commitments outstanding, adjustments in the estimated annual overhead rate, estimated price adjustments on certain purchases, and estimated charges on cancelled contracts with suppliers.

The system, designated Allocations for Budgetary Control (ABC), produces graphs on 200 projects each month to keep Rocketdyne management informed when costs and budgets don't line up. On each of the graphs are two plots: one line representing planned expenditures, and another showing actual expenditures. Precise differences are shown numerically.

ABC has thus far proved its worth in the *Atlas, Thor, Jupiter* and *Saturn* programs. Cost collection centers, the IBM 709, and a cathode ray tube setup combine to put cost graphs in the hands of top management within 10 days after the close of each month.

Budgetary responsibility for all phases of a function is assigned to the manager in charge. A production manager, for instance, is responsible for budgeting the cost of testing parts which his department turns out, even though the testing may be performed by another group. Thus action can be brought to bear on trouble spots spotlighted by the month-end graphs.

Cost details are collected and classified according to functional responsibility, then transferred to key-punch cards. At month's end, card information is transferred to magnetic tape and transmitted to the Los Angeles Division of North American, 30 miles away. This microwave link directly connects computers at the two NAA divisions.

On arrival at the LA division, data are fed into an IBM 705 computer to up-date the "balance-forward" records and these results are then transmitted by microwave back to Rocketdyne. The processed data are fed into the IBM 709, which converts them into graphic data and portrays them on a 7-inch cathode-ray tube. Photographs are then made of the presentation with a 35-mm camera. It takes less than 12 minutes to photograph the 200 monthly charts.

After processing, photos are bound into report books, and placed in the hands of management the following day.

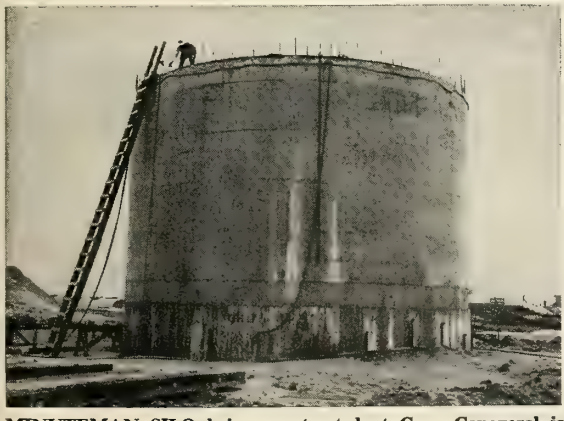
• **Model parts list**—A master list of every item needed to build a particular rocket engine is the result of pressures of time, and the available solution of a high-speed data processing system. Dubbed MPL by Rocketdyne, the model parts list shows, for each type of engine, the parts to be manufactured in-house, the raw material involved, the parts to be purchased, and the likely spare parts to be needed in the field.

Listing items on punched cards, the division files by alphabetical and numerical order. In addition to the usual identification number and part description, the cards show where the part fits, how many are used in each engine, instructions for manufacturing or purchase, a breakdown code if the component is part of an assembly, and a Federal manufacturer's code. Changes are recorded and distributed daily. New MPL's are compiled every other week, reflecting the latest modifications in an engine.

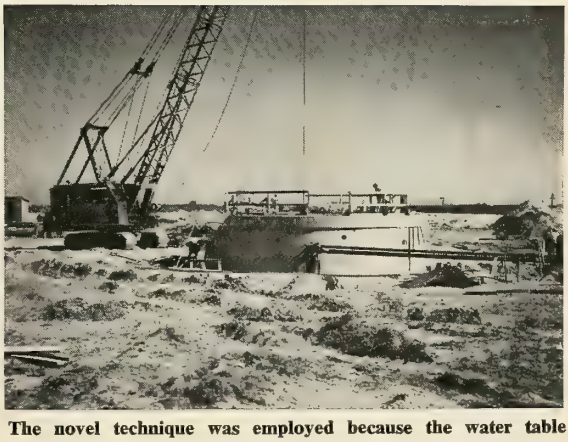
If a standard bolt should fail during an *Atlas* test, the MPL could be used with the computer (IBM 709) to indicate rapidly each engine using that bolt, so that every one can be checked for reliability.

The MPL system allowed Rocketdyne to go into production on the new MA-3 *Atlas* engine within hours after receiving the go-ahead from the Air Force. The system chose every item which was interchangeable between the old and the new engine and wrote new orders for production; the division signed contracts with suppliers for many of the remaining parts.

Sinking a Minuteman Silo



MINUTEMAN SILO being constructed at Cape Canaveral is poured in sections above ground and then sunk into the sand.



The novel technique was employed because the water table is about 5 ft. below surface, preventing hole digging.

'Hot' Bolts Best fo Impact Location

But tests by Sandia indicate that liquids with skunk-like odors may have value; fire-orange paints evaluated

by B. E. Dieruf*

Radioactive bolts, liquid odor-producing agents, and phosphorescent fire-orange paint were used in a recent missile test program to find a better method for rapid impact location.

The "hot" bolts won hands down, but some highly malodorous mercaptans were strong contenders for the honors. Their dedicated persistence—even when buried—earned a limited assignment in future recovery applications. (A mercaptan—an oil liquid similar to the alcohols or phenols, but containing sulfur—is the principal ingredient in skunk oil.)

Tests were performed by Sandia Corp. at White Sands Missile Range, N.M., to support optical tracking and to aid in identifying aboveground debris after impact. Helicopters were used to facilitate search in probable impact areas.

• **Past problems**—After an experimental flight test, the missile often must be recovered so that any test data stored in tape recorders can be analyzed and components can be examined to determine what damage, if any, occurred during the test.

It has always been difficult to locate the point of impact, particularly in the case of an air-launched missile.

If the only consideration during a flight test were to simplify recovery of the missile itself, this could be accomplished fairly easily. One would simply study the terrain and determine the best impact location with respect to camera, radar, and sound ranging stations. The launch point for each missile would be established in accord with the best impact location.

The missile recovery, however, generally is not the most important guide in determining proper launch conditions and location. The launch point frequently is chosen to insure good camera coverage during the launch phase. This results in one or more "fixed" launch points. When any significant number of flight tests have been scheduled, there will be variations in their launch parameters—planned and unplanned—and consequent variations in the flight of the missile in its range, direction, and duration of flight.

The missile may impact anywhere from a few miles to as many as 100 miles away—in a heavily instrumented area, such as the designated impact areas at WSMR, or in a lake region, mountainous area, or some other rather inaccessible location.

Participants in the flight test usually agree upon any changes in flight plan which will prevent the missile from landing in obviously unsatisfactory locations; in spite of these concessions, however, the major criterion in setting the test flight pattern is the best possible coverage in the launch region, rather than in the impact region.

• **Compromises**—In addition to these deliberately planned factors which create difficulties in locating a missile, additional problems make it hard to more than approximate the planned launch conditions.

Many factors enter into the problem for an air launch—in particular, the speed, position and direction of the aircraft at the moment of launch.

In a typical test program, both the aircraft contractor and the range personnel want a maximum number of missile rounds fired per hour by the aircraft on the range. But the missile contractor and the fuze contractor are more concerned that the actual launch conditions are as close as possible to the test plan.

Because of these conflicting desires, compromises are made. Tolerances established for the launch frequently permit a firing corridor extending two miles on each side of the flight line and 3000 feet above and below the requested altitude.

If tolerances are too narrow, aircraft and range time are wasted in efforts to conform to them; if they are too lax, desired launch parameters rarely are achieved.

There are of course many other problems. The presence of any of these conditions or any combination of them can increase considerably the dimensions of the probable impact area.

Experience indicates that a radius of five miles must be drawn about the predicted impact point to include any significant percentage of the total impacts of unguided missiles which travel 30 to 60 miles. For guided missiles, capable of extensive maneuvering, this area would have to be increased considerably.

Guided missiles often can be homed more closely to a specified impact point by placing a target—such as a radar beam or a heat source—in the impact area.

• **Radioactive bolts**—For range safety in the experiment employing radioactive bolts, it was necessary that they have a short half-life. If the unit were not recovered, a short half-life for the radioactive material would insure that the personnel hazard would dissipate rapidly; however, any delays in the test program made use of a short half-life element expensive.

Selected bolts were stainless steel, 10-32 screw thread. A hex head, 5/16-in. across flats and 5/16-in. high, contained a pellet of antimony 124. Antimony 124 has a half-life of 60 days.

At the time of procurement, each bolt had a radioactive output of 3 Roentgens/hour at one foot. This output was selected so that the bolt at the ground surface would produce a usable indication of 0.15 R—roughly five times the background level—even if the search helicopter were 100 feet away and 100 feet up. Search passes could be made every 200 feet.

Missiles used during the tests were unretarded, and they impacted at at least 400 mph. The impact generally buried the entire missile with the exception of a few fin fragments about the crater.

A bolt was installed on each fin, in the hope that one or more fins would break off at impact and remain on top of the ground. Since soil provides a good shield, strong radiation is needed to obtain a significant indication from a buried source.

Four flights were made carrying radioactive bolts. The first two were standard flights and the bolts were installed in the fins. On the first shot the bolts were of no assistance in recovering the unit when buried in soft earth.

On the second round, the missile impacted on hard ground, and the fins were scattered over a large area—up to 30 yards from the crater. The impact

* *Project engineer, Sandia Corporation, Albuquerque, N.M.*

occurred within one mile of a camera station, so a good plot of the flight was available, but the bolts would have insured recovery of the missile in any event.

The other two tests on which the bolts were used had different flight parameters. On both of these flights the missile was cut in two in flight with primacord (an explosive).

The forward section was unstable aerodynamically. It decelerated rapidly, and consequently did not bury on impact. In anticipation of this, bolts were installed in the forward section of the missiles—four on the first, and five on the second.

These rounds were not tracked to their point of impact by either camera or radar, and thus furnished a good opportunity for testing the effectiveness of the radioactive bolts. The first of these missiles landed in a cleared area and could undoubtedly have been found without the aid of the bolts, but it first was located by the scintillation counter in the helicopter. The second landed in a heavy brush area, but was located easily by the helicopter. The impact spot of this test flight was so obscured by brush that, even after the scintillation counter indicated impact location, the searchers had to hover over the area for several minutes before they located the missile visually.

During these tests with the active bolts, only two men received any appreciable exposure, and even this was well under the allowable 3 R in a three-month period. Both of these men were active in the installation and recovery of the bolts on all of the units tested.

Of the three methods attempted to facilitate missile recovery, the radioactive bolts proved most satisfactory. With a helicopter-borne scintillation counter, a large area of ground—even though extremely rough—can be covered in a short period.

If the search were extended in time, a recorder could be used with the counter to reduce operator fatigue. On level ground, radioactive bolts would help a ground research party considerably, but in rough terrain the sources would be shielded and their effectiveness reduced considerably.

Missiles which bury on impact require different techniques. It might be possible to use a much stronger source for the radiation, or to add a tail line with an attached source to the missile, or perhaps to make arrangements to have the radiation source ejected immediately before missile impact.

• **Odor producers**—On several of the flights, a very powerful odor-producing agent—one of the mercaptans—was used. Four 8-ounce bottles of the liquid were placed in the missile and arranged so that they would shatter on impact, thereby permeating the dirt in the crater and reaching the surface. The mercaptans were chosen because of their astonishingly strong odor.

A quantity of amyl mercaptan (boiling point: 126°C) was used in some preliminary tests and in two of the flight tests. In one preliminary test, an 8-ounce bottle was buried in a foot of loose dirt and shattered with a blasting cap. In another test, a bottle was shattered with dynamite, so that the liquid was completely vaporized.

The tests had similar results. In both cases, a band of very strong odor approximately 0.2 mile wide formed downwind. The terrain where the tests were conducted did not permit checking the odor at further than 2 miles, but the strength of the odor at this distance indicated that it would have been detected easily even at 3 miles.

One day after the test the odor was appreciably weaker, but still noticeable 50 yards downwind.

The first flight missile with this material in the nose landed about 50 feet from the recovery party, so the odor was not needed to locate the impact point. Excavation of the crater, needless to say, was quite unpleasant. The second round landed within a half mile of the recovery party with similar results.

The amyl mercaptan was quite expensive—about $100 a quart—and since about a quart was needed per flight a material was needed which would satisfy the requirements and still be significantly less expensive. Butyl mercaptan, with the trade name "Spotleak," was found to be much cheaper—about $1.00 a quart—and was quite similar chemically.

The only significant difference between the two materials was that butyl mercaptan had a lower boiling point (98°C). Because of this, it dissipated too rapidly in the air and left only enough odor to make the excavation of the crater unpleasant.

Only one flight test was made with this material. The flight missile landed near a camera station and was located without the assistance of the mercaptan. One hour later, the odor scarcely was noticeable 40 yds. downwind.

• **Visual locaters**—Opinions varied concerning the value of the phosphorescent-type paints in facilitating the acquisition and tracking of the missile with cameras.

In this test series, half of the missiles were painted black and white, and the other half were painted fire-orange with black markings. Tracking the fire-orange missiles was not appreciably easier; however, the fire-orange fragments around the impact point were much more visible and identifiable.

On another test flight, two 6-ounce cardboard containers of "glitter" (small, shiny pieces of silvered glass such as used on posters and signs) and two 6-ounce containers of red paint pigments were placed in the aft section of a missile.

When the "glitter" was sprinkled on the ground during a preflight test, it produced bright reflections noticeable from a considerable distance, but very little of this material was scattered on the ground by the actual impact, and the effect was unnoticeable from any distance.

Radiosonde Readied for Launch



ROCKET-BORNE radiosonde, developed by Army Signal Research and Development Laboratory and produced for the Signal Corps by Atlantic Research Corp., is loaded into nose cone of *ARCAS* rocket. It will separate 40 miles up and float down.

GE Fuel-cell Generator Now Due for Delivery to Services

One of the first practical military applications of fuel cells—devices that convert chemical energy directly to electricity—is now undergoing evaluation testing. The 30-lb. unit, a portable power supply which produces 200 watts of 24-volt direct current for 14 hours, replaces a conventional 55-lb. generator or 80 lbs. of batteries.

The fuel-cell generator is being developed by General Electric for Navy's Bureau of Ships and the Army Signal Corps to power a portable field radar. First units are scheduled to be delivered for military evaluation this month.

With added fuel, the power pack is designed to operate at full load for a minimum of 2000 hours without maintenance. GE scientists, however predict a much longer life. Experimental fuel cells have been operated continuously for more than a year.

Thermal efficiency—electrical power out vs fuel energy in—is reported to be 50% at full load and more under partial load. This compares to 35-40% efficiencies of the best internal combustion engines or turbine generators.

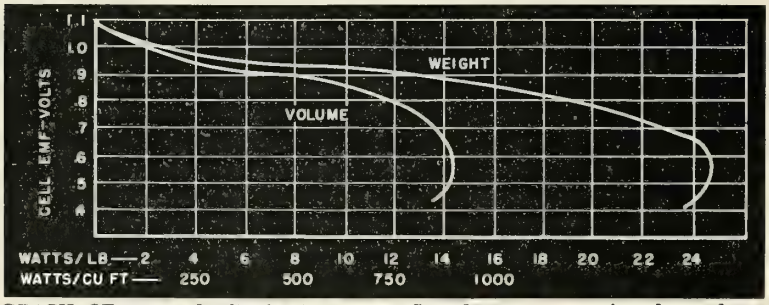
• **Simple and quiet**—Heart of the GE unit is a series of 30 ion-membrane fuel cells, each an 11-in. square assembly approximately ¼-in. thick. The hydrox cell consumes oxygen from the surrounding air and hydrogen produced by the decomposition of a metal hydride "fuel." Such a system is silent, odorless, has no moving parts, operates at negligible internal pressure and temperature, is simple to operate, and uses a solid electrolyte rather than a caustic liquid.

According to the GE announcement, the power pack can be refueled with no interruption in operation. The metal hydride is contained in reusable, hermetically sealed canisters, each containing approximately six lbs. of fuel to keep the unit going for 14 hours at full load.

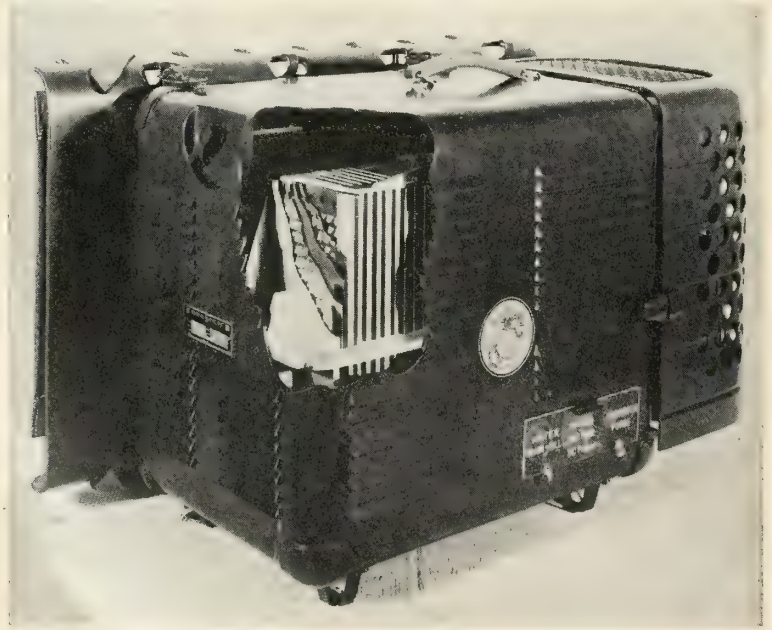
Although the principle of the fuel cell has been known for well over 100 years, only in the last year or so has there been any significant development effort. This effort has already shown some amazing results, however: less than a year ago, GE demonstrated its first working model—a tiny unit which generated only enough power to turn a toy airplane propeller. A few months after that, Allis-Chalmers produced a propane-fueled generator powerful enough to drive a farm tractor and plow.

The many merits of fuel cells—high-energy density, reliability, wide operating range, non-attended operation, and ability to operate in zero-gravity and high-shock environments—have generated intense military interest. Anticipated applications range from submarine to satellites.

Much research is being done under military contracts; probably as much or more is being done entirely by industry, with its own funds.



GRAPH OF power density (watts per pound) and power per unit volume shows significant improvement over previously published data.



CUTAWAY MOCKUP of GE fuel cell power pack shows arrangement of individual fuel cells. Perforated guard on right end protects gas generation system.

Computers Converse Among Themselves at Model Basin

Two Navy computers have been talking to each other in a common mathematical language through an electronic data processing system designed, built, and installed recently by Electronic Engineering Co. of California.

Known as the ZA-100 Computer Language Translator and located at the Navy's David Taylor Model Basin near Washington, the system permits an IBM 704 to freely exchange mathematical data or process raw scientific material with a Remington Rand Univac.

The ZA-100 can translate Univac data into IBM 704 data or vice versa, or it will translate analog or binary data from hydro-mechanical and structural tests and spectrum analysis data into either of the two computer formats. This system is capable of performing 13 electronic data translations and is the largest delivered to date by the firm.

Other "interpreters" are in use at the Systems Development Corp., Santa Monica, Calif.; The Martin Company, Denver, and North American Aviation, Inc., Missile Division, Downey, Calif.

Luskin Heads Lockheed NASA Program

Harold T. Luskin has been named program manager directing Lockheed's Missile and Space Division's production of an initial order of 16 advanced *Agena-B* satellites for the National Aeronautics and Space Administration. The *Agena-B* will be used as launch vehicles atop *Atlas* and *Thor* first-stage boosters for earth orbiting and deep space missions. Luskin, who joined LMSD in 1959 as a consulting scientist for satellite systems development, co-authored the Air Force's first major study on earth satellites for military use. Prior to joining the firm, he headed a scientific research team at Douglas working on *Zeus* and *Honest John*.


LUSKIN

Dr. Charles L. Critchfield: Former director of scientific research for Convair division of General Dynamics Corp., accepts the position of vice president-research with Telecomputing Corp.

G. W. Soderquest, R. E. Wilkinson and **H. Kilberg,** former engineering personnel with RCA at AFMTC, have formed a new missile electronics R&D firm, Astonautics, Inc. Company's field of interest will be radio interference and frequency analysis, infrared and computation systems.

Iden F. Richardson: Appointed a vice president at Hughes Aircraft Co. Will continue to serve as manager of the company's commercial products activities.

George C. Stewart: Former director of sales for Dalmo Victor Co.'s aviation radar and ground support equipment line, named vice president-customer relations and contracts for Air Logistics Corp.

Robert O. Bullard: Elected vice president and general manager of Baldwin-Lima-Hamilton Corp.'s Electronics and Instrumentation Division. Was formerly general manager of General Electric's Power Tube Department at Schenectady.


BULLARD

Seymour Winuk: Former sales manager for the Selenium Rectifier Division of Radio Receptor Co., joins Britton Electronics Corp. as vice president in charge of sales and will direct the firm's semiconductor marketing activities.

Frederick I. Scott, Jr.: Joins the engineering staff of Litton Industries' Electron Tube Division as a senior engineer. Was previously employed by Eitel-McCullough as a design and development engineer for RCA.

Donald R. Piatt: Named director of engineering at Universal Controls Inc. Was formerly vice president of research and engineering for the Underwood Corp.

Robert E. Zator: Joins American Potash & Chemical Corp.'s market research group as an analyst.

Charles F. Adams: Elected chairman of Raytheon Co., succeeded as president by Richard E. Krafve, former executive vice president.

Dr. James King, Jr.: Joins the technical staff of Electro-Optical Systems, Inc., as a senior scientist in the Energy Research Division. Was formerly a senior research engineer at Atomics International in the Solid State Physics group.

Benjamin O. Delaney: Former assistant Technical Operations manager promoted to manager succeeding **John C. Geist,** now associate director at Vitro Laboratories. **William L. Freienmuth,** assistant head of the Systems Development department will assist Delaney.


DELANEY

R. Harvey Whidden: Elected to the newly created position of executive vice president-marketing for Bulova Watch Co. Inc.

Stanley M. Smolensky: Appointed executive director of marketing at Thiokol Chemical Corp.'s Reaction Motors Division.

Hughes Aircraft Co. appoints five laboratory managers: **Dr. R. L. Roderick,** ballistic missile and ballistic missile defense systems; **J. W. Ludwig,** space systems; **Leonard Mautner,** special systems; **R. K. Ausbourne,** tactical missile systems and **Dr. L. J. Money,** tactical aircraft systems.

Fred S. Hage, Jr.: Former assistant to the president and director of advertising and public relations at Solar Aircraft Co., promoted to the newly created position of director of marketing.

Edward F. Burton: Elected vice president-engineering at Douglas Aircraft Co., succeeding **Arthur E. Raymond,** retired.

O. F. Henning: Named marketing manager for Texas Instruments Inc., Geosciences & Instrumentation division.

Wassil D. Tussusov: Elected chief of Electronics Engineering at Photronics Corp., a newly-formed scientific research and development organization. Was formerly associated with the Electronic Laboratory of Pupin Cyclotron Laboratories at Columbia University and Control Instrument Co., Inc.


TUSSUSOV

William J. Curran: Named director of market research for the Defense and Industrial Group, Packard Bell Electronics, assigned to the firm's Washington, D. C., office. Was formerly an economist with the Missile and Space Vehicle Dept. of General Electric.

Paul Petrack: Appointed general manager of the Silicon Division of Columbus Electronics Corp. Was formerly product manager for I.T.&T. Semiconductor Components Division and with the Semiconductor Division of Radio Receptor Co.

John L. Kennedy: Formerly navigation systems group leader, elected special staff engineer for Wilcox Electric Co. He will serve as a consultant to all of the firm's departments.

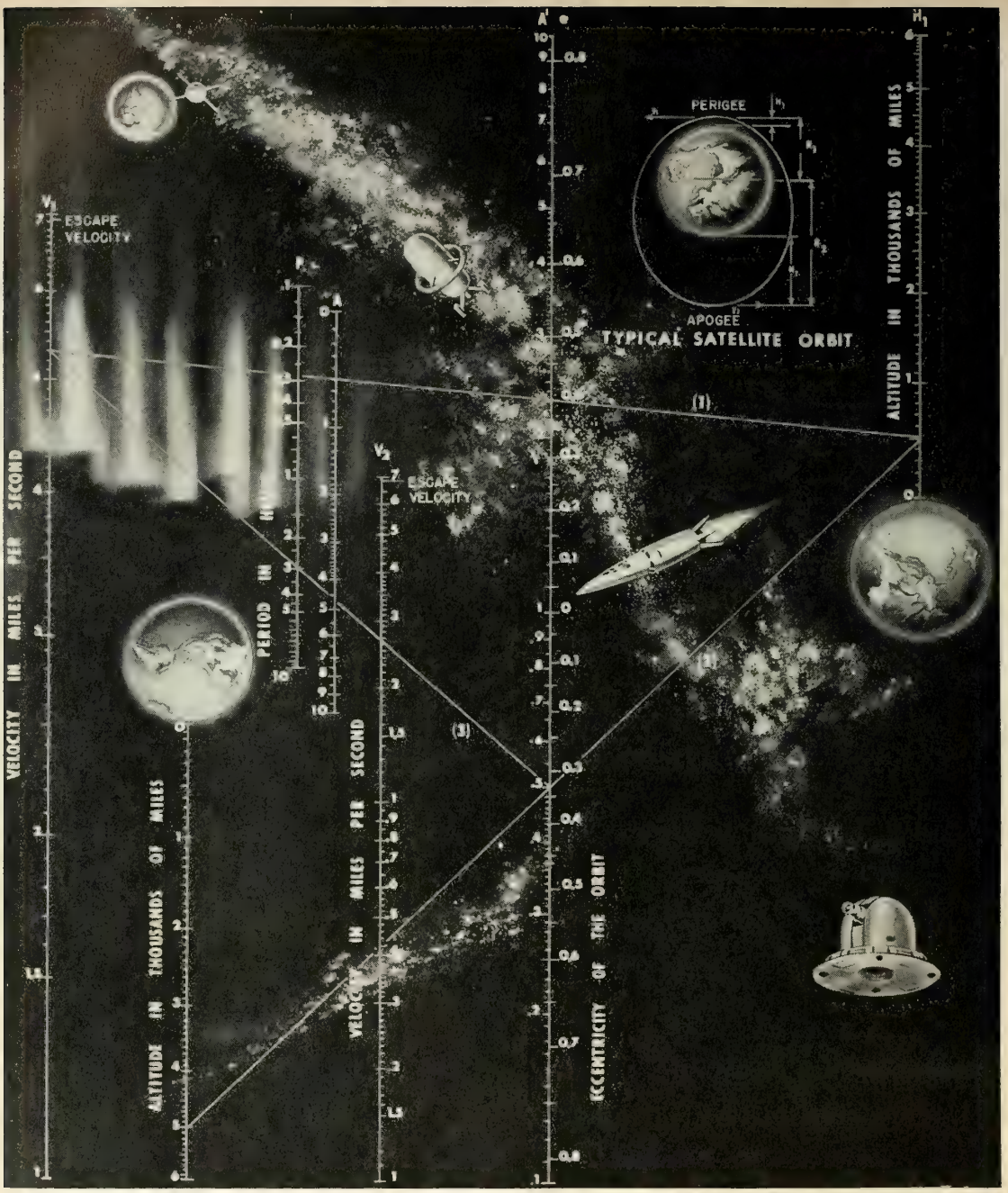
Dr. Franklin E. Lowance: Appointed president of Advanced Technology Corp., a research subsidiary of Electronic Communications, Inc. Was previously president-engineering of the Crosley Div. of Avco Corp.

Christian H. Pedersen: Former production supervisor of Superior Tube Co.'s Nuclear Products division, promoted to director of the Mechanical Development Dept.

Frederick A. Henry (USAF, ret.): Appointed manager of long-range planning for Summers Gyroscope Co. Previous posts: director of planning, Associated Missile Products Corp.; assistant to the vice president and general manager of A. O. Smith Corp., and executive contract officer for Fletcher Aviation Corp.

Bernard W. Eades: Appointed manager-Value Engineering for the Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc. Previously served as manager-Value Engineering for Stromberg-Carlson; sales manager, Pressco Casting & Manufacturing Co.; sales engineer, Industrial Division of Revere Copper & Brass Co. and industrial engineer for General Motors Corp.


EADES



SATELLITE ORBIT CHART EXAMPLES—1. A satellite at an altitude of 500 miles is given a speed of 5.3 miles per second in a direction parallel to the earth's surface at that point. Find its altitude and velocity at the other end of its orbit, and find the eccentricity and period.

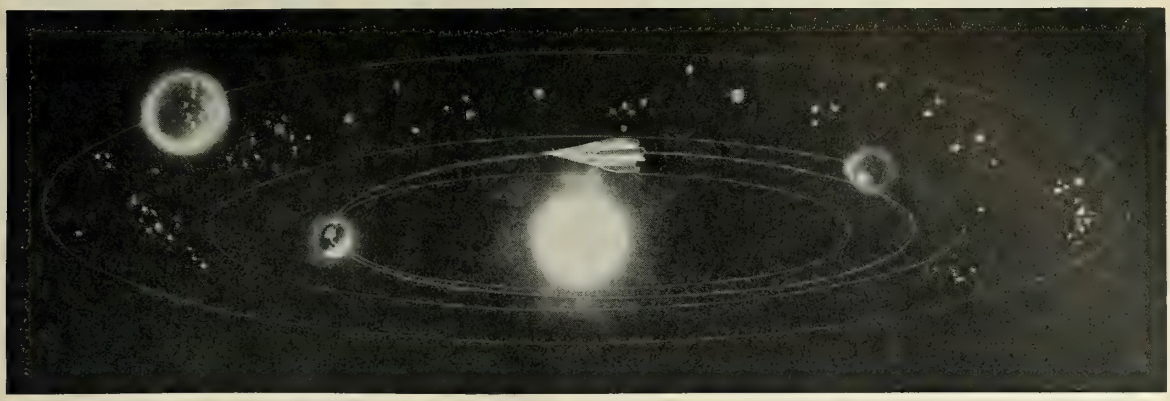
Solution: Connect 500 miles on the H_1 scale to 5.3 miles per second on the V_1 scale to 5.3 on the V_1 scale. Read the value of A = 0.5. Connect 0.5 on the A^1 scale to 5.3 on the V_1 scale. Read V_2 = 2.65 miles per second and P = 2.9 hours. Connect 500 on the H_1 scale to 0.5 on the A^1 scale, extending it to intersect H_2 at 5000 miles.

Therefore, at the far end of the orbit, the altitude is 5000 miles and the speed is 2.65 miles per second. The period is 2.9 hours, and the eccentricity is 0.33.

2. A satellite has a perigee altitude of 500 miles and an apogee altitude of 5000 miles. (a) What decrease in speed at perigee is required to produce a circular orbit? (b) What increase in speed at apogee would produce a circular orbit? (c) What would be the period?

Solution: (a) Connect 500 on the H_1 scale to 5000 on the H_2 scale. Read the value of A^1 = 0.5. Connect 500 on the H_1 scale to 0.5 on the A scale and extend this line to cut the V_1 scale at 5.3 miles per second. A line from 500 on the H scale through A = 1 meets the V scale at 4.6 miles per second. A line from 4.6 on the V_1 scale to 1 on the A^1 scale gives P = 1.5 hours. Therefore a decrease from 5.3 to 4.6 miles per second would produce a circular orbit altitude of 500 miles. The period would be 1.5 hours.

How To Plot Satellite & Planet Orbits



The history of the natural laws determining the motion of the moon about the earth and of the planets orbiting the sun is classic in the history of observation and the application of these observations to mathematics. From them Sir Isaac Newton (1642-1727) expounded his universal law of gravitation, a work for which he was later knighted.

It is interesting, indeed, that it was he who first established as fact the possibility of an artificial satellite. Scientific efforts of later years were mostly concerned with the application of Newton's basic natural laws to bodies in our solar system. Only in recent times have these laws been utilized to predetermine the paths of artificial bodies orbiting the earth and the sun.

A satellite may be caused to travel any one of an infinite variety of paths depending upon the initial direction and velocity given to it by the rocket booster.

Tiring of the computations required to determine these trajectories, at the Huntsville, Alabama, U.S. Army Rocket and Guided Missile Agency, scientists Ferdinand Mitchell and Thomas Moore prepared the graphical charts or nomographs indicated by the straight lines on the *Satellite and Planet Orbit Charts.*

These nomographs are drawn so that results of calculations may be found quickly from the relation of points upon them. By following the examples, one can quickly become skilled in the use of the nomographs for the determination of satellite orbits around the earth or for planets and asteroids orbiting the sun.

For a background, artist Hughes Michael has depicted satellites performing various tasks including the speculative one of capturing an asteroid which, perhaps is made up of nickel-iron.

Or if you prefer a simpler project and would be satisfied with traveling at an aphelion velocity of 17.9 miles per second at a distance of 94,400,000 miles from the sun by next July, you can just throw away your pencil, relax in your chair and wait knowing full well that you are rushing there on planet earth; and that both earth and pencil will faithfully obey Newton's Universal law of gravitation.

(b) The speed at 5000 miles altitude is 2.65 miles per second, as shown on the V_2 scale. A line from 5000 on the H_1 scale through A = 1 cuts the V_1 scale at 3.25. Finally, a line from 3.25 on the V_1 scale to A^1 = 1 cuts P at 4.5 hours. Therefore, an increase from 2.65 to 3.25 miles per hour at apogee would produce a circular orbit at 5000 miles altitude.

(c) The period would be 4.5 hours.

3. A satellite at an altitude of 250 miles is given a horizontal speed of 4.5 miles per second. Determine its altitude at the other end of the orbit.

Solution: Connect 250 on the H_1 scale to 4.5 on the V_1 scale. Read A = 1.2, extending this line to the H_1 scale. This line cuts H_2 scale at altitude less than H_2 = 0. Hence, this satellite does not orbit, since its path intersects the earth.

DESCRIPTION OF THE CHARTS

The charts illustrate the elliptical or circular orbits followed by planets or satellites, in terms of the heights and speeds at the ends of fthe major axis of the orbit.

The satellite orbit (at the left) applies to satellites of the earth. It contains 6 scales, not including the "A" scale. From right to left they are: (1) the altitude H_1 in the thousands of miles above the earth's surface at either perigee or apogee; (2) the eccentricity of the orbit; (3) the speed, V_2, at the end of the major axis opposite H; (4) the period of the satellite's revolution; (5) the altitude, H_2, at the end of the major axis opposite H_1; and (6) the speed V_1 at the point H_1.

The planet orbit chart (at the right) applies to satellites of the sun. Its scales are essentially the same, except that distances are measured from the sun instead of from the earth.

These charts do not attempt to take into account such effects as the slightly non-spherical shape of the earth, or the effects of the attraction of other bodies.

The eccentricity is a number, lying between zero and one, which specifies the shape of the orbit. Its value is zero for a circular orbit. The flatter the orbit, the greater the eccentricity.

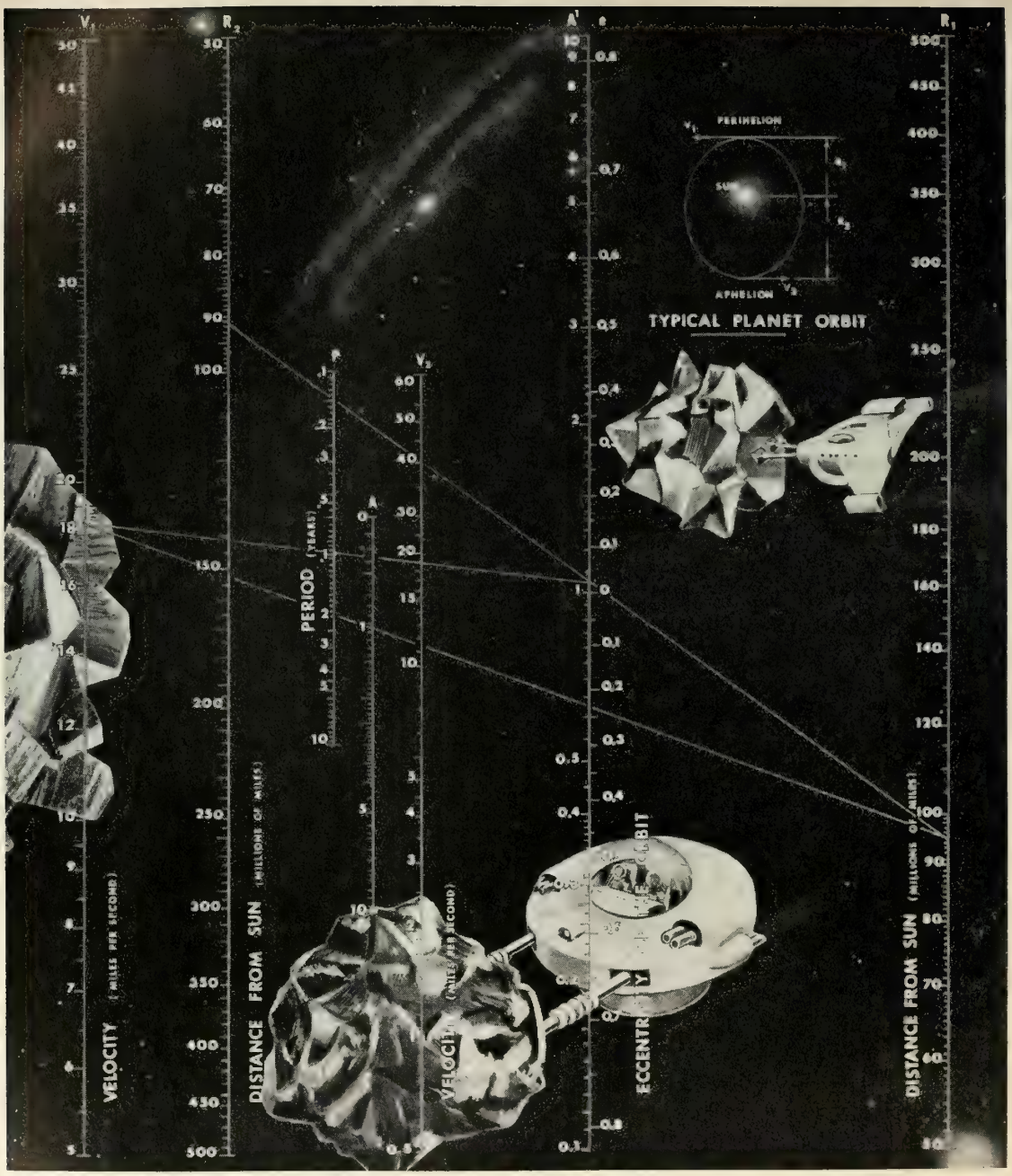
HOW TO USE THE CHARTS

There are three lines to draw. Line 1 extends from the H_1 (or R_1) scale to the V_1 scale. Line 2 extends from the H_1 (or R_1) scale to the H_2 scale. Line 3 joins the V_1 scale to the e scale. These lines are drawn in whatever order is dictated by the given quantities of the problem.

The intersection of line 1 with the A scale, the intersections of line 3 with the P and V scales, and the intersections of lines 2 and 3 with the A and e scales are read. The construction should always be such that the values of A and A^1 are equal.

NOTE

If line 1 passes through A = O, the value of V_1 is the escape velocity at that altitude. If the value of A (or A^1) is one, then V_1 is the speed required for a circular orbit at the given altitude.



PLANET ORBIT CHART EXAMPLES—1. The earth's orbit around the sun has an eccentricity of 0.017 and its period is 1 year. Find the perihelion distance and speed, and the aphelion distance and speed.

Solution: From the e scale, we note that an eccentricity of 0.017 is equivalent to $A^1 = 1.03$. A line from this point on the e scale through P = 1 year intersects the V_1 scale at 18.3 miles per second, and the V_2 scale at 18.9 miles per second. The line from $V_1 = .3$ through A = 1.03 cuts the R_1 scale at 95 million miles. The line from $R_1 = 95$ million miles through A = 1.03 cuts R_2 at 91 million miles.

Therefore, at perihelion the earth's distance from the sun is 91 million miles and its speed is 18.9 miles per second. At aphelion, the distance is 95 million miles and the speed is 18.3 miles per second.

2. The artificial Planet Pioneer IV was launched by the U.S. Army on March 2, 1959. Its perihelion distance is 93 million miles and its speed at perihelion is 20.8 miles per second. Determine its aphelion distance and speed, and find its period.

Solution: A line from 93 million miles on the R_1 scale to 20.8 miles per second on the V_1 scale cuts the A scale at 0.68. A line from $A^1 = 0.68$ to $V_1 = 20.8$ cuts V_2 at 14 miles per second and cuts P at 1.4 years. The line from $R_1 = 93$ million miles through $A^1 = 0.68$ intersects R_2 at 140 million.

Therefore, the aphelion distance is 140 million miles and the aphelion speed is 14 miles per second. The period is 1.4 years.

contracts

ARPA

$1,800,000—Raytheon Co., for finding the best practical method of detecting ICBM's among a flock of decoys. Program involves analysis of data collected by missile tracking radar.

NASA

$27,683—High Vacuum Equipment Corp., Hingham, Mass., for services and material to design, fabricate and deliver a vacuum system.

MISCELLANEOUS

$1,700,000—Lear, Inc., Santa Monica, for follow-on production of automatic flight control and stabilization systems for *Q-2C* drones. Subcontract from **Ryan Aeronautical Co.**

$800,000—Levinthal Electronic Products, Inc., subsidiary of **Radiation, Inc.,** Palo Alto, Calif., for design and production of four tropospheric scatter radio power amplifiers. Subcontract from **Page Communications.**

NAVY

$1,870,000—Temco Aircraft Corp., Dallas, for manufacture of booster and sustainer motors for the *Terrier* missile.

$1,600,000—Temco Aircraft Corp., for flight test work and services on the *Corvus* missile.

$700,000—Giannini Controls Corp., Pasadena, for free gyros for the *Talos* missile. Subcontract from **Bendix Aviation Corp.**

$306,000—Midwestern Instruments, Tulsa, Okla., for production of high gravity recording oscillographs.

ARMY

Hexcel Products, Inc., Berkeley, Calif., for research and development work on high-energy propellants. Amount not disclosed.

$9,170,710—Hercules Powder Co., Wilmington, Del., for continued production of propellant and explosives plant maintenance at the Radford, Va., arsenal.

$6,300,000—Convair Division, General Dynamics Corp., for continued development of *Redeye* missile.

$5,723,807—Western Electric Co., New York City, for *Nike-Hercules* missiles.

$5,303,907—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant* missile system.

$4,077,000—Western Electric Co., research and development on *Nike-Zeus.*

$3,457,070—Radioplane Div., Northrop Corp., Van Nuys, Calif., for *RP-76* target missile production.

$1,134,013—Chrysler Corp., Detroit, for the *Redstone* missile system. (Two contracts.)

$1,070,080—Butler Manufacturing Co., Kansas City, Mo., for 16 fuel transporters for the *Jupiter* missile.

$794,518—The Martin Co., Orlando, for *Lacrosse* research and development program.

$651,000—Western Electric Co., New York City, for *Nike* spare parts and components.

$490,275—Gilfillan Bros., Inc., Los Angeles, for *Nike* system components.

$189,426—Electro-Optical Systems, Inc., Pasadena, for research and development of techniques for obtaining massive hypervelocity particles by electronic means.

$167,894—Minneapolis Honeywell Regulator Co., Aeronautical Div., St. Petersburg, Fla,. for *Jupiter* gyroscope AB-7 GS-3.

$158,780—National Research Corp., Cambridge, Mass., for developing a basic scientific understanding of ablation.

$150,000—Radiation, Inc., Melbourne, Fla., for ground stations for *Courier* communication satellite system, satellite checkout.

$117,900—Firestone Tire & Rubber Co., Los Angeles, for repair parts for *Corporal* missile (two contracts).

$82,375—Pacific Construction Co., Fairbanks, Alaska, for additional modification to *Nike* sites Tare, Peter, Mike and Jig.

$57,772—Redstone Machine & Tool Corp., Huntsville, Ala., for *Saturn* fabrication services.

$49,567—Ford Motor Co., Newport Beach, Calif., for study of nuclear weapons effects.

$32,600—Brown Engineering Co., Huntsville, Ala., for *Pershing* engineering and fabrication services.

$32,587—The Martin Co., Orlando, for concurrent repair parts, *Lacrosse* missile.

$26,968—Northern Roofing and Sheet Metal, Anchorage, Alaska, for additional modification to *Nike* sites.

AIR FORCE

Boeing Airplane Co., Aero-Space Div., for preparing a preliminary design for a recoverable booster for spacecraft. Amount not disclosed.

The Garrett Corp.'s AiResearch Manufacturing Co., Los Angeles, for study of various infrared detectors and recommendation of cooling them in extremely high altitudes. Amount not disclosed.

Hathaway Instruments, Inc., for modification of ground support equipment in the *Titan* testing program. Subcontract from **The Martin Co.-Denver.** Amount not disclosed.

$6,000,000—Kellogg Switchboard and Supply Co., for intersite communications in the *Atlas* missile complex.

$3,500,000—Lockheed Aircraft Service, for installation and flight test of an airborne electronic system that will provide a seaward extension of the SAGE defense network. Subcontract from **Burroughs Corp.**

$2,900,000—IBM Corp., Federal Systems Div., Owego, N.Y., for development of prototype model bomb navigational missile guidance system.

$320,093—North American Aviation, Rocketdyne Div., for services, material and design data to conduct a program in in-service engineering analysis for the *Thor* and *Jupiter* propulsion systems and associated ground support equipment for both systems.

$310,293—North American Aviation, Rocketdyne Div., for maintaining and operating a contractor storage site for support of *Atlas* propulsion subsystem.

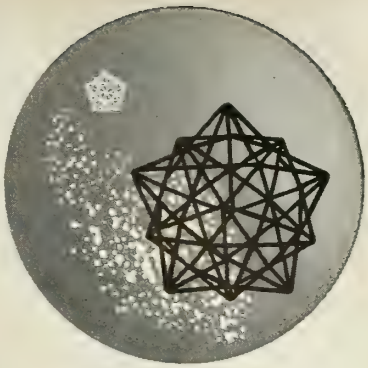
$105,000—University of Chicago, for research directed toward studies of lunar properties.

$65,101—Pickard and Burns, Inc., Needham, Mass. for research and development on accurate methods of tracking and communicating with space vehicles.

$56,028—Thiokol Chemical Corp., Reaction Motor Div., Denville, N.J., for continuation of 'Research on the Influence of Ions on Rocket Combustion Processes.'

$54,406—Midwest Research Institute, Kansas City, Mo., for research on unsteady-state solid-propellant burning.

$33,500—Packard Bell Computer Corp., Los Angeles, for satellite computer.



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SCIENTISTS

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Minuteman

by William J. Coughlin

LOS ANGELES—The Air Force has accelerated the *Minuteman* program drastically to bring the missile to operational status by the summer of 1962, rather than sometime in 1963. Maj. Gen. Osmond J. Ritland, Commander, Ballistic Missile Division, said the acceleration comes partly as a result of slashing early silo tests at Edwards AFB from 18 to eight.

Ritland told the Aviation Writers Association meeting here that *Minuteman* is "a major economic breakthrough" in the ballistic missile program.

Flight tests are due to begin at Cape Canaveral later this year. Flightweight engines of the missile have already been static-tested by the contractors, Thiokol Chemical Corp. for first stage, and Aerojet-General Corp. for second stage.

Ritland said the Air Force has found a straightforward silo configuration to be adequate, rather than a complex U- or W-shaped silo to cope with hot exhaust gases.

• **Precise environment**—Assembly of the missile after operational status is achieved will be done at centrally located production depots "where the environment is conducive to precision assembly and checkout procedures."

Hill AFB, Ogden, Utah, will be the first assembly and recycle facility. Indications are that the Air Force will not transport finished product from Boeing's plant in Seattle, but will ship subassemblies from various first-tier subcontractors to the "production depots" for final assembly.

Construction cost for each *Minuteman* squadron is expected to be $20 million for each launch site, and construction will probably extend over a period from 15 to 18 months.

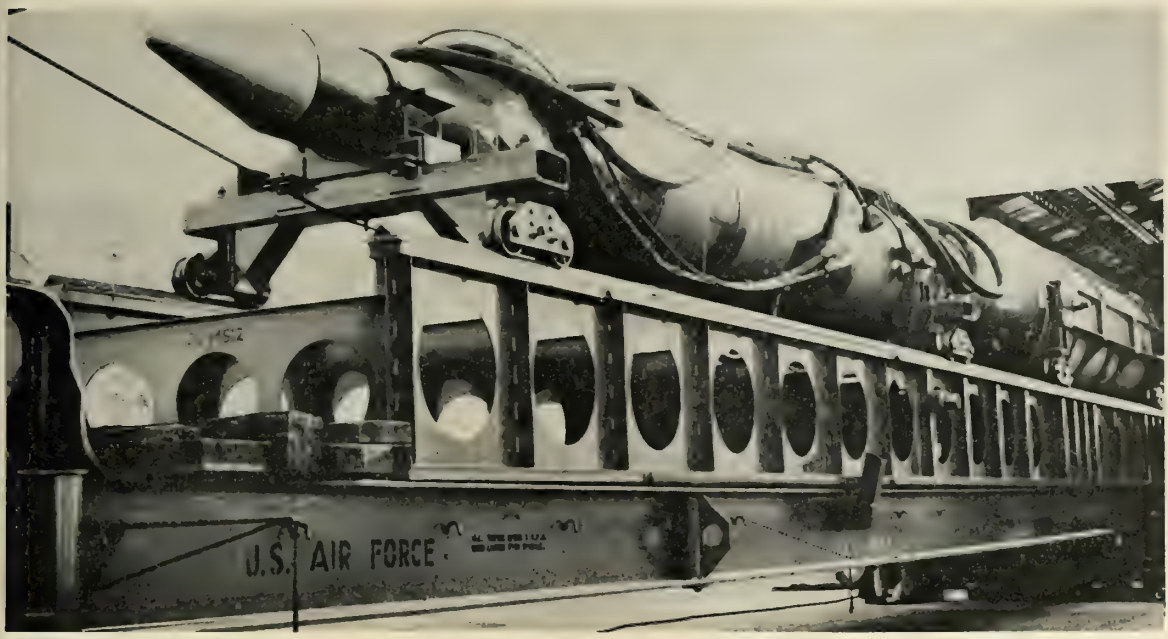
The Air Force has said the mobile trains carrying the missile initially will be on "pre-selected sidings" with missiles zeroed in on targets. Other trains will be underway around the country, each within a short distance of these sidings.

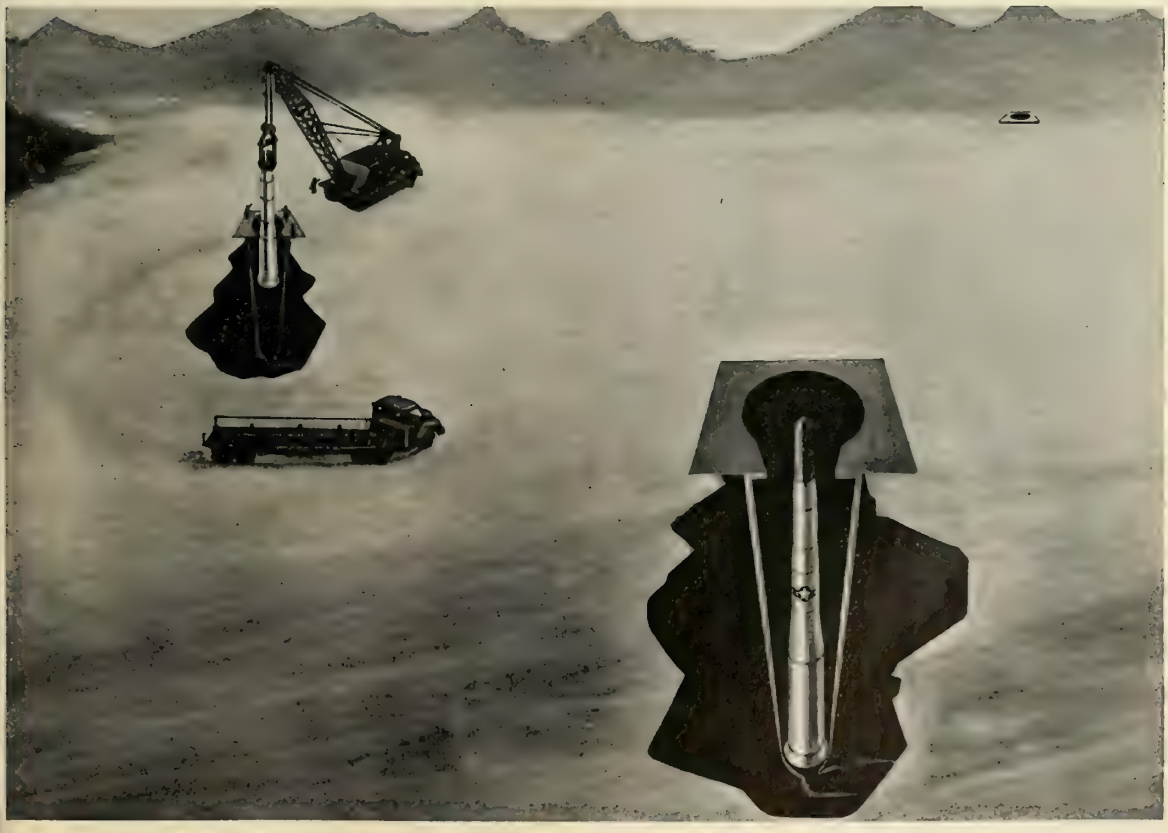
• **Trend reversed**—Ritland noted that *Minuteman* "reverses the historical trend toward progressively more complex and more costly weapons."

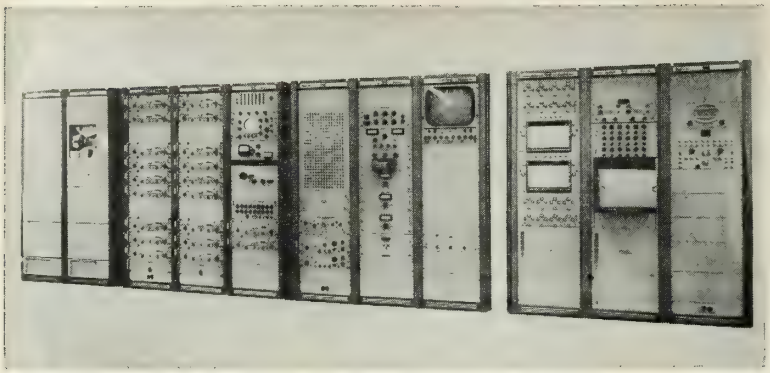
A total of 1500 tests were conducted by Air Force and Boeing before silo tests at Edwards AFB. These ranged from 1/20 to 1/3 scale.

Pictures on these pages are of the full-scale Minuteman *silo-test model which made its first successful tethered shot from a silo at Edwards AFB, Calif., on Sept. 15, 1959.*

peed-up: Operational In 2 Years







Pershing Analog Data System

The analog portion of the MADRE (Martin Automatic Data Reduction Equipment System), which will be used to process telemetry data from test missiles such as the *Pershing*, was delivered recently by Electro-Mechanical Research Inc.

The 11 racks of equipment feed telemetry data into a companion high-speed digital acquisition and computing system for handling of missile test results. All decommutation equipment is controlled from a single centralized panel. A 390-jack central patch-panel enables the operator to combine analog and digital lines in any desired combination.

EMR supplied to the Martin Co. a tape recorder/reproducer, subcarrier discriminators, tape-speed compensators, a decommutation subsystem, a high-frequency galvanometer recorder, two low-frequency pen recorders, check-out equipment, an audio amplifier and a speaker for playback of a voice channel or track.

In this portion of the MADRE system, the recorded radio telemetry signals transmitted during tests are played back, separated and demodulated, decommutated where necessary, displayed and recorded or applied to digitizing equipment.

Circle No. 225 on Subscriber Service Card.

Liquid H_2 Thermometer

Highly accurate temperature measurements of liquid hydrogen (–422.9°F) will be possible with a miniature platinum resistance thermometer announced by Trans-Sonics Inc. of Burlington, Mass.

The transducer incorporates a trimming network that permits accuracy and interchangeability to be maintained to ±0.1°F over the range –400° to –435°F. The transducer has a resistance change of 27.6 ohms over its operating range. Construction is of stainless steel.

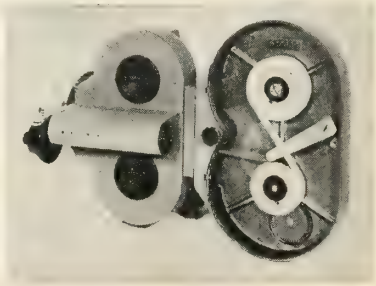
Circle No. 226 on Subscriber Service Card.

60-Second 16mm Developer

A new technique of processing movie film right in the camera within 60 seconds of exposure has been announced by Specialties Inc. The innovation lies in the development of RAPROROLL, a chemically treated paper that develops and fixes film automatically on contact.

In the magazine processor, the RAPROROLL and exposed film or photographic paper are pressed together under nominal pressure. The paper releases its liquid to the emulsion on the film. The required quantity is carefully controlled by web thickness and composition. There is no dripping; free liquids, pumps, seals and precision metering applicators are eliminated. Each area of emulsion receives a fresh application. There is no re-use with the accompanying danger of contaminative by-products remaining from previous applications.

RAPROMATIC processing is available on a production basis for 16-mm. film negative processing.



Circle No. 227 on Subscriber Service Card.

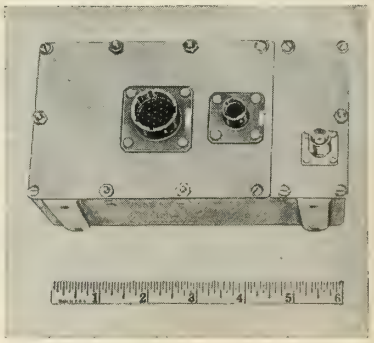
Missile Command Receiver

Development of a new command receiver for use in missiles was announced by the Crosley Division.

About the size of a kitchen matchbox, a miniaturized command receiver weighing only three pounds has been developed by the AVCO Corp. The receiver will be used in missiles as a safety device, among other things. Crosley executives explained that should a missile go awry when it is fired, an operator on the ground can push a button that sends a radio signal to the command receiver to destroy the missile in flight.

Crosley said the new receiver is a fully transistorized solid-state device that affords great reliability. Use of solid-state components helps account for the receiver's small size and light weight.

The unit is equipped with four



channels that accept four separate radio commands, and its circuitry is such that combinations of commands can be executed without the use of mechanical relays.

Circle No. 228 on Subscriber Service Card.

Machining Power Source

Maximum metal removal rate of 20 cu. in. per hour in electrical discharge machining is possible with Elox Corp.'s new ER-300 Roughing Power Supply.

The ER-300 is a completely electronic power supply having no moving parts. It is silent and can be moved about easily. When aluminum electrodes are used with the ER-300 the electrode wear ratio is between 20 and 50 to 1 end wear. In the rough machining of contour or cavity type dies for forging or metal forming, machining may be

completed at full metal removal rates to within 0.060 in. of final contour size. Finish machining is then easily accomplished by switching to any Elox NPS power supply without moving the die set-up, as all Elox Power Supplies are interchangeable.

In addition, ER-300 is applicable to rough machining through hole-type die openings that are currently rough-sawed to shape.

Circle No. 229 on Subscriber Service Card.

Leak Detector Improved

A mass spectrometer-type leak detector capable of tagging one part helium in 10,000,000 parts of air has been developed by Consolidated Electrodynamics Corp.

The CEC Type 24-210B Leak Detector operates on 105-125-volt, 60-cycle power outlets and weighs 155 pounds. Response time is less than one second for 50% full-scale deflection of the leak rate meter on the x1 scale. Six positions providing attenuations of x1, x5, x10, x100, and x1000 allow a wide range of leak rates to be tested.

The device operates in temperatures of 40 to 100°F and in any humidity up to 95%. Characteristics of drift, linearity, clean-up and noise are termed excellent by the manufacturer.

Circle No. 230 on Subscriber Service Card.

Pure Beryllium Tubing

Pure beryllium tubing in sizes from .250 to 2 in. outside diameter is available from Superior Tube Co., Norristown, Pa., which has been appointed agent in the United States for Chesterfield Tube Co., Chesterfield, England.

Because of its low neutron absorption, attractive thermal properties and high strength-to-weight ratio, beryllium tubing has wide potential application in nuclear reactors and in aircraft and missiles, Superior says.

The tubing is produced from sintered billets by the hot extrusion method. Bore-sized tubing with closer internal tolerances is produced in a limited size range. Superior will produce beryllium tubing in this country.

Circle No. 231 on Subscriber Service Card.

Pneumatic Regulator

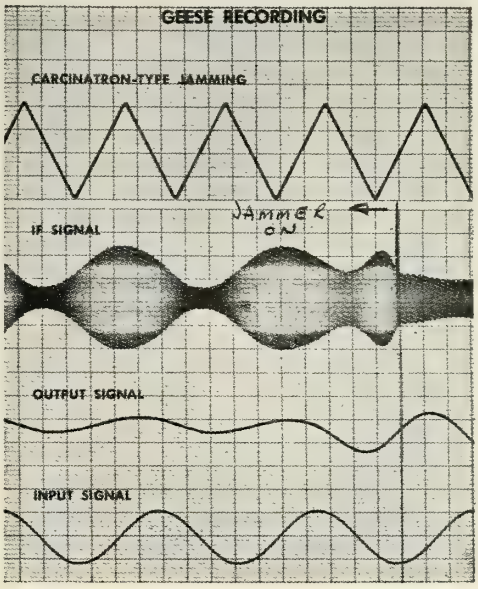
A large pneumatic regulator, designed for use with helium by the Vision Engineering & Sales Co., has proved efficient on both fixed installations and in certain OEM applications.

The regulator's operating pressure inlet: 100 to 20,000 psi. Regulated pressure, using dome loading principle, is adjustable from 100 to 20,000 psi. Proof pressure is 40,000 psi. Flow rate is to 100 lbs. per minute helium with 6000 to 10,000 psi inlet pressure.

Circle No. 232 on Subscriber Service Card.

SYSTEMS ENGINEERS AND SCIENTISTS

Almost any conceivable signal can be generated on GEESE; these signals can be carefully controlled in frequency, phase and amplitude, and their instantaneous relationship can be recorded. GEESE has the flexibility to fully evaluate advance radar, communications and guidance systems and the effects of various jamming and anti-jamming techniques.



EVOLVING LARGE-SCALE SYSTEMS CONCEPTS

AND DEVELOPING THE TOOLS THAT SPEED THEIR DESIGN CYCLE

Defense Systems Department is directing its technical capabilities toward the development of large-scale electronic systems. Inherent within this work program is the recognition, definition and solution of problems in every aspect of the systems technology.

To accomplish this ambitious task, a growing number of studies are being directed toward the development of unique tools that will aid in the design of superior systems in less time, at lower cost.

A recent contribution by Defense Systems Department in this technological area is GEESE (General Electric's Electronic System Evaluator). Utilizing advance computer techniques, it enables systems engineers to accurately predict, optimize and synthesize system performance prior to design.

GEESE is indicative of the scope of Defense Systems Department's involvement in the systems technology. Many programs offer systems-oriented engineers and scientists an opportunity to participate in new areas of long-term importance.

Senior members of our technical staff would welcome the occasion to discuss personally and in detail the career positions available with this growing organization. Address your inquiries in professional confidence to Mr. E. A. Smith, Box 5-G.

DSD DEFENSE SYSTEMS DEPARTMENT
A Department of the Defense Electronics Division

GENERAL ELECTRIC

Northern Lights Office Building, Syracuse, New York

Gyroscopic Attitude Control

The attitude of a space vehicle can be controlled by two gyroscopes, instead of reaction jets or inertia wheels, with a device developed by the Electronics Division of Chance Vought.

Vought's Twin-Gyro Controller uses the gyros for muscle power instead of merely as a reference system as in inertial guidance. The controller consists essentially of two identical single-axis gyros gimbaled to a common frame. The frame is torqued about one axis by the controller. Thus three controllers can be used to control the attitudes of a vehicle about its roll, pitch and yaw axes.

Since rotors operate at constant speed, power requirements are low.

Circle No. 233 on Spbscriber Card.

One Part Epoxy Adhesive

A one part 100% epoxy adhesive has been announced by Metachem Resins Corp. The thixotropic paste can be applied to any surface, including vertical ones, without sagging or running. The elimination of the usual two-part concept results in quicker, less expensive applications.

Designated META-BOND 321, the adhesive has a bond strength of 3200 psi at 25°C after a short cure. The bond will remain stable up to 200°C—higher in certain circumstances.

Besides the adhesive qualities, the material has excellent dielectric insulation properties. It has a shelf life of over a year if stored below room temperatures. The company recommends its METATERGE 1405 as a cleaning agent to convert the uncured resin to a water-dispersible system to aid in the cleaning of equipment.

Circle No. 234 on Subscriber Service Card.

new literature

THIN FILM COATINGS—The properties of fluorocarbon coatings, silicones, epoxy resins and other coatings are discussed in this brochure issued by the Industrial Coatings Division of National Glaco Chemical Corp. Included in the descriptions are applications to impart chemical and corrosion resistance, wide-range temperature stability, electrical qualities, dry lubrication, and anti-stick characteristics.

Circle No. 200 on Subscriber Service Card.

ELECTRONIC CAPACITORS, FIXED, PAPER-DIELECTRIC—Complete rating and dimensional tables for a wide range of standard commercial, MIL-C-25A, and Permafil capacitors are given in a 28-page brochure published by General Electric. Bulletin GET-3032 covers such AC-DC applications as blocking and bypass service, power supply filters and other general-purpose military and commercial uses. In weight, units describe range from a few ounces to 150 lbs.

Circle No. 201 on Subscriber Service Card.

MICROWAVE COMPONENTS. Radar Design Corp.'s 16-page catalog illustrates a wide range of coaxial and waveguide attenuators and terminations—the latter available in medium power as well as low. Also described is a new Machinable Microwave Absorber—RADITE #75.

Circle No. 202 on Subscriber Service Card.

PLASTIC PRODUCTS OF TEFLON, RAYLON AND KEL-F—A catalog describing in detail the basic shapes available from Raybestos-Manhatten. Mechanical packings, gaskets, accessories for fluid handling equipment, custom machined parts, thin-walled tubing, flexible wire-braided, rubber-covered hose, bondable Teflon and adhesives, "O" and back-up rings, bearings and teflon coatings are among the many items in the booklet of interest to the missile engineer.

Circle No. 203 on Subscriber Service Card.

SIZE 18 VELOCITY-DAMP SERVO-MOTOR DATA—Dimensional drawings, torque-speed curves, electrical and mechanical characteristics are detailed for the Model 18 VM 460 servomotor. Published by the Helipot Division of Beckman Instruments Inc., the data sheet also contains information concerning areas of application for velocity damp units.

Circle No. 204 on Subscriber Service Card.

SPECIFYING LAMINATED PLASTICS AND VULCANIZED FIBERS—A comprehensive guide to the ups and downs in a basic family of fast-growing materials. Published by Taylor Fibre Co., the booklet contains a quick selection chart which specifies various plastics and fibers according to properties. Common errors and mistakes prevalent in specifications concerning these materials are discussed.

Circle No. 205 on Subscriber Service Card.

CUSTOM MOLDED INORGANIC INSULATION—The various properties of Havelex, formerly G. E. Mycalex, are described for design engineers in the missile/space industries. Issued by Haveg Industries, Inc., the bulletin aids in utilization of such properties as continuous operation at 1000°F with high dielectric strength, arc resistance and no moisture absorption. The various operations of the firm's Taunton Division, formerly G.E.'s plastics department, are included.

Circle No. 206 on Subscriber Service Card.

letters

(continued from page 7)

No Slight Intended

To the Editor:

Thank you very much for your April 4 article on ion propulsion activities at Electro-Optical Systems, Inc. I would, however, like to point out that your continued use of the term "quick and dirty" (M/R, Feb. 1 and April 4) in reference to our construction of an ion engine for the Air Force is somewhat misleading.

This term implies a hasty and unsophisticated approach to a most important project. Such an implication is most definitely erroneous. The ion engine program presently under way at Electro-Optical Systems requires fifteen months of intense deliberation, skill, and accomplishment. The project demands the highest type of technical performance, and as a result, the finished product will be far from a "quick and dirty" device. It would be unfortunate to have this fact misunderstood.

Again, thanks for your interest in our programs. I bring up this point only to avoid any public misimpression that might arise through the use of the terms.

David T. Traitel
Manager, Information Services
Electro-Optical Systems, Inc.

M/R meant the term as praise, not blame. Under an Air Force contract, Electro-Optical Systems is building an ion propulsion device based on the present state of technology. We meant to contrast the Air Force approach with that of the National Aeronautics and Space Administration, which expects to award a contract later this year for research on an ion device that will incorporate sophisticated, but untested, concepts. Research at several centers in the last year has definitely established the feasibility of an ion engine. We are pleased with the Air Force decision to build one and fly it early.—Ed.

Publicizing Industry's Role

To the Editor:

Reading your April 18 issue last evening, I was particularly impressed with your editorial "The Things We Stand For."

It is indeed encouraging that you identify the responsibilities of both Government and *private industry* in developing and putting into operation the weapons needed in the missile/space field. I am sure that the industry is cognizant of its responsibilities along the lines you have spelled out. On the other hand, I am not equally sure there is public appreciation that industry does have a role—much less that it has a responsibility—in these new weapon systems.

I think you have done a good job in pointing out the partnership which necessarily must, and in fact does, exist between Government and industry.

Roger C. Fleming
Director of Public Relations
Allison Division
General Motors Corporation
Indianapolis, Ind.

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when and where

MAY

Aerospace Medical Association, 31st Annual Scientific Meeting, Americana Hotel, Miami Beach, May 9-11.

1960 Symposium of the Institute of Radio Engineers' Professional Group on Microwave Theory and Techniques, Hotel del Coronado, San Diego, May 9-11.

Instrument Society of America, National Power Instrumentation Symposium, Drake Hotel, San Francisco, May 9-11.

National Rocket Society, Semiannual Meeting and Astronautical Exposition, Ambassador Hotel, Los Angeles, May 9-12.

Second Southwestern Metal Congress and Exposition, American Society for Metals, Sheraton Dallas Hotel, and State Fair Park, Dallas, May 9-13.

1960 Electronic Components Conference, sponsored by IRE Professional Group on Component Parts; AIEE, EIA, and Western Electronic Manufacturers Association, Hotel Washington, Washington, D.C., May 10-12.

American Institute of Chemists, Annual Meeting, Radisson Hotel, Minneapolis, May 11-13.

New York University Conference, "The Critical Million—How to Talk to the Nation's Scientists and Engineers . . ." New York City, May 17.

ASME Production Engineering Conference, Shroeder Hotel, Milwaukee, May 17-19.

Society for Experimental Stress Analysis, 1960 Spring Meeting, Hotel Severin, Indianapolis, May 18-20.

Society of American Military Engineers, National Convention, Washington, D.C., May 19-20.

National Telemetering Conference, ARS, IAS, ISA and AIEE, Miramar Hotel, Santa Monica, Calif., May 23-25.

German Society for Rocket Engineering and Space Flight Research, 12th Annual Meeting, Heidelberg, West Germany, May 23-25.

TAPPI Coating Conference, 11th Annual, Edgewater Beach Hotel, Chicago, May 23-25.

ASME Design Engineering Conference & Show, Statler Hilton Hotel, New York City, May 23-26.

American Society for Quality Control, Annual Convention, Sheraton-Palace, Hotel, San Francisco, May 24-26.

Japanese Rocket Society, Second International Symposium on Rocketry and Astronautics, University Club in Tokyo, May 24-28.

IAS Specialists Meeting, Guidance of Aerospace Vehicles, Hotel Somerset, Boston, May 25-27.

The Psychophysiological Aspects of Space Flight, sponsored by the School of Aviation Medicine, ATC, to be held at the Aerospace Medical Center, Southwest Research Institute, San Antonio, May 26-27.

Society of Naval Architects and Marine Engineers, Spring Meeting, Statler Hotel, Washington, D.C., May 26-28.

Field Engineers

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You probe the insides of complex airborne computers, navigation and guidance, and associated ground support equipment. And you work with important customer personnel — high level scientists, engineers and executives.

Here is demanding, responsible work. It requires a high level of engineering know-how and judgment, plus good appearance and personality. Sound education and experience are essential. (BS degree in a technical field and from 3-5 years electronics experience.)

The salary is excellent, reflecting the job's duties and responsibilities. At expanding Kearfott, your own desires will decide whether you wish to remain and advance in the Customer Services and Parts Division, or use the wide experience you have gained to join exciting programs in other Kearfott divisions.

Openings start at Kearfott's home in Little Falls, New Jersey, with nation-wide assignments to follow later. You will enjoy all company fringe benefits, including educational programs, and will be paid full expenses for your first six months in the field. If all this sounds like the job for you, write in confidence to Paul Kull, Dept. 10-S.

GP KEARFOTT DIVISION
GENERAL PRECISION INC.

1225 McBride Avenue
Little Falls, New Jersey

Will Britain Step Down?

Britain has been a great world power for four hundred years and more. Within the next few weeks or months she may make the decision which would leave her militarily impotent and automatically eliminate her from the summit conferences of the future.

The decision: to eliminate the nuclear bomb and missile from her arsenal of weapons. The effect would be great and far-reaching—much more so than the general public now realizes.

Britain recently abandoned her own atomic missile program—concentrated in the *Blue Streak* ICBM. It was then reported that she would buy the American *Polaris* and *Skybolt* instead.

Now, as reported by M&R's London correspondent (Page 13), Britain is very near a decision to abandon her position as a nuclear-armed power. Not only would she not buy American atomic weapons, but she would give up those she already has.

To put it baldly, England feels that in the event of a general war she would be the first target and that she would have insufficient warning to either get off her own weapons or protect herself.

England is tired of being in this position.

Any decision, of course, will come from the politicians and not the military. But British politicians reflect British public opinion more realistically, probably, than U.S. politicians reflect U.S. public opinion.

And the opinion of Britons today is that they would be sitting ducks with little chance to either fight back or survive in event of a nuclear attack.

This isn't a new thought, but it is gaining strength. And if Britain does drop her role as a great nuclear power, what will be the effect on the rest of the free world—particularly, what will be the U.S. position?

Britain would immediately relinquish certain commitments to NATO—not her role as a general participant, probably, but certainly her job in NATO's deterrent force, in which British bombers at present carry her own atomic bombs.

Part or all of this role would have to be picked up by other NATO members, either with nuclear-armed planes or missiles, probably the latter.

The United States would have to move both its nuclear-armed bombers and fighters from their bases in Britain.

The *Thor* bases would either have to be abandoned or moved to a site on the continent.

These could be the military results. From the political point of view, the result could easily be Britain's stepping down from her position as one of the great powers. It is difficult to believe that the Soviet leaders would pay much attention to an atomically neutralized Britain.

Britain's leaders will try to delay their decision as long as possible. Giving up her historically great place in the world of nations would not be easy.

But she must face up to certain geographic and economic facts. She cannot afford her own missile program. She objects to buying the *Polaris* probably because she knows American subs will have to be patrolling her waters anyway—because of the range of the sub-based *Polaris*. Close as Britain is to Russia, the airplane-based *Skybolt* would not be a complete or effective weapon unless the RAF could maintain a high degree of constant air alert—and this Britain cannot afford either.

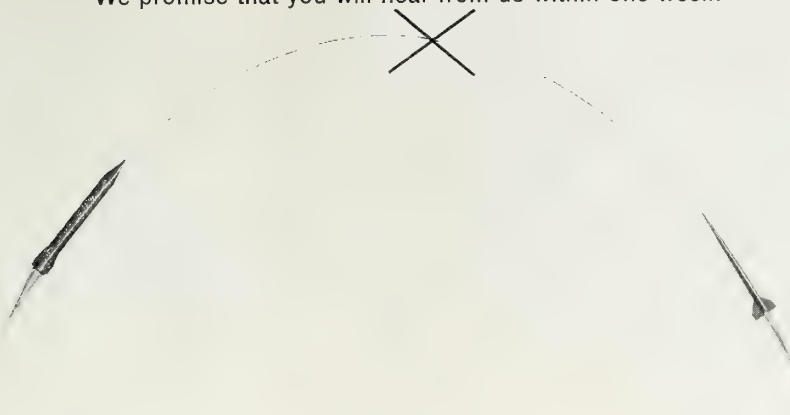
To remove their nation from her place as Number One on the Soviet target list, British leaders would have to deny bases to American atomic weapons whether missiles or bombers, as well as give up their own.

Who takes Britain's place? France? Germany? a new NATO nuclear force under direct command of SHAPE?

If Britain does take this step, if she does give up her place as one of the great world powers, filling the vacuum which will result could give the Western World its greatest test yet—both politically and militarily. Ministers at the Istanbul NATO meeting were not unaware of this—nor will the chiefs of state be unaware of it at the May 16 meeting in Paris.

Clarke Newlon

We promise that you will hear from us within one week!



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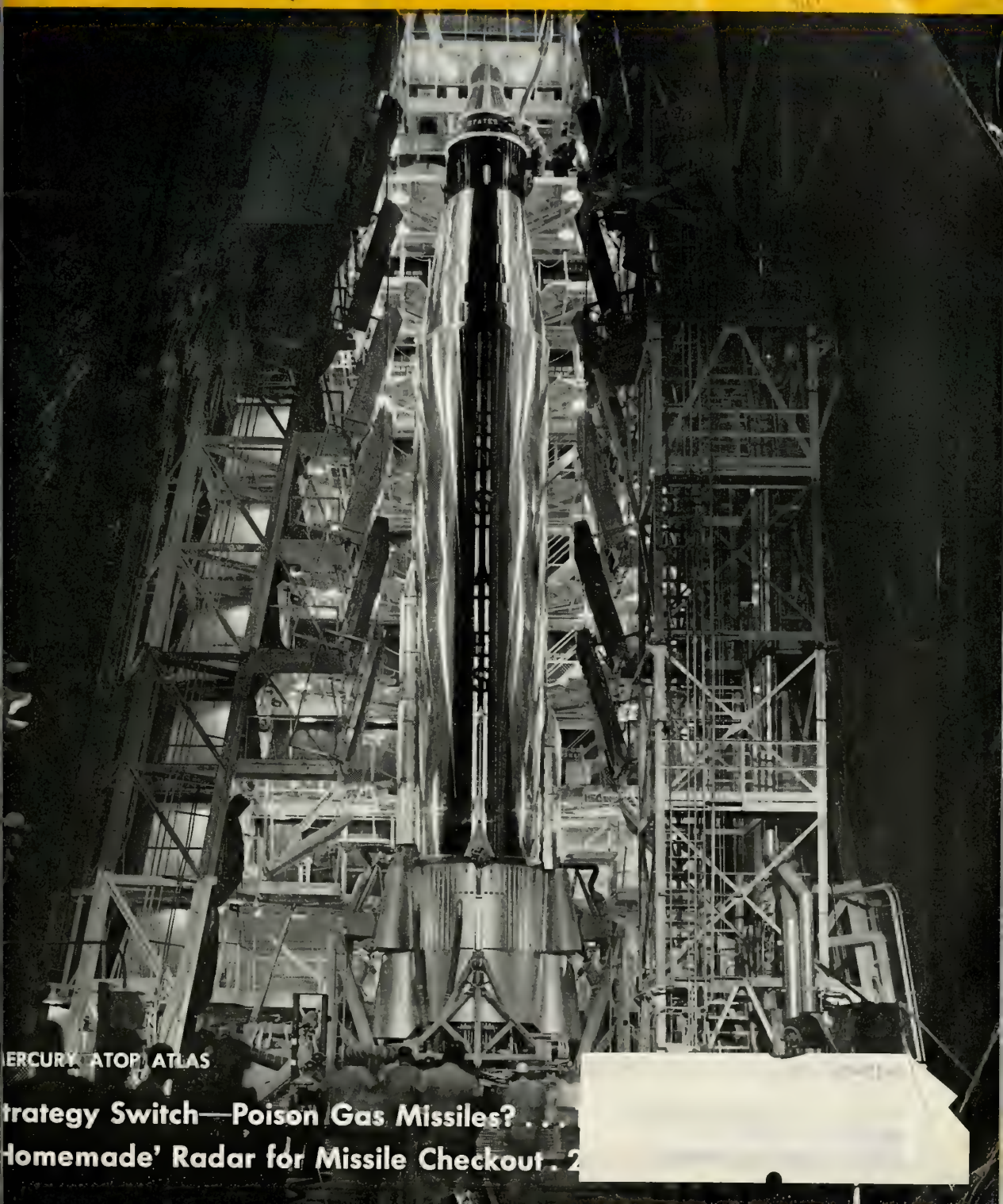
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May 16, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



ERCURY ATOP ATLAS

trategy Switch—Poison Gas Missiles? . . .

Homemade' Radar for Missile Checkout . 2

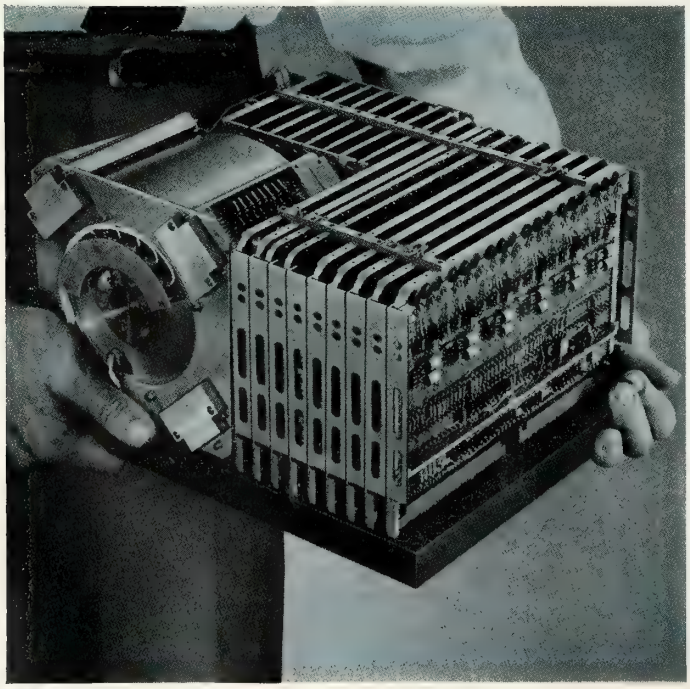
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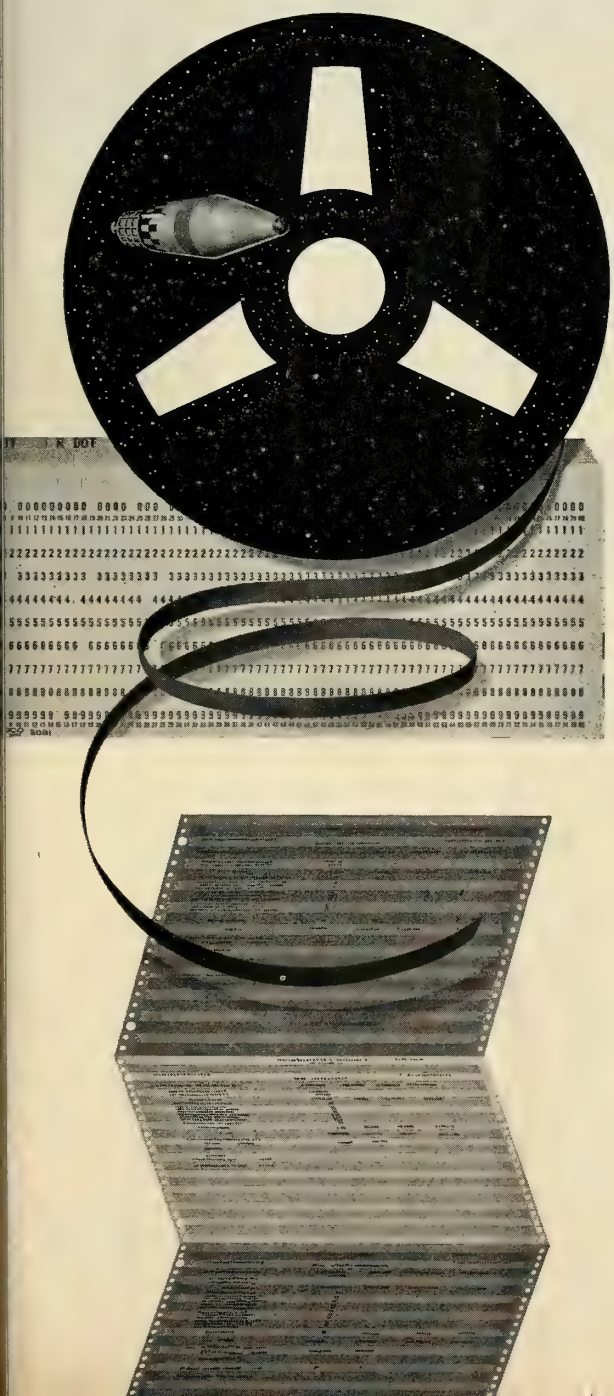
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GPD LI-04

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INFORMATION PROCESSING



Information Processing plays a vital role in the Lockheed Missiles and Space Division's activities—from aiding basic research and development to supporting current military and commercial projects. The Division's computing facilities are among the most advanced in the country and include: two—IBM 7090; two—Sperry-Rand 1103 AF; one—Control Data Corp. 1604, in addition to a variety of other advanced peripheral equipment. Future plans include several IBM 1401 Data Processors.

Functions of Information Processing encompass: Preparing programs and operating large, high-speed digital computers; responsibility for the Division's analog computing activities—including set-up and operation of analog computers, used both as simulators and in solving problems; the reduction of highly complex and critical telemetry data received from missiles and space vehicles.

Further activities involve performing data reduction for Quality Assurance and Manufacturing, and programming of Administrative Data Processing and Financial Forecasting Problems for the entire Division.

Expanding the scope and depth of present programs in Information Processing has created positions for engineers and scientists with experience in these important areas:

DIGITAL COMPUTER SYSTEMS DEVELOPMENT including monitors, compilers and information retrieval systems.

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Engineers and Scientists: Work in the broad spectrum of Information Processing functions provides constant challenge at Lockheed's Missiles and Space Division. If you are experienced in the above areas, you are invited to write: Research and Development Staff, Dept. E-29A, 962 W. El Camino Real, Sunnyvale, California. U.S. Citizenship or existing Department of Defense industrial security clearance required.

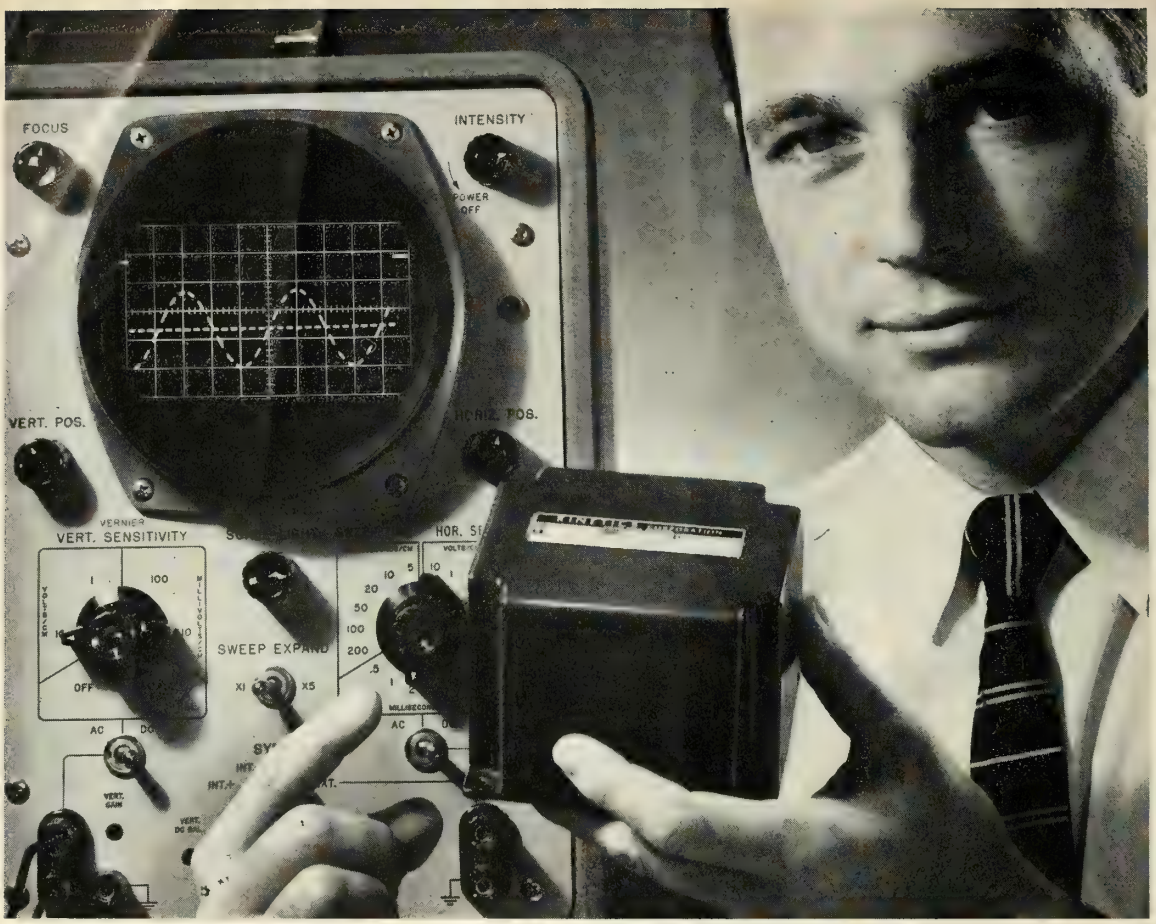
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Kinetics electronic commutator offers greater accuracy and over 10,000 hrs. life



The Kinetics electronic commutator features modular construction, achieving maximum space utilization and easy application to various configurations.

As shown by the pattern on the scope, the new electronic commutator now available from Kinetics Corporation offers a high degree of commutation fidelity. Note the extremely short rise and fall times with no apparent deterioration of signal. Faithful reproduction such as this will continue through a forecast life of 10,000 hours or more. This commutator is recommended for all aircraft and missile multiplex telemetering systems where accuracy and long life are required.

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Write for more information on this electronic commutator. Kinetics Corp., Dept. K-23, 410 South Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

May 16, 1960 Volume 6, No. 20

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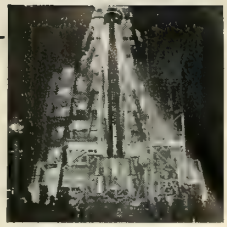
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THE COVER

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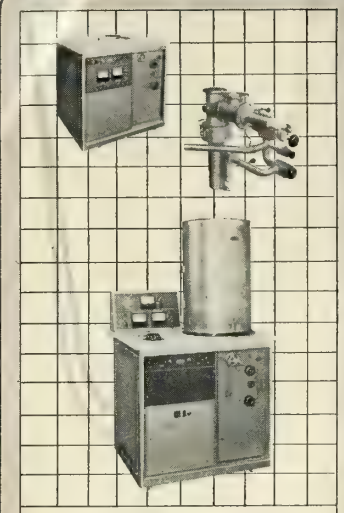
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letters

Deep Interest in ASW

To the Editor:

We have read with great interest your inaugural issue containing the new section on ASW Engineering . . . in fact, all of the succeeding issues have been equally interesting.

We have distributed your magazine to all of our engineering staff as required reading. We feel that articles such as "The Sea Is Never Neutral" will go a long way in educating the defense industry to the new defense requirements of our country.

We will look forward to future articles with equal interest.

Asa E. Snyder, Executive Vice President
USI Technical Center, Division of U.S. Industries, Inc., Pompano Beach, Fla.

Burns and Roe and Bomarc

To the Editor:

In the January 18 M/R, there was an article concerning *Bomarc* which was of considerable interest to us inasmuch as Burns and Roe, Inc. had complete responsibility under subcontract to Boeing Airplane Company for designing and furnishing all ground support equipment for the IM99A *Bomarc* missile, including design and construction of the Model 1 shelter at Cape Canaveral, and detail design of the Model 2 shelter which is the operational shelter for the early tactical bases.

Your article refers to the paper given by Ostling and Kelly of Boeing at the Society of Automotive Engineers Annual Meeting in Detroit, and mentions Anderson-Greenwood Company by name as having "laid down the basic foundation of the system."

We would like to call your attention to page 4 of the Ostiling-Kelly paper in which they state "Burns and Roe prepared specifications and began active design of the tactical prototype equipment. This included the Model 1 launcher shelter." Also on page 5, ". . . a new subcontract to Burns and Roe for the redesign, with the first four tactical bases being approved for construction using this Model 2 shelter."

As one of our country's largest architect-engineering firms, we are justly proud of the part that Burns and Roe has played in the defense of our country and in our nation's assault on space. Our contributions include important phases of *Bomarc, Nike-Zeus, Talos,* and Project *Mercury,* to mention but a few of the large programs with which we have been and are associated.

Kenneth A. Roe, Executive Vice President
Burns and Roe, Inc., New York City

We thank Mr. Roe for calling our attention to our omission of his firm's important part in the Bomarc system.—Ed.

Admiral Not 'Down'

To the Editor:

We were sorry to see Admiral L. J. Dow (USN Ret.) carried as "Down" in The Countdown, M/R, April 25. Naturally, Admiral Dow also was disappointed. Our release repeated his name several times, and we wonder how you could have slipped on this one.

Edward W. Locke, Director, Customer Relations
Defense Product Headquarters
Westinghouse Electric Corp., Washington, D.C.

We're sorry too. We knew better; we just slipped.—Ed.

Deterrent Duplication?

To the Editor:

I read with interest Mr. Ted Wallace's letter ("The Gap: Another View") in M/R, April 11, and found myself in agreement with his exposition, up to his conclusion—unification of the Defense Department.

Although this panacea is strongly advocated by many responsible citizens, its major weakness is that "Unification" does not (alter) personalities, training, backgrounds and prejudices of the people who would have to make it work. It would leave a gap of 30 years, to raise O-1 level (ensign, second lieutenant) officers in a unified environment wherein they would not lean heavily on their special backgrounds—air, sea or land.

The basic weaknesses are far more political than fiscal. There is plenty of money in the $41-billion budget to provide adequate hardware to meet our world commitments and potential threats from potential enemies. The difficulty is the displacements of people and industries that would occur if orientations were properly made to meet the threats.

For example, to boil a complex idea down to simplicity, our main objective in a nuclear environment is to scare the Russians out of attacking us with nuclear weapons. We can do this by two methods: (1) Plan to knock out their ability to bomb us or (2) Simply hold over their heads the threat of mass destruction of their cities. The first plan lacks feasibility on several counts, the major ones of which are (1) It assumes that we know where their missile pads are located and (2) Assumes that we would start the war. We would have to know (1) before we could do (2) unless we want to commit suicide by awaiting their retaliatory blow. Further, the second alternative is quite obviously abhorrent to the United States.

For the Russians, it is quite a different story. First, they know where our launching pads are. Second, they have a history of jumping first.

No matter how you slice it, those who have seen the devastation of Hiroshima and Nagasaki, wreaked by "small" bombs, will never believe that an *Atlas* or *Titan* missile, sticking up over the ground like a sore thumb, will ever survive one blast—to say nothing of several, which some people claim it will take to knock them out. And when we are blasted, we are all

blasted, citizens and soldiers alike. Thus, we seem to invite atack on our military might, as we did at Pearl Harbor.

With *Hawk, Falcon, Sparrow, Nike,* and the like, the days of the manned aircraft in a non-nuclear war, for the purpose of bombing an enemy, seem numbered. If we plan to use these aircraft for nuclear attacks through long-range atomic weapons (which we haven't got yet) we are going to have another system duplicating *Polaris, Minuteman, Atlas* and *Titan,* all of which are designed to knock out, or deter, the Russians in their civilian haunts. What with fallout and the prevailing winds, it seems we are spending an awful lot of money to kill the Russians more than once. Since it will be years before the latter three missiles will be operational in any numbers, and still years before our long-range airborne missile is operational, one wonders whether we should not choose but two systems and concentrate on them. If *Atlas* is vulnerable today, it sure as hell will be vulnerable tomorrow.

The "Great Debate" of this election year quite properly should be over the best way of replanning our defense effort for support of the infantryman and marine who will most likely bear the brunt of non-nuclear war. This involves primarily a de-emphasis on the "kill 'em more than once" duplication of nuclear weapons, and an emphasis on mobility of forces overseas, logistics supply, and the means to protect those supplies in transit against a determined, real, in-being Soviet submarine force.

When one contemplates that a single B-58 bomber costs as much as two fully equipped destroyer escorts, and one *Atlas* (plus its pad and environment) costs three time as much (according to Air Force figures), one wonders where the emphasis should be placed. We have had to make mass movements of troops overseas on the two occasions in recent years when our national way of life was at stake. We have had to supply them. The crying need for modern ASW vessels, and the crying Army need for more modern weapons and mobility, are much more immediate requirements than a duplicated (nay, quintuplicated) system of massive retaliation which, excepting *Polaris,* is a dream promising fruition in the vague 1963-65 era.

J. K. Taussig, Jr.
Annapolis, Md.

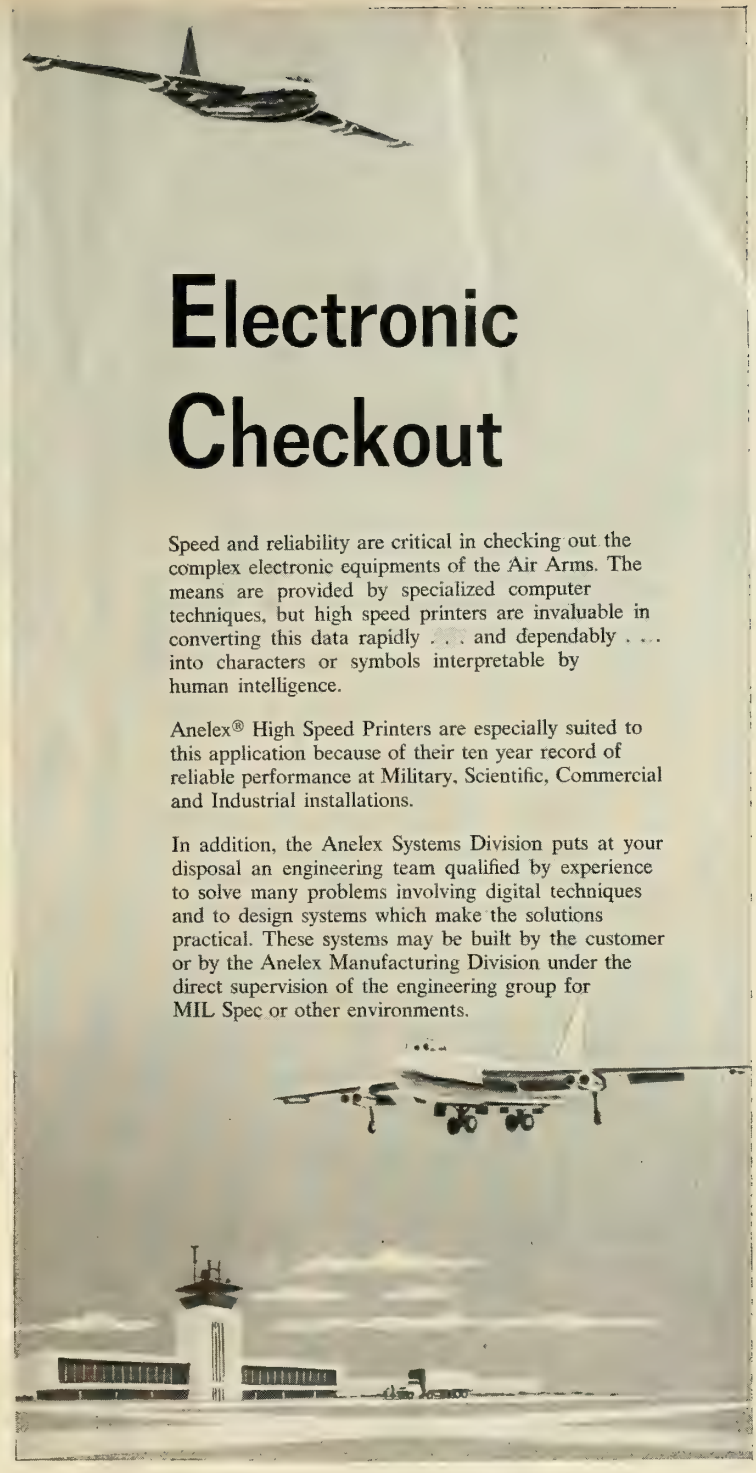
ICBM's Called Superfluous

To the Editor:

I would greatly appreciate an explanation from someone of why we need our ground-based ICBM's while the *Polaris*-submarine concept is certainly much cheaper, more accurate (because of shorter distance-to-target required), and less vulnerable (because it is a moving target and can travel over four fifths of the earth's surface)?

William Gill
Technical Publications
North Reading, Mass.

Might try the Air Force.—Ed.



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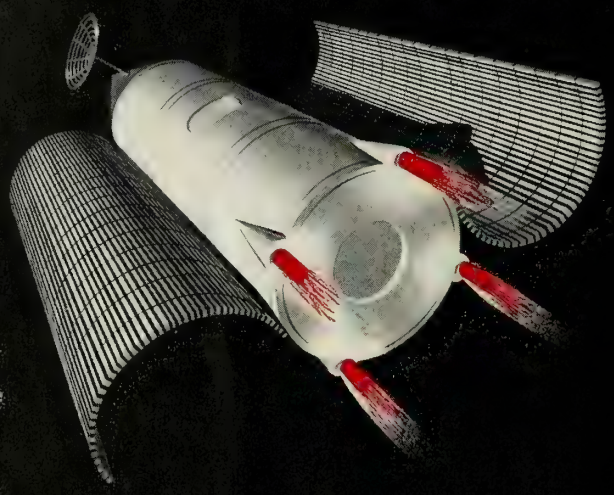
NUCLEAR POWER PACKAGES FOR SPACE

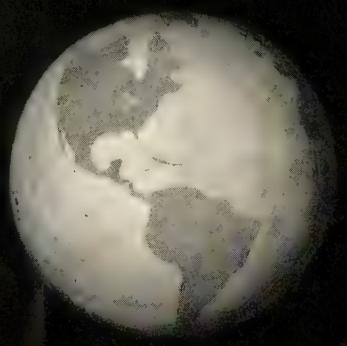
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The Countdown

WASHINGTON

Bureaucrats Descend on SP

With *Polaris* all but operational, bureaucrats are understood to be trying to strangle the Navy's Special Projects Office with red tape. The SP program which produced the submarine-launched missile three full years ahead of schedule is now being reviewed and re-reviewed by dozens of outside government officials. They are getting into the act in time for the curtain calls by suggesting ways the whole thing could have been done cheaper or faster.

Shelters Get Second Look

High costs of new offensive weapon systems are making some officials take a second look at Civil Defense mass shelter plans—long gathering dust. The argument is heard in some Pentagon circles that the U.S. could buy more defense by spending $20 billion on shelters which could save 50-75% of the population than by investing in more nuclear missiles.

A Third Time Out

Clayton Fritchey, who helped guide two presidential campaigns of Adlai Stevenson, has now moved into the camp of Sen. Stuart Symington. What's more, the former deputy chairman of the National Democratic Committee is an unpaid worker.

Question of Boosters

NASA—apparently stung by word going around that it is out of rocket booster money—is now saying it will start launching *Juno II's* at the rate of one every two weeks, commencing in September and continuing for the remainder of the year. Some scientists have been saying the *Juno II* program was being shelved from 12 to 18 months for lack of boosters.

2-minute Saturn Test

Look for another full cluster test of the *Saturn* booster within two weeks. This one will run a scheduled two minutes.

On the Pad

Launching of the next R&D *Transit* navigation satellite will come in about a month. It will weigh about the same as the 275-lb. *Transit* which went into orbit April 13.

INDUSTRY

Solid vs. Liquid Sparrow 6B

Battle is on for the contract—expected to hit $27 million over five years—to build a new motor for the advanced *Sparrow 6B*. The Navy has laid down requirements to add 40,000 ft. altitude and give the air-to-air bird a five-year storage life. Already solid proponents are saying pre-packaged liquid won't do the job, and vice versa. Word from BuWeaps, however, is that either type could do the job. Bids are due next week.

Aerojet Reorganizes

All service functions as well as operating activities of Aerojet-General are being put under one manager at its home plant in Azusa, Calif. Under the reorganization, William L. Rogers has been named vice president in charge of the plant.

Titanium for Typhon?

Navy missile R&D men are reported seriously considering requiring the use of titanium in the *Typhon* surface-to-air missile (formerly *Super Talos*) to improve either range or warhead capability.

Job Opening

Rumors making the rounds of Space Technology Laboratories have Richard Horner, former AF R&D chief and now associate director of NASA, heading up the new non-profit corporation the Air Force is forming to replace STL. Lending credence to the reports is the recent revelation by Horner that he is quitting NASA soon. Salary for the new job: probably $40,000 plus.

Dollars & Pounds

Scout—the alleged "poor man's rocket"—now is pegged at $750,000 per copy instead of $500,000 . . . Each *Redeye* costs $1300, including $75 disposable launcher . . . and it's disclosed the production launcher for *Sergeant* will weigh 2000 lbs. less than the 18,000-lb. R&D version.

New Name Tag

The designation of the Army's *T-238* chemical warfare rocket has been switched to the *M-55*. Norris Thermador is the manufacturer of this 115-mm missile.

INTERNATIONAL

French Working on Sub Reactor

The United States has agreed to provide the French with enriched uranium with which to build an experimental reactor for a nuclear-powered sub. The French say, however, they won't cut tin on the sub until the reactor tests are completed—which means it will be three to five years before construction starts.

Russian Stand-off Missile

A new delta-wing Soviet jet bomber is reported to have as standard equipment 20 air-to-surface missiles with 75-mile ranges.

Germans Making Research Rocket

Test firings of a new meteorological rocket being made by Deutsche Raketengessellshaft at Hanover are scheduled this summer at Cuxhaven, Germany. The rockets will have a 25-mile ceiling.

Malafon Almost Ready

A new ASW missile, the *Malafon*, is expected to be operational this year aboard a French Navy escort vessel. The surface-to-underwater rocket torpedo is reported to have a range over 10 miles.

radical shift suggested . . .

Army Seeks Poison Gas Missiles

Need seen to balance Red weapons in chemical area; philosophy on gas is changing

by James Baar

High Army officials are pushing for the creation of a vast "deterrent" stockpile of poison gas warheads and missiles.

Sanction of the new Army proposals would entail a radical shift in U.S. strategic thinking. It also would call for a direct reversal of U.S. public opinion on the use of poison gas.

One of the first preliminary steps in the direction of the Army's chemical and biological warfare proposals already is under way. The Army is purchasing thousands of the new 115-mm *M-55* missile—a secret chemical agent-carrying rocket that can be fired on a battlefield in salvoes.

The next logical step would be a build-up of a stockpile of tactical-range missile warheads carrying chemical and biological agents rather than conventional or nuclear charges. The final step would be the stockpiling of similar warheads for IRBM's and ICBM's.

Behind the Army drive are arguments that:

• Russia already has a large capability of fighting with chemical and biological agents and the weapons are already in the hands of the Red Army in quantity along the Iron Curtain in Europe.

• The only way to prevent Russia from using these weapons in any future war is to have a similar arsenal.



MAJ. GEN. MARSHALL STUBBS

• In the age of the H-bomb, chemical and biological warfare has taken on a practical and almost humanitarian aspect.

The Defense Appropriations Bill as it recently cleared the House already has $35.5 million in it for the purchase of more than 100,000 *M-55's* along with multiple 45-tube launchers that fire the missiles in salvoes.

The *M-55*—formerly called the *T-238*—is manufactured by the Norris Thermador Co. of Los Angeles. No contracts have been let for the T-145 launchers.

The Administration asked for $32 million for the *M-55*. The House added $3.5 million more—enough to buy 13,000 *M-55's* alone, along with an undisclosed number of the launchers.

These would provide U.S. troops with a limited capability. However, to give U.S. troops anything matching Soviet capabilities of waging chemical and biological war, far larger funding will be needed in FY 1962 and the years following it.

• **Reds favor chemicals**—Army proponents of building up U.S. chemical and biological warfare capabilities stress that the Russians probably will never use nuclear weapons on Western Europe when they have so much more to gain by using chemical or biological warheads launched by missile.

Such an attack would enable Russia to:

• Capture intact the great Western European industrial centers.

• Temporarily incapacitate and then enslave Western European populations.

• Avoid the uncontrollable effects of nuclear fallout and residual radiation that would result from any all-out attack with nuclear weapons.

These same arguments can be applied to a great extent to the United States.

A Soviet ICBM launched against Pittsburgh could obliterate the city with a multi-megaton warhead. But the same ICBM if equipped with a warhead carrying chemical or biological agents could kill or incapacitate the entire population of Pittsburgh, leaving the city open for Soviet colonization or plunder.

Chemical and biological agents available today to both the United States and presumably Russia are capable of delivering a wide variety of blows to large population centers or military installations. These range from temporary paralysis and loss of ability to function rationally to temporarily

What Price 'Humanitarianism?'

Maj. Gen. William M. Creasy, former head of the Chemical Corps., on the "humanitarian" reasons for NOT using poison gas:

"Iwo Jima was defended by some 21,000 Japanese. In taking Iwo Jima we had some 25,000 casualties. I do not have these numbers reversed. Of these casualties, there were some 7000 deaths, American deaths. At that time, there was available to the military commander chemical agents which he had the logistical capability of using, against which the Japanese forces had no protection. Their masks at that time did not protect against these chemicals. He was denied, by the then existing policy, the use of these materials . . . Presumably this was not the thing for Americans to do.

"Let us see what the net result of all this humanitarian fervor of ours was, other than the 7000 dead marines, and the other 18,000 casualties. What happened to the 21,000 Japanese? Most were killed, most by white phosphorus and flame throwers."

incapacitating illnesses and rapid death. Nor does this require great quantities of the agents.

Maj. Gen. Marshall Stubbs, chief of the Army Chemical Corps, recently told the House Military Appropriations Subcommittee:

"With 10 carriers (ICBM's or aircraft) dropping 10,000 pounds each, it would mean that with dry biological warfare material, a potential enemy would get at least 30% casualties in the total of the United States."

• **The gas "gap"**—Stubbs said the 10 carriers—preferably ICBM's to insure delivery—would drop their lethal charges into the atmosphere at about 30,000 feet. Obviously, a similar attack could be launched against the Soviet Union with more missiles because of the larger area.

However, U.S. strategic planning is not ready for this kind of war which calls for a large land army to occupy areas attacked by chemical or biological agents. On the other hand, Russia already has a large army that could be used for swift occupation of Western Europe or the United States through use of the growing Soviet fleet of air transports.

As for Russia's capability, Col. S. E. Baker, Stubbs' deputy assistant, testified: "We credit the Soviet with the ability to wage biological and chemical warfare on a large scale. He possesses a tremendous capability in chemical warfare."

Asked whether Russia had modern equipment to deliver CW and BW agents, Colonel Baker said: "They have very modern equipment. Throughout their Army there are a great number of rockets. Rockets are fine weapons for disseminating chemical agents."

Lt. Gen. Arthur G. Trudeau, Army Chief of Research and Development, said "one sixth of the Soviet ground potential is chemical as far as weapons with their forces in Europe are concerned."

Asked if a chemical and biological warfare gap existed between Russia and United States military capabilities, Stubbs said: "That is my opinion."

Aeronutronic Gets Contract For AF Version of Scout

Aeronutronic Division of Ford Motor Co. was chosen last week to be system engineer and payload and test contractor for the Air Force version of NASA's *Scout* solid-propelled satellite launcher.

It received a contract for $2,676,000.

First flights will be held from Cape Canaveral this year, according to Gerald J. Lynch, the Aeronutronic General Manager.

Giant New Red Rocket Spotted by U-2 Spy Plane

Photographs of several huge Soviet rockets some 200 feet long appeared this last week to have been the secret goal of the U-2 spy plane downed in Russia May 1.

This was reported to be the substance of secret briefings given Congress by Central Intelligence Director Allen Dulles. The U-2 story that emerged from the fog of speculation was understood to go something like this:

• The U.S. already has pictures of the 200-foot rockets which have been moved to a known ICBM and satellite-launching site near the Aral Sea.

• Possibly the rockets were being prepared for a new space shot outstripping anything to date, since the Soviet rockets are only 30 feet shorter than the giant *Saturn*.

• The U-2 was seeking more pictures of the activity at the launching site.

• The U-2 was not hit by a "remarkable rocket" as claimed by the Russians but apparently the pilot was forced to bail out or crash land because of some mechanical difficulty.

The CIA chief, it was learned, said that the glider-like U-2 was under U.S. radar surveillance and there was no sign that it had been hit by a rocket as claimed by Soviet Premier Khrushchev. He speculated that the plane may have stalled trying to change altitude and that the pilot bailed out because the ejection system failed.

• **Fakery?**—A picture of the wrecked plane exhibited by Khrushchev was probably faked, according to U.S. officials, as were pictures that the Soviet premier said came from its cameras. Dulles reportedly told Congressmen that after capture of the U-2 the Russians probably sent one of their own recon planes over the same route Pilot Francis G. Powers had taken and photographed military installations they considered unimportant enough to make public. Since the CIA knew the U-2 was taking pictures of missile bases, intelligence officials considered it significant that none were revealed by Khrushchev.

Furthermore, one of the photos Khrushchev did make public of an airfield with four-engined bombers lined up wing-tip appeared to have been taken from an altitude of about 7000 ft. The U-2 was reportedly flying at altitudes from 65,000 to 72,000 on this mission.

Dulles reportedly told Congress that the U-2 flights were authorized because of the Strategic Air Command's need to obtain better information about Soviet air defenses. Russia has been spending 18-20% of its defense budget on air defenses and U-2 flights have been attempting to locate installations of the *SA-2* and *SA-4* antiaircraft missiles, as well as the new *SA-6* Soviet anti-missile missile.

• **Better AICBM's?**—The *SA-2* and *SA-4* correspond, respectively, to the U.S. *Nike-Ajax* and *Nike-Hercules* and are said to be as good or possibly better.

Disclosure of the *SA-4* by U-2 and other intelligence sources gave high priority to such projects as *Bullpup* and *Skybolt*, because bombers could not fly out of the reach of the newer Soviet antiaircraft missile.

The *SA-6* AICBM, Dulles reportedly told Congressmen, is further along than *Zeus* and may be in production.

The lower altitude flight was authorized so that the cameras could get a better look at the Aral Sea base. Several Soviet missile bases were in the flight path of the U-2, which took off from either Peshawar, Pakistan, or Adana, Turkey, and was headed northwest to Bodoe, Norway, when it was downed near Sverdlovsk. The U-2 could have flown over a base in the Murgab Oasis (see "Russia's Missile Bases" M/R, Feb. 15, p. 26), and then headed north over Aral'sk and Magnitogorsk, two more ICBM sites. Aral'sk also is a satellite launching base. (see M/R, Sept. 7, 1959, p. 21.)

American military experts were quick to scoff at theories that the penetration of the U-2 some 1300 miles inside Russia indicated any weakness in Soviet defenses against SAC bombers.

Despite the international political repercussions of the U-2 "incident," the United States is expected to continue using it over Russia until satellite surveillance systems can be perfected. Both Samos *and* Midas *are believed at least two years from operational capability.*

At week's end, the Air Force readied a second test of the Midas *infrared early-warning vehicle. The first attempt to orbit a* Midas *failed on Feb. 26. The first shot of the recently accelerated* Samos *television satellite will be made this fall.*

The slim new look . . .

Way for Combat Zeus Opened—Slightly

Backers of the Western Electric *Nike-Zeus* antimissile missile took heart this last week from the recent transfusion of $25 million into the program for preproduction work.

The money, which the Defense Department authorized the Army to take from other Army funds, will be used mostly for the development of special machines for the mass production of thousands of miniaturized electronic components used in *Zeus* radars.

These components are normally made by hand at an average cost of about $20 each. The Army hopes to reduce the cost to about $5 each through the use of mass production methods.

The new authorization was the first break in the Administration's position on *Zeus* since it froze an extra $137 million in preproduction money voted by Congress for *Zeus* last year. The $137 million remains frozen.



NIKE-ZEUS airframe maker Donald Douglas, Jr., leans on tactical model.

Pentagon sources now estimate that with the extra $25 million it should be possible to have an operational *Zeus* system of significant size by 1966. But this would depend on a decision to proceed with production within the next year.

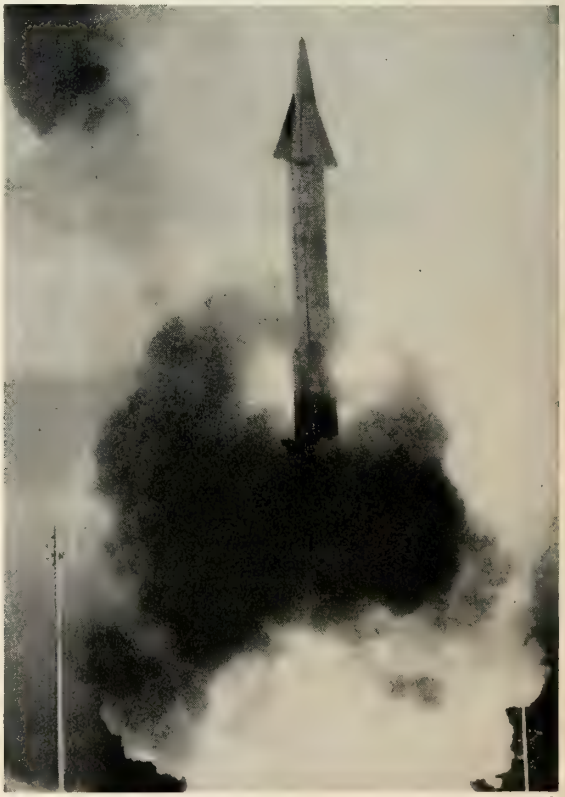
Meantime, the test program with new configurations of the approximately 65-foot AICBM continues.

Tests with the original model which was built with huge fins to gather flight data in the atmosphere have ended. The interim model with greatly reduced fins will be used for the next few tests. The even trimmer new tactical models are expected to be first tested about mid-summer.

The tactical three-stage model is about five feet in diameter. The booster is about 24 feet long; the second stage about 20 feet; the third, including the warhead, about 21.



FIRST BIG-FINNED *Zeus* configuration roars from surface launcher at White Sands Test Range on Feb. 3.



SECOND CONFIGURATION of *Zeus*, with most fins removed, was launched from underground silo at White Sands April 28.

Franke Says Polaris Is On Schedule, Will Go 1200 Miles

ANAHEIM, CALIF.—Secretary of the Navy William B. Franke asserted here that despite reports to the contrary the *Polaris* system will be ready on time and will prove as effective as the Navy has claimed it to be.

"All critical tests have been passed with flying colors by both missile and submarine—and the entire system will be ready as advertised," he said in a Navy League speech.

"There seems to be some belief that—since announced ranges for *Polaris* missile test flights have been about 900 miles—the missile will only go that far and not 1200 miles as the Navy has claimed," the secretary noted. "For the record, these test missiles carry heavy recording devices and transmitters which enable us to analyze the performance of the various components of the missile. These instruments will not be required in the tactical missile which will go 1200 miles."

Franke noted that some critics have asserted that accuracy of the *Polaris* is not as good as that of land-based intercontinental ballistic missiles. "The accuracy of *Polaris* promises to be as good as that of any known missile today," he said, "and this includes the necessary accuracy of positioning of the submarine at sea."

The Navy secretary also took note of Air Force criticism that *Polaris* submarines can be tracked and destroyed.

"*Polaris* submarines have detection equipment and anti-submarine torpedoes for protection just like other submarines," he pointed out. "Any nuclear-powered submarine is hard to find when it is avoiding detection—even for our own well-trained forces . . . the possible launching areas available to us and the tactics we intend to use make this a hollow fear."

Franke stated also that at any given moment about one-half of all *Polaris* submarines will be on station and ready for firing—not one-third as some critics have claimed.

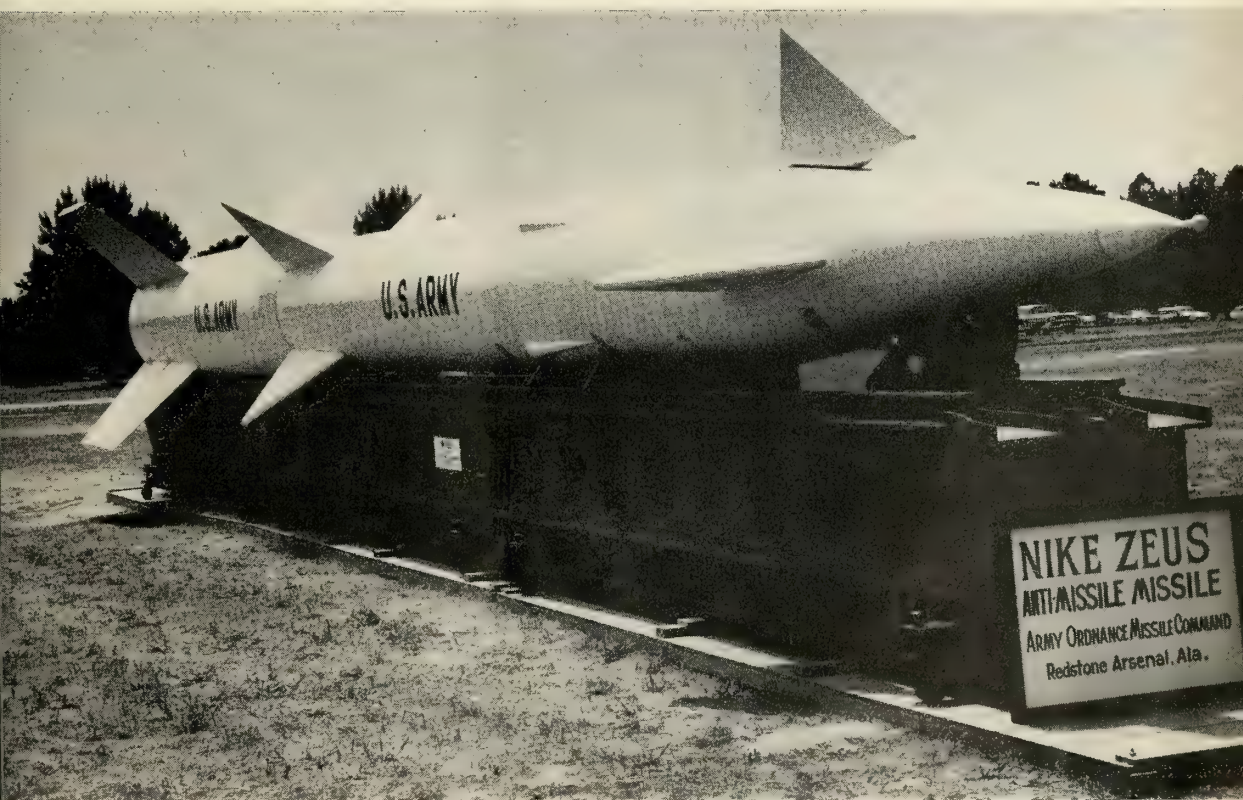
—news briefs—

LONG ATLAS SHOT DELAYED—The Air Force last week delayed again the 9000-mile *Atlas* shot aimed at the Indian Ocean near South Africa. No new date was scheduled but it was expected to be in a few days.

NUCLEAR SUB CIRCLES GLOBE—The submarine Triton traveled 36,000 miles on an 84-day underwater voyage around the world ending May 10. Capt. Edward L. Beach was skipper of the 7750-ton nuclear sub.

HOUSE OKS REVISED FUNDING—The House last week approved the $39.3-billion defense money bill as drafted by the Appropriations Committee to include additional missile funds over those originally requested (M/R, May 9, p. 14).

SOVIETS UPGRADE ROCKET FORCES—Premier Khrushchev last week disclosed the establishment of the rocket force as a separate branch of the armed forces under the command of Marshal Mitrofan Ivanovich Nedelin, a former top artillery commander.



THIRD EVEN TRIMMER tactical configuration of *Zeus* was first displayed publicly at Ft. Benning, Ga., this month (M/R, May 9). Rocket jets enabling the warhead to maneuver are in the forward fins.

ARS Meet Hears New Nozzle Concept

LOS ANGELES—A new nozzle concept for liquid propellant rocket engines was introduced by Rocketdyne Division of North American Aviation at last week's American Rocket Society meeting here. The design is claimed to be one step beyond the plug, or spike nozzle recently developed, and is said to incorporate all the advantages of the plug nozzle without its disadvantages.

Other developments unveiled at the semiannual meeting included a Lockheed-devised composite negative/positive ion beam propulsion system which would eliminate one of the major problems of present ion systems: the neutralization of the accelerated, positively-charged beam. A paper by two Chance Vought engineers described a design for a tactical solid propellant missile motor using gimbals to increase accuracy.

The rocketdyne development was brought out in a paper by G. V. R. Rao, who described the nozzle configuration as an "expansion-deflection" type. The expansion of the exhaust gases occurs around the corner of a centrally-located plug, and the flow is deflected by the wall contour of a conventional-appearing exhaust chamber, which is about half the length required for conventional engines in the same thrust-level class.

• **Nozzle advantages**—The E-D nozzle incorporates such advantages as reduced weight and length (over all other types of liquid rocket engine nozzle configurations), reduced cooling requirements, good performance at high and low altitudes, ease of throttling, and possible simplified thrust vector control.

The nozzle, in cross-section, resembles a conventional liquid propellant rocket, with the exception of the inverted-T-shaped plug extending through the center of the injector plate and down the center of the combustion chamber and throat. The other major apparent change is in the shape and length of the exhaust chamber, which has a much more pronounced shoulder contour than previous rocket engines.

To attain the same thrust level, the E-D nozzle need be only half as long as a conventional chamber and the same length as the plug nozzle design. According to rocketdyne, the engine has more design flexibility than the plug nozzle concept, and can more easily have its thrust level varied, in order to perform a specific mission.

Advanced theoretical and experimental work is being done under contract with the Air Force Flight Test Center at Edwards AFB, Calif.

• **Composite ion beam**—Elimination of the problem of neutralization in ion propulsion systems was suggested by M. A. Gilleo and S. W. Kash of Lockheed Missile Systems Division, who proposed one of a number of devices for creating composite beams of such charged particles.

Benefits of the composite system include useful application of the energy currently wasted through radiation from the thermionic emitter surfaces. This energy would be applied to useful thrust in a composite beam device. A more compact ion engine could also result, as well as the use of less chemically reactive materials for fuels than is now possible.

Suggestions include the surface ionization of negative ions, with specific reference to halogen, the ions of which are particularly suitable. Ionizing surface could be tungsten or another refractory metal, activated by thorium, barium or strontium.

• **Gimballed tactical motor**—Five full-scale prototype missiles have been fired by Chance Vought to prove out its method of accurately controlling a tactical missile. The development, reported by R. J. Blalock Jr. and J. G. McCracke, was designated Project Fire, and completely proved the feasibility and practicability of the system, according to the company.

The system provides that, for short ranges and extreme accuracy, the rocket motor should gimbal to provide control up to the time of burnout. For longer ranges, or where control is necessary after burnout, aerodynamic fins attached to the motor casing still utilize the gimballing system to provide aerodynamic control. This system eliminates need for a dual control system, as well as the requirement for elaborate sealing from high temperatures.

The prototype test vehicle developed and used by Chance Vought was 145.5 in. long and 12 in. in diameter, weighed 530 pounds, and had a range of 12 miles maximum and 1000 feet minimum. The solid rocket motor generating 1000 lbs. thrust was produced by the Solid Propulsion Operation of Rocketdyne.

Undersea Rocket Travel Seen

by William J. Coughlin

LOS ANGELES—Development of underwater rocket and ramjet engines for high-speed military and commercial submarines was forecast here at the first session on underwater propulsion ever held by the American Rocket Society.

Dr. George F. Wislicenus, director of the Garfield Thomas Water Tunnel at Pennsylvania State University, told the session large seagoing vessels of the future might travel entirely underwater powered by such engines.

"There is no known reason why travel or the operation of propellers, pumps, or turbines with extensive cavitation should not be feasible," he stated.

He admitted that flow problems involved might be considerable.

"Nevertheless," he said, "since propulsion with thrust values exceeding the weight of the vehicle is regularly accomplished in the rocket field, the possibility of underwater travel at speeds many times greater than those presently used can no longer be ignored."

He said the problems involved should be easier for a propulsor than for a pump and noted that as speed increases, propulsion machinery weight becomes more critical, "forcing progressive change from the propeller to the pumpjet, to the ramjet, to the rocket."

For underwater ramjet and rocket engines, thrust augmentation by means of devices working on the principle of a jet pump could be used to increase efficiency, Wislicenus suggested.

• **Sameness**—Similarity between between underwater and conventional rocket engines was stressed by another speaker at the session, Leonard Greiner of Experiment, Inc., Richmond, Va. He said considerations in choosing the optimum system for a given application in either space or under water are similar.

Greiner suggested that the best fuels for maximum performance of heat engines in underwater missiles might be aluminum and zirconium, using free seawater as both oxidant and diluent.

This might require some unconventional approaches, he admitted. But he noted that to date in underwater propulsion greater emphasis has been placed on practical considerations while attainment of truly high-performance capability has been relegated to a secondary role.

Other papers at this initial ARS underwater session were presented by Robert Brumfield, U. S. Naval Ordnance Test Station, Pasadena, Calif., and Calvin A. Gonogwer of Aerojet-General Corp., Azusa, Calif.

Congress Split on Joint Space Group

by Paul Means

A majority of House Space Committee members—including their chairman—are opposing suggestions by NASA officials that they merge into a joint committee with the Senate Space Committee.

On the other hand, an M/R poll of members of the two committees this week shows those on the Senate space group generally favoring creation of a single body similar to the Joint Committee on Atomic Energy.

The suggestion was made by certain NASA officials, including Assistant Administrator Richard E. Horner (See M/R, April 25) because they felt that NASA employees had to spend too much of their time testifying before Congress. If the two space committees were merged, the space agency experts would have to testify only once, rather than twice, in support of their authorization proposals.

• **Background**—The proposal for a joint space committee was originally written into the Space Act, but was taken out by the House of Representatives. The House has traditionally been wary of joint committees, because they feel that the Senators tend to dominate them.

A poll of House Space Committee members indicated that while the vote might be close, a majority was opposed to merging their group with the Senate Committee.

The basic arguments made for a Joint Committee are:

• Congress would get all of the information it needs, but the witnesses would have to spend only half as much time testifying.

• Since the authorization bill sent to both Houses will be identical, fewer problems would have to be ironed out in conference committee.

• The record of the Joint Committee on Atomic Energy indicates that House members are not overshadowed by the Senators, and that constructive legislation can result from such a partnership.

The basic arguments made against a Joint Committee are:

• It defeats the bicomeral system set up by the Constitution.

• There is an advantage of having witnesses testify twice in that new information is often acquired.

• Senators cannot always meet at times when Congressmen can, and vice versa.

• **Brooks opposed**—"Unalterably opposed" to the Joint Committee idea is Rep. Overton Brooks (D-La.), chairman of the House Committee.

Brooks maintains that joint committees defeat the Constitutional intent of a bicameral legislature. He also thinks that House members of joint committees are overshadowed by their Senate colleagues, and that the House does not look on joint committee legislation as having been deliberated upon by one of its own committees.

Another objection Brooks has is that many members of the House Committee gave up good assignments on other committees to join the House Space Committee, and would feel "let down" if they now had to share their authority with the Senate.

Agreeing with Brooks is Rep. John W. McCormack (D-Mass.), House Majority Leader and ex-chairman of the temporary House Space Committee.

Rep. B. F. Sisk (D-Calif.), fifth-ranking Democrat on the Committee, said that while he opposed joint committees in general, the present situation might "show justification" for a joint committee, and the idea ought to be considered. Sisk said he hadn't made a final decision either way.

• **Break for House members?**—Supporting the theory of joint Committees is Senate Space Committee member Clinton Anderson (D-N.M.), who is also chairman of the Joint Committee on Atomic Energy.

Anderson, who has written articles about the workings of his joint committee, thinks that House members are not overshadowed by Senators on joint committees, but that they actually play a more active part.

This is true, Anderson says, because House members are limited to one active committee and their joint committee assignment, while senators may be members of two or three active committees. This gives the Representative more time for his joint committee assignment than the Senator.

NASA Successfully Tests Production Line Capsule

NASA has successfully completed an abort test with the production line *Mercury* capsule and its escape system.

The capsule will next be tested on top of an *Atlas* down the Atlantic Missile Range in July (see cover picture).

Launched off of a rail at Wallops Island May 9, the capsule was lifted 2400 feet into the air, where it was caught by the wind and dropped into the water three-fourths of a mile off the beach. Total time elapsed between lift-off, pickup by helicopter, and return to Wallops was 17 minutes.

The capsule will be sent back to McDonnell for tests.

The production line escape system which lifted the capsule was a six-ft.-long, one-ft.-diameter solid rocket by Grand Central which produces 50,000 lbs. of thrust through three nozzles for one-half second. Its thrust would subject the astronaut to 24 g's during a pad abort.

The test was accomplished by bolting the capsule's adapter ring to a rail. Explosive bolts release the capsule from the adapter ring at lift-off.

Fairchild's New Drone



FIRST PICTURE of Army Signal Corps' *AN/USD-5*, Fairchild Engine and Airplane's surveillance drone, shows bird on its mobile ground launcher.

Underground Nuclear Tests to Resume

President Eisenhower last week approved resumption of underground nuclear explosions for the purpose of improving detection techniques.

The U.S. plan was put before a committee of U.S., British and Soviet experts at Geneva. The President told his May 11 press conference that no nuclear explosion will be set off without coordination with the international group of experts.

James C. Hagerty, the President's press secretary, said earlier the explosions would not necessarily be below a seismic magnitude of 4.75 (an arbitrary international standard based on the effect of a 20 kiloton Hiroshima-size bomb buried deep in the tuff at the Nevada test site).

As to timing, Hagerty said merely that it is hoped the tests will begin before the end of the year. Actually, the Atomic Energy Commission is able to proceed much faster. The test site has been on standby readiness since tests were suspended Nov. 1, 1958. In the meantime, work has continued on digging and readying tunnels.

The new tests will be conducted under Project Vela, a scientific program directed toward an improved capability to detect and identify clandestine explosions, both underground and in outer space. Officially, they will not be directed toward weapon development.

• **For reliability data**—Nevertheless, it is obviously impossible to conduct nuclear explosions without learning something of value in designing weapons. Even if the experiments are identical to those conducted in the past, information is learned of the reliability of such devices.

It can be safely assumed that reliability is a subject of considerable interest to nuclear weapon designers. When testing ended in 1958, the *Minuteman* ICBM was in an early stage of development. Even if the *Minuteman* warhead design had been completed by then, it could not have been tested very extensively. Thus reliability would have to be a problem.

To some extent, this must also be a problem with respect to *Polaris*. Although the fleet ballistic missile was farther along than *Minuteman* in 1958, there have been some changes in *Polaris* design in the interim. Again, one must assume that further tests of the operational warheads would improve reliability.

Hagerty said the President's decision bore no relationship to the change in U.S.-Soviet relations that followed the downing of a U-2 reconnaissance plane inside the Soviet Union May 1. He recalled that Soviet negotiators at Geneva had agreed to a proposal that underground explosions be held to improve detection techniques.

• **Salt bed project**—Another program of underground tests also is based on agreement between scientists of East and West at Geneva. The Atomic Energy Commission is going ahead with plans for several experiments under its Project Plowshare, a program of developing non-military uses for nuclear explosions. The furthest along is Project Gnome, a plan for a 10-kiloton explosion in a deep salt bed near Carlsbad, N.M.

The AEC in March asked bids from contractors on preparation of the site. The actual tests, a year away, would not be held without the specific approval of the President. However, an AEC spokesman noted that Soviet delegates at Geneva have already agreed in principle to underground tests for development of non-military applications.

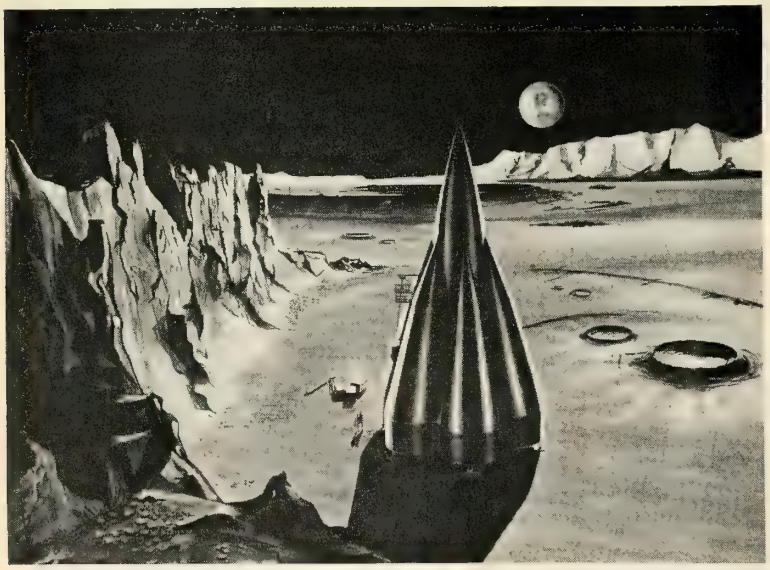
The purpose of Project Gnome is to study the behavior of the explosion in salt, to examine seismic effects and to get measurements on the recoverability of isotopes and the feasibility of power production from underground explosions. The Gnome explosion would take place at a depth of about 1200 ft. and melt the salt for about 20 days. About one-third of the energy of the explosion would be captured in the molten salt.

The Gnome results would have obvious bearing for Vela. Last week, the Atomic Energy Committee released testimony by experts indicating that it is much easier to muffle a nuclear explosion in salt than in granite or the tuff underlying the Nevada Test Site.

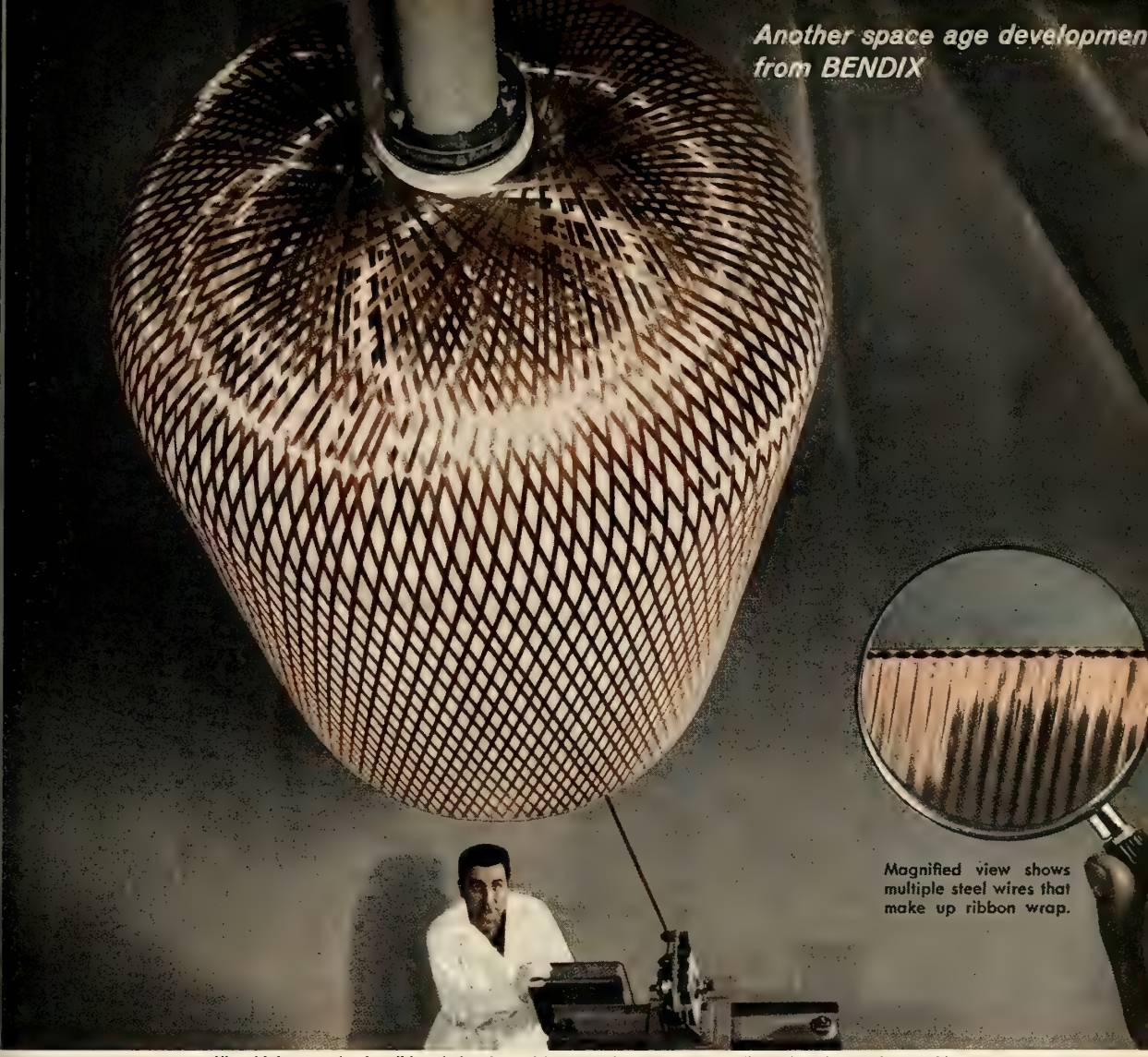
• **Muffling contrast**—For example, Dr. Richard Latter of the Rand Corp. calculated for the committee that the seismic effect of a 20 kiloton bomb in a hole 360 ft. in diameter would be reduced by a factor of 300 if the hole were in salt—but only by a factor of 50 if the hole were in Nevada tuff.

Witnesses told the committee the maximum reduction of seismic effect is by a factor of 300. The volume of such a hole would be about 91,000 cubic yards per kiloton. A one megaton warhead fired at the center of a hole with a volume of 91 million cubic yards would give a seismic effect the same as a 3-kiloton device packed solid.

Nuclear Spaceship Concept



MARS IN A MONTH and thorough exploration of the moon are capabilities of a nuclear-powered spaceship such as shown in this Douglas Aircraft Co. artist's conception. Max W. Douglas, assistant chief engineer-space systems, says a trip to Mars in a ship powered by a low-energy system might take nine months compared with one month for the nuclear. For travel to the moon, he said, a nuclear transport could weigh less than a DC-8 jet plane and carry a 17,000-lb. payload.



Ultra high strength wire ribbon being formed into a rocket case on specially designed wrapping machine.

UNIQUE BENDIX WIRE *RibbonWrap* REDUCES WEIGHT, INCREASES RELIABILITY OF ROCKET CASES

Bendix has licked the problems of weight and reliability in flight weight pressure vessels. Secret of the Bendix-developed rocket cases: many tiny ultra high strength steel wires formed by adhesive bonding into a highly efficient ribbon. Weight and distribution of the binding adhesive is precisely controlled. Result—rocket cases with test strength as high as 531,000 psi, *equivalent to a hoop stress of 350,000 psi UTS in a homogenous case.* A specially designed Bendix machine generates the rocket case. The best wrap pattern for each case is mathematically determined and precisely controlled. Finished product is a rocket case tailor-made for configuration, strength and reliability.

For more complete information, write Rocket Equipment, Bendix Products Division, South Bend, Indiana.

The Bendix wire RibbonWrap gives you these important advantages:

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Charyk Outlines STL's Non-Profit Replacement

Here is how Dr. Joseph V. Charyk, Air Force Undersecretary for R&D, describes "Corporation A"—the technical organization that will take the place of Space Technology Laboratories in directing Air Force development programs. He told Congress recently:

. . . The plan which has been evolved calls for the formation of a new non-profit corporation which will provide the desired technical support to the Air Force's ballistic missile and space programs for the foreseeable future. Functions appropriate to the new organization, which have been handled by STL up to the present time, will be transferred to the new organization as expeditiously as possible. It is anticipated that a nucleus of personnel from STL will provide the initial technical skills required by the new corporation.

In order to avoid any possible disruption of the approved development plans, STL will retain detailed systems engineering and technical direction responsibility for *Atlas, Titan* and *Minuteman*. The present restrictions imposed on STL and Thompson Ramo Wooldridge in regard to competition for hardware contracts arising directly from these projects will be maintained. STL will also receive certain experimental space projects presently under contract and due to be completed in the near future.

Functions to be assumed by the new corporation under Air Force program management include advanced systems analysis and planning, research and experimentation, initial systems engineering, initial technical direction, and technical monitoring in the field of ballistic missiles and space systems. In addition, the new corporation will provide technical staff assistance in the evaluation of ideas and proposals submitted by private industry.

The proposed nonprofit corporation will work closely with the Air Force in long range planning, systems analysis and systems comparison studies. As technical advisor to the Air Force, it will review ideas and concepts generated throughout the industry and government in order to insure the proper interaction between military requirements and technical capabilities. This detailed analysis, together with appropriate supporting experimentation, will provide the soundest possible basis for the initial engineering specifications of a system, including the sub-systems requirements, specifications, interactions, and interfaces. This initial systems engineering work will provide the basis for requests for proposals to the industry.

The new corporation will also play an important role in the evaluation of the resultant proposals, and so provide the Air Force with the best technical assistance for the selection of the contractor who will have responsibility for the detailed systems engineering and the major sub or associate contractors. After the contractors have been selected and the development program launched, the new corporation, through technical review, monitoring, and analysis will serve to insure that technical deficiencies and weaknesses are isolated and that the impact of new data, new developments, and modified requirements on the total systems concept is properly assessed and that, accordingly, appropriate changes are introduced as promptly as possible.

The details of corporate structure, organization, and staffing are now being formulated and will be announced at the appropriate time.

Perry Now Industry Editor

For more than a year, Donald E. Perry, one of the pioneer writers in the missile/space field, has ably served as the managing editor of this magazine. He now has asked to return to a job where he can resume his work as a writer, and we are happy to announce that he has been appointed to strengthen our coverage of the nation-wide missile/space industry. His first assignment will be to expand coverage of M/R's newly established ASW Engineering department. He is well qualified to do this—Don was designated Qualified in Submarines in 1942 and served more than six years in submarines, most of the time on combat patrol. William E. Howard, associate editor for over a year, has been named Acting Managing Editor.

Clarke Newlon
Executive Editor

financial news

Boeing Airplane Co.—Earnings for the first quarter more than doubled that of the same 1959 period, at $4 million up from $1.7 million. Sales rose to $395.7 million from $325.1 million. However, backlog on March 31 was down to $1,960 million compared to $2,329 million in 1959.

Radio Corp. of America—First-quarter profits increased slightly to $13 million from $12.9 million in the like period last year. Sales rose to $361.2 from $321.8 million a year ago.

Burroughs Corp.—Earnings rose 60% on a 22% revenue increase. Net income totaled $2.4 million on revenues of $98.7 million. Current defense contracts for computer and classified electronic communications devices total some $16 million.

The Martin Co.—Sales and revenue for the quarter ended March 31 totaled $140.4 million, about $18.5 million over the same period in the previous year. Net income was $3.5 million, almost $5 million more than 1959's first quarter total.

North American Aviation—Sixth months net income dipped somewhat, although sales for the half-year ending March 31 were higher than that of the same period in 1959. A net income of $11.6 million was realized on sales of $498 million while in the corresponding period last year income was $13.2 million on sales of $449.1 million.

Westinghouse Electric Corp.—Net income for the first quarter in 1960 increased 35% and sales increased 4% over the same 1959 period. The company had an income of $19.4 million on billings of $458.8 million. New defense orders more than doubled those booked in the first quarter of 1959, with total orders increasing 20%.

Texas Instruments—First quarter sales and net earnings hit record highs for the company's 30 year history. First quarter sales totaled $56.2 million, compared to the previous years $30 million. Earnings reached $3.9 million over $2.4 million for first quarter 1959.

Consolidated Diesel Electric—Reported a first half net income (ending Jan. 31) of $106,505 on sales of $12.9 million compared to a loss for the same period a year ago of $161,298.

Chance Vought—Profits dropped sharply, because of a sharp decline in scheduled deliveries of jet fighters, according to the company. Net income dropped to $883,162 from $1.5 million for the first quarter ending March 31. Aircraft and missile sales declined to $52.2 million from $66.3 million in the like 1959 quarter. Income from other divisions brought gross income to $62.7 million off from $66.3 million in 1959.

Allis-Chalmers Mfg.—The machinery maker's sales totaled $126.4 million compared with sales of $84.1 million for the same three month period ending March 31, 1959. Net income climbed to $2.6 million, compared to a net loss of $3.6 million the year before, when strikes occurred in ten of its plants.

Missile Work Brings Boom to Ogden

OGDEN, UTAH—A sleepy little Western rail and livestock center of a generation ago has grown in a scant four years into one of the nation's major missile development and production centers.

By the time the *Minuteman* ICBM goes into full production next year, almost 10,000 will be employed directly or indirectly by missile/space contractors in this community on the desert shore of the Great Salt Lake.

The Ogden metropolitan area has more than doubled its population since 1940—mostly in the last few years—from 56,000 to an estimated 116,000.

Marquardt Aircraft Corp. in 1956 became the first major missile contractor to settle in Ogden. It decided then to build a major ramjet engine production center; Marquardt and the Air Force have since spent more than $15 million to build the facility, which employs 1700 persons.

• **Air Force aid**—The following year, Thiokol Chemical Corp. bought 11,000 acres of desert land around Brigham City, in Ogden's northern suburbs. With the Air Force picking up 40% of the check, Thiokol built a $16-million center for research, development and production of solid propellants. Employment at Thiokol reached 3100 this year.

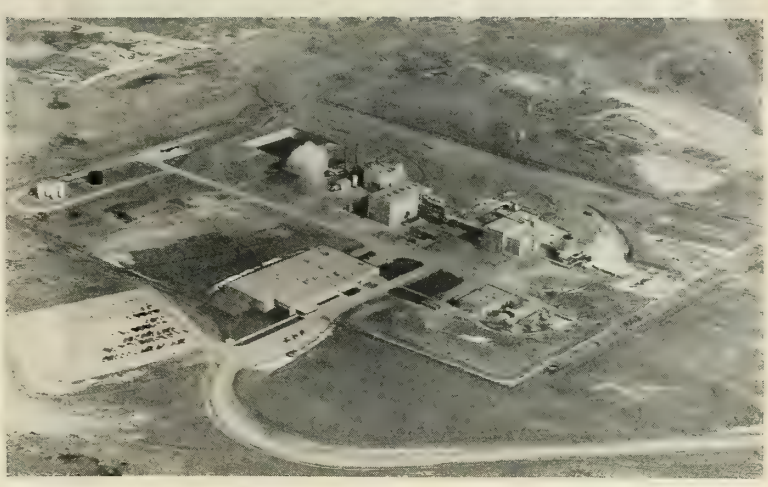
Last fall, the Air Force chose Thiokol as sole source for the first stage and backup source for the second stage of *Minuteman*. Construction has begun on a $34-million production plant that will employ another 1500 when it is completed.

In February, Thiokol decided to establish a headquarters here for its far-flung rocket operations, under the direction of Vice President Harold W. Ritchey.

At Hill Air Force Base, 15 miles from Ogden, the Air Force and Boeing Airplane Co. are building an $11-million plant for the assembly and recycling of *Minuteman* missiles. At least 1000 will be employed there.

A fourth major missile/space concern, Sperry Rand Corp., moved into the Ogden area in 1959. The Sperry Rand plant, which assembles the Army's *Sergeant* missile, has 900 employes and another 700 are anticipated.

• **Small firms too**—The influx of new industry was at least in part a result of a well planned and financed industrial development program, launched by the Ogden Chamber of Commerce in 1954. During the first two years, the new Industrial Bureau succeded in inducing several small plants employing 10 to 25 people to locate here.



WORLD'S LARGEST ramjet engine test center, operated by the Marquardt Corp. for the Air Force, is on the east shore of Great Salt Lake near Ogden.

Smaller concerns continued to move here along with the bigger manufacturers. Supporting plants provide tooling, engineering and similar subcontract services for the area's new industrial giants. Not all the newcomers are in the missile/space business. They include a Pacific Iron and Steel Corp. fabrication plant, a Westinghouse facility and a Del Monte Food Products distribution depot.

An average of $30 million a year is being spent on commercial construction in Ogden—whose total assessed valuation was less than $50 million a decade ago. Home construction, both in new starts and total value, in the first two months of 1960 was double that of 1959. New roads are being built in the area at a rate of about $20 million a year—a level that would have been a two-year budget for all of Utah a few years ago.

School construction is booming too. The two Ogden school districts are spending more than $15 million a year on construction. A few years ago, the entire city budget was less than $2 million.

"The field for tool, die and engineering plants, small or large, is wide open here right now," says Bernie R. Diamond, manager of the Ogden Chamber of Commerce. "The Ogden growth story has been an exciting one because it has shown what can happen when business and industrial leaders pool their resources and brain power."

mergers and expansions

HUGHES AIRCRAFT CO.'s ground system group will hire 600 engineers and scientists during the next nine months. Current work force at the Fullerton, Calif. facility numbers 6000 people working on 26 military contracts.

NARMCO RESINS & COATING, division of Narmco Industries, Inc., has changed its name to Narmco Materials Division. Narmco Industries itself was recently acquired as a wholly-owned subsidiary of Telecomputing Corp.

HERMETIC SEAL CORP. of Nutley, N.J. has taken over complete management of Connector Seals Corp. in Pasadena, Calif. Connector's line of hermetically sealed connectors is used in aircraft, missile and atomic energy programs.

CONTROLS CO. OF AMERICA has merged its subsidiary, Solid State Electronic Controls, Inc., into the parent company to be operated as the Electron Division.



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Technical Countdown

PROPULSION

Nitrogen Textroxide Capacity Boosted

Hercules Powder Co. is quadrupling production capacity at its nitrogen tetroxide plant in Hercules, Calif. N_2O_4 is the storable liquid oxidizer planned for *Titan*. Fuel will be 50-50 mixture of hydrazine and UDMH. AF gave go-ahead for new Olin Mathieson anhydrous hydrazine plant last month (The Countdown, May 2). Present UDMH capacity is reported adequate.

Minuteman Second Stage Tested

Aerojet-General reports full-duration test firings of flight-weight *Minuteman* second-stage powerplants. The number of such tests was not disclosed.

Redstone Engine Production Ends

The last *Redstone* engine has been rolled out of Rocketdyne's Canoga Park, Calif., plant for delivery to the Army. The Chrysler missile, first flight-tested in 1953, was the first large rocket-powered missile to reach production status in the U.S.

Big Mixer Under Construction

United Technology Corp. has contracted for construction of a 200-gallon mixing machine at its new development and test center south of San Jose, Calif. Swinerton & Walberg Co. will build the mixer by July 1. It will be the first building in a 60-structure complex.

GROUND SUPPORT EQUIPMENT

Expensive Experimentation

It costs $2000 per hour to operate any one of its 19 test stands in the Santa Susana mountains, Rocketdyne estimates.

Saturn Equipment Design Started

Hayes Aircraft and Brown Engineering have won the first contracts for engineering and drafting services in connection with design and development of support equipment for *Saturn*. Birmingham Ordnance District awarded the contracts of $674,000 and $517,000.

Combo Analog-Digital Computers?

Future electronic computers will combine analog and digital techniques to provide a better system than is supplied by either method alone. A committee of representatives from Sperry, Stromberg Carlson and Melpar made the prediction in a special report to the American Ordnance Association.

ASW ENGINEERING

Navy Writes Early to Santa

The Navy has two "desired" items for oceanic research—when and if money becomes available: a large shore facility for systematic, rapid data handling, reduction and publication; and a fixed habitable laboratory to be placed at great depth.

ELECTRONICS

TAHA Tests Nearly Complete

Service test evaluation of TAHA—reported to be the world's largest receiving antenna and the only tapered-aperture antenna—is scheduled for completion next month. The antenna—1000 ft. long, 500 ft. wide and 250 ft. high, was built by Development Engineering Corp. for the Army Signal Corps under a $900,000 contract at La Plata, Md.

Better Test Radar for Hercules

The Army has installed extra high-power acquisition radar and more versatile tracking radar for the *Nike-Hercules* at White Sands. The new system is designed to provide greater detection ranges for smaller and faster targets.

Guidance Accuracy Betters Requirement

Better than 1′ of arc accuracy is claimed for the Ball Bros. guidance system for the satellite preceding NASA's orbiting astronomical observatory. The NASA requirement was 5′.

Transistor Sales Spurt

Sales of transistors in the first two months of 1960 were almost double that of the same period last year, according to an EIA announcement. Volume is running close to $25 million a month.

Tracking Ship Instrumentation Begun

Chance Vought's Range Systems Division is producing instrumentation for the first Navy tracking ship assigned to the Pacific Missile Range. Under a $2-million contract, CV will provide telemetry, tracking, data transmission, navigation, timing, aerology, communications, radio command, surveillance and other equipment for the S. S. Skidmore Victory, which had been in mothballs. Work will be done at Ingalls shipbuilding yards, Pascagoula, Miss.

Ideas, Anyone?

For installation in drones, the Navy is waiting for someone to come up with a scoring device that does not require any special instrumentation in the missile.

ADVANCED MATERIALS

Titanium Process Developed

Clevite Corp. has developed a low-cost process for manufacturing parts from powdered titanium—with strength and corrosion properties similar to wrought. In another titanium development, the Army reports use of the metal has lowered the weight of the bazooka-fired *Davy Crockett* by 80 lbs. Titanium Metals Corp. of America estimates Ti requirements for *Davy Crockett* will be 2 million lbs. over the next five years—compared with overall total shipments of 6.5 million lbs. last year.

Simulation Chamber Planned

General Electric is following the trend to bigger simulation facilities, with plans for a big vacuum chamber and a solar source at its MSVD, Philadelphia.

Homemade Radar Checks Out Missiles

Do-it-yourself system built from scraps and surplus by GE specialist to test missile radar beacons

by Hal Gettings

CAPE CANAVERAL—A homemade radar system—fathered by urgent need and the lack of money in the budget—is being used here to check out *Atlas* radar beacons. Reminiscent of earlier days at the Cape when "make-do" was the rule, the system was built by a General Electric instrumentation specialist with salvaged parts to his own design. Total cost of parts and labor amounted to less than $5000. A comparable manufactured system would have cost $20-25,000.

Missile radar beacons must be tested while the bird is in the hangar and again on the pad prior to launch. Range facilities at Canaveral were not always readily available for this testing. Money for a separate checkout system was not in the budget. In addition, time did not allow for the usual procurement, design and development lead time. But the fact remained that the beacons had to be tested before flight, and launches could not be held up for the test.

The problem was solved by an ingenious do-it-yourself project under Henry R. Brown of GE's MSVD Instrumentation Laboratory at the Cape. Using a combination of available surplus parts, scrap, modification, and original design, he came up with a radar system that has done the job well and provides the potential design for a manufactured system.

• **Antenna**—Probably the best example of ingenuity in the building of the "Mark Zero" radar is the antenna. Since no C-band antenna reflectors were available in the scrap pile, one had to be built from scratch. For the basic shape, Brown used the shipping cover from a Mark II nose cone. This was converted to a parabola by filling the center portion with plastic and covering the entire inside surface with aluminum foil. The focus was determined by aiming the dish at the sun and measuring the focal point. The foil was then tensioned and taped in place to fix this point at the proper distance.



RADAR ANTENNA was built from discarded nose cone shipping cover partially filled with plastic and covered with aluminum foil.

The antenna feed was made from a coax-to-waveguide adapter and held in place with salvaged steel scraps.

Final gain figure of 35 db compares favorably with a manufactured antenna. VSWR was measured at 1.2:1.

• **Transmitter**—The big problem in the design of the transmitter was the necessity of using an available magnetron. The one on hand was designed for 200 watts peak power with five volts on the filament. For this application, it was necessary to overdrive the magnetron to produce 1000-2000 watts peak with six volts on the filament. In spite of the heavy overload, the original unit was still going strong after many hours of use.

A special delay line and transformer combination was designed to provide the maximum power output, a minimum usable pulse width (100 pps), and maximum antenna gain.

• **Receiver**—Prime target of the receiver design was maximum sensitivity. This was achieved by a hybrid video amplifier designed to take advantage of both tube and transistor characteristics. The high input impedance of the vacuum tube provides maximum gain, while transistors give threshold of noise control for maximum pulse amplitude and minimum noise amplitude. The negative spike from the main bang has been reduced to a negligible value.

Frequency measurement and diplexing posed interacting problems. These were overcome by marrying a secondary standard (frequency meter) cavity with a C-band mixer and using a standard 60 mc i-f strip.

• **Performance**—The beacon checkout system is located near the hangar and about two miles from the launch pad. It is used to test the beacon both in the hangar and on the pad. Digital readout counters tied to receiver and transmitter check the number of pulses received against number transmitted.

In addition to its primary function, the system is used to monitor range checkout during the countdown.

Performance of the "jury-rigged" system to date, according to GE engineers, has been most satisfactory. It is but one more example of the imagination and ingenuity necessary to get the big birds off the pad and to their target.



'Copter Makes Air Catch

by Donald L. Zylstra

New helicopter techniques are being developed to solve the thorny problem of "air-catching" *Discoverer* data packages—and perhaps even manned *Mercury* capsules.

Up to now the Air Force has been trying to snag *Discoverer* capsules with a trapeze-type gear dragged by fixed-wing aircraft. So far the airplanes have not had a real chance at a mid-air catch, since none of the capsules have been sighted. An attempt to recover the capsule of *Discoverer XI* failed when the 300-lb. capsule apparently went into orbit.

Sikorsky Aircraft Division of United Aircraft Corp. and the All American Engineering Co. recently demonstrated to a military-technical group how a Sikorsky S-55 helicopter could catch a 124-lb. package suspended from a parachute 24 ft. in diameter. The demonstration, at Sussex County Airport, Del., included the lowering of the 141-lb. total to the airport apron with All American's 15C pick-up winch.

The S-55 trailed a 20-foot pole pointing diagonally downward and aft, from a position directly below the winch. The pole supported a grapnel-like hook attached to a nylon towline leading from the winch. When the hook caught the parachute canopy or shrouds, the line was paid out 60 to 75 feet, so the chute and package could be towed without danger of fouling with the helicopter.

• **Lots of time**—Chutes and packages were released from a light, fixed-wing aircraft from a 10,000-foot altitude. Rate of descent for the chutes was approximately 1500 feet per minute. With this rate of fall, helicopter pilots demonstrated that they had ample time for multiple passes at the chute—up to seven or eight tries in recent successful recoveries.

Sikorsky's chief pilot D. D. Viner and test pilot Robert Perrone said "several attempts could be made" on chutes with rates of descent as fast as 2000 to 3000 feet per minute. During the Sussex Airport tests, observers saw the copter retrieve a chute on the first pass as well as on the third try, with recoveries being made at altitudes ranging from 8000 to 1000 feet.

Because recovery is made at speeds from 20 to 60 knots in helicopters, the aircraft can achieve more approaches and can make corrections in approach later and closer to the parachute than fixed-wing planes. Airplanes are forced to close on the chute-borne package at speeds from 105 to 150 knots.

Because of slower speeds, helicopters may experience greater difficulty in "arriving at the recovery scene," pilots said. But, if three or four helicopters were airborne at the time and site of missile re-entry, at least one would have an excellent chance of arriving on time. Such tactics are possible with slower, more maneuverable helicopters. Faster airplanes would endanger each other if used in this way. Even if fixed-wing craft make the recovery, as in the case of drones, waiting helicopters could probably relieve them of their heavy, dangling loads and lower them safely.

• **Eye on canopy**—Pilot Viner explained that approaching descending parachutes is a technique well within the skill of any competent helicopter pilot. In retrieving airborne instruments, the pilot aligns himself with the drifting chute, employing an aerial counterpart of the "seaman's eye." If he can keep the convex parachute canopy just visible above his instrument panel during the final seconds of approach, he has an excellent chance of completing his recovery.

Predictions that downdrafts from helicopter rotors would collapse the parachute canopy proved entirely unfounded, test pilots said. Pendulum reactions after the hook engaged the chute damped out promptly after the "towing" began. Swinging motion of the package also proved negligible in lowering payloads to the ground. Drag while towing posed no problem in maneuvering the helicopter.

Buried Moon Bases Studied By Army

Buried lunar bases are the long-range objective of a series of studies under way at the Army Corps of Engineers.

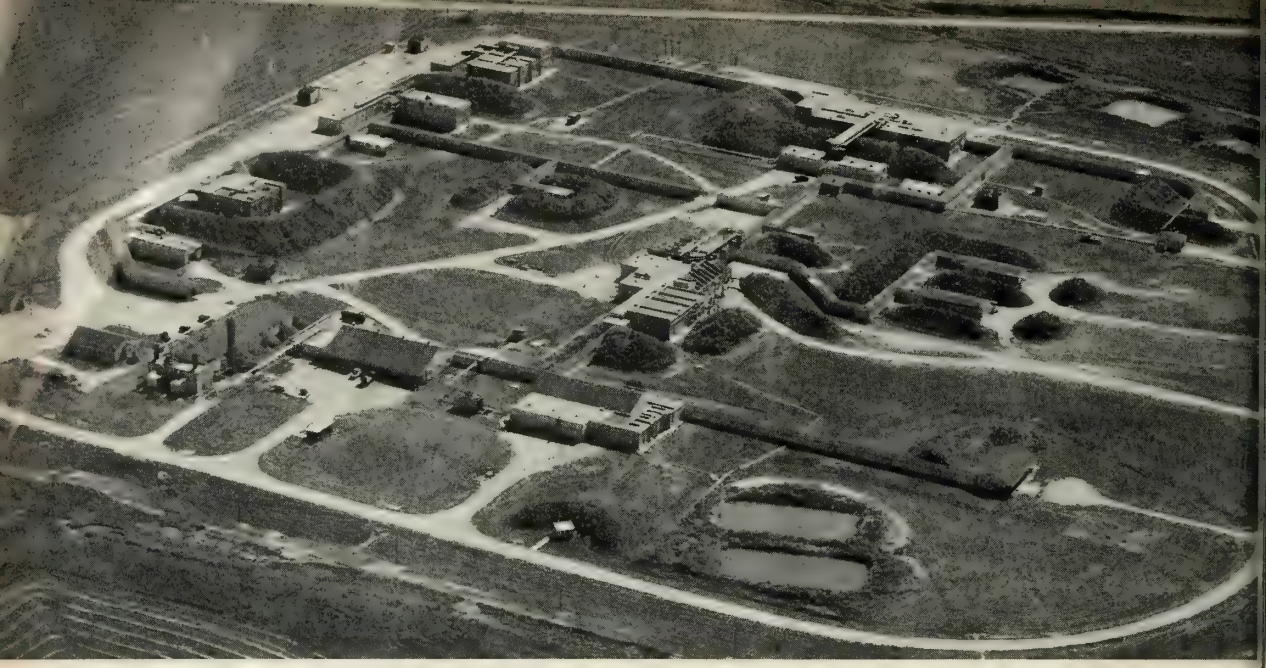
Chief Engineer Lt. Gen. Emerson C. Itschner told the House Space Committee last week that U.S. space vehicles will be capable of taking teams to the moon within the next decade—making such facilities mandatory for all but preliminary explorations.

One concept envisions prefabricated units sent by cargo rockets and assembled on the moon with a minimum of labor. Another alternative would be inflatable structures. All would have to be buried for insulation and meteorite protection. Power would be supplied by small nuclear reactors.

The capability of the Corps of Engineers for this type of work is amply illustrated by the construction, this summer, of a semipermanent camp housing 100 men beneath the Polar Ice cap in Greenland, says Itschner. Nuclear power will supply light and heat.

Lunar conditions are much worse than those found on earth; for this reason, a long R&D program will be necessary. Itschner says this program should be initiated soon, since it must be carried out simultaneously with development of rockets large enough to handle the transportation phase.

Army Engineers are already working on moon maps and, in addition, are planning special satellite instruments to supplement existing photographs.



SOLID PROPULSION plant, now wholly owned by Rocketdyne, occupies 12,000 acres near McGregor, Tex.

propulsion engineering

Rocketdyne Solid Operation Grows

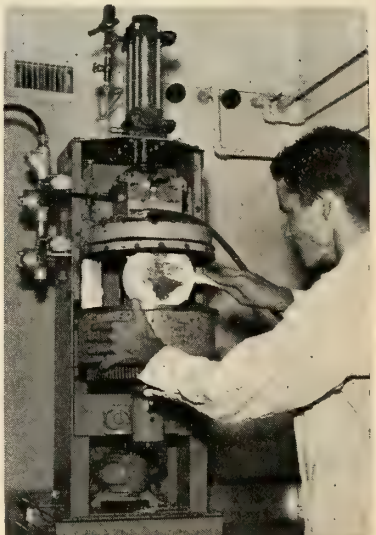
Former Astrodyne facility increases R&D; company feels it is now ready for any solids job that needs to be done



PRE-MIX of oxidizer, metal powders and inert binder for igniter is carried out by Rocketdyne's R. L. Powell.



PROTECTED behind heavy glass and steel partition, worker pours propellant ingredient into mixing bay hopper.



MIX-MULLER blades are cleaned after remote-control mixing operation is completed and material is dried.

by Jay Holmes

McGREGOR, TEX. — Rocketdyne's Solid Propulsion Operations—a bomb-loading plant in World War II and a JATO producer in the Korean War—now says it can take on any solids job that needs to be done.

Two ownership changes in the last two years have marked the latest shift in emphasis—from straight production to production mixed with a heavy share of research and development.

Phillips Petroleum Co. operated the plant from 1952 until 1958 as its Rocket Fuels Division, producing JATO units for the Air Force. In February, 1958, Phillips and North American Aviation joined to form Astrodyne Inc.

The new company set out on a long-range program of modernizing facilities and expanding research capability.

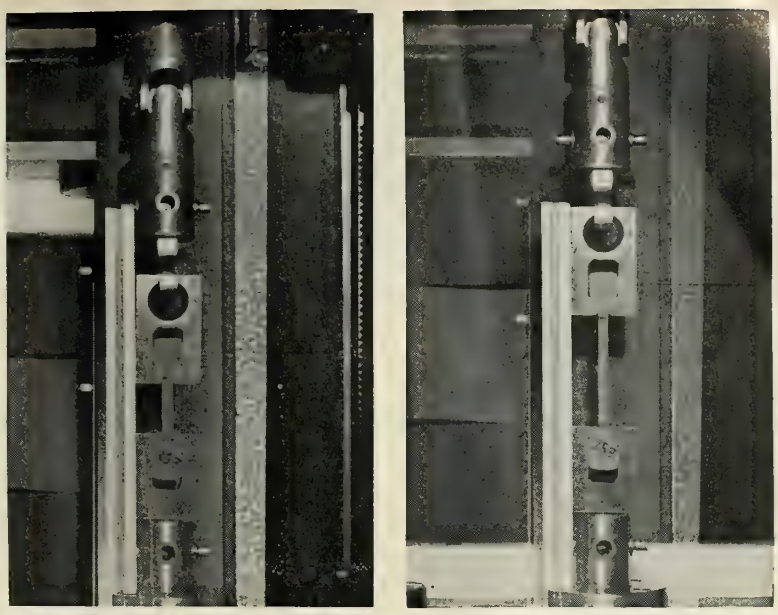
On Oct. 1, 1959, North American bought the Phillips interest and established the plant as Rocketdyne's Solid Propulsion Operations. The solid propulsion team at McGregor now is supported by basic research in advanced propellants carried on at Canoga Park, Calif.

• **Big leaguers**—The Rocketdyne team, headed by Vice President T. E. Myers, now feels it has graduated to the major league in solid propulsion. Symbolizing this, Rocketdyne is one of six bidders in the current competition on Air Force Project 3059, a proposal to build a booster of about 100 million pound-seconds total impulse.

So far, Rocketdyne SPO has not snared any major ($10-$20 million) contracts from the big operators in the field. The present production activity consists of a small amount of residual JATO work and a few gas generator contracts. Gas generators are a growing field as the major liquid engines switch from liquid to solid gas generators for simplicity. SPO already has one contract to supply turbine starters for a Rocketdyne liquid powerplant, and makes the generator for the Navy's solid-propelled *Tartar* and *Terrier*.

Research is a major activity here. S. C. Britton, research lab group leader, heads a staff of 50 studying such areas as propellant ballistics and physical properties, processing techniques and new missile and spacecraft applications at company expense and under Air Force study authorizations.

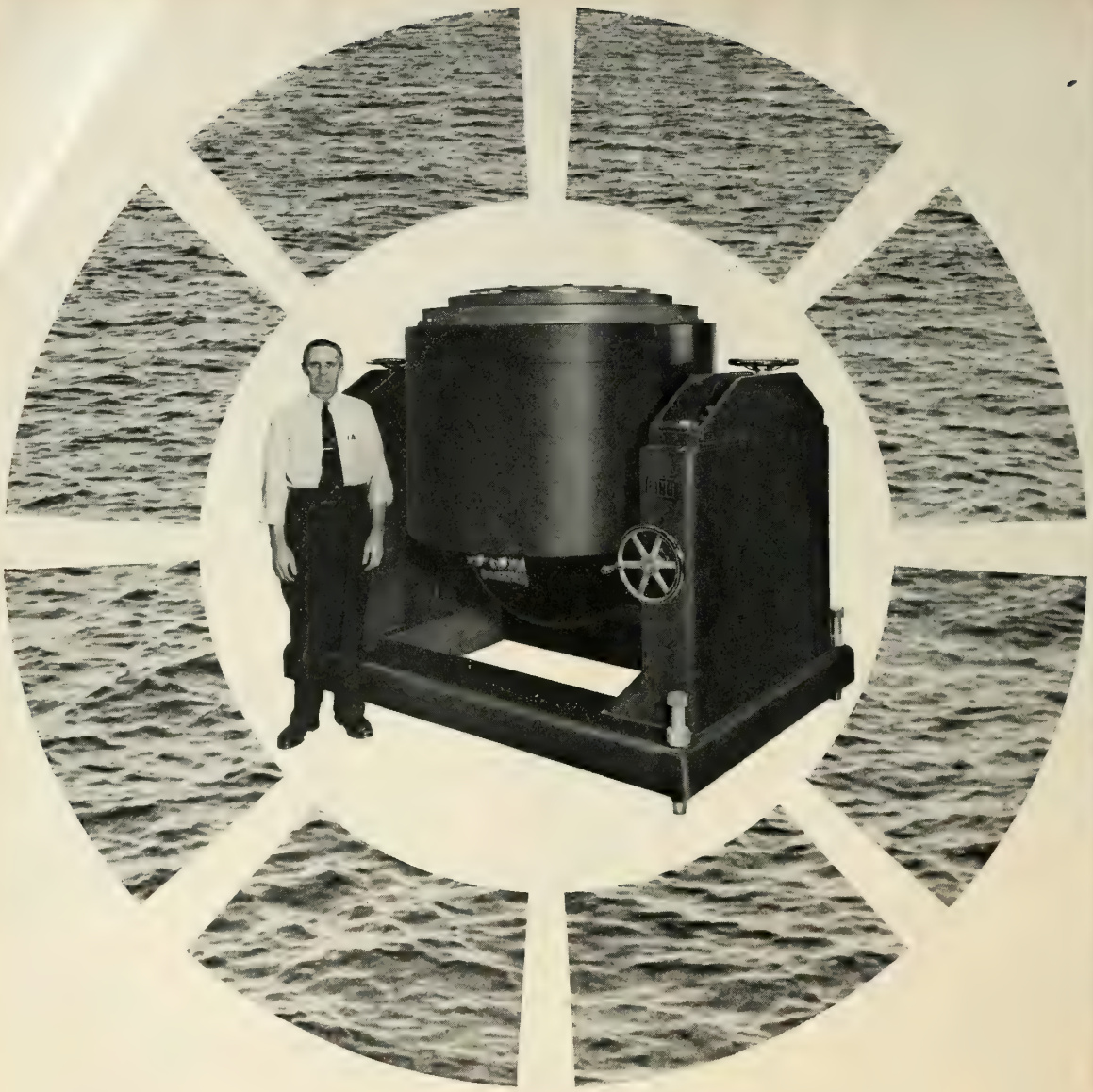
Although it has done some work with polyurethane-base propellants, Rocketdyne is beginning to be identified with the polybutadiene class, very similar to the polysulfides. Britton said improved physical properties have been developed in two classes of polybu-



TENSILE TESTS demonstrate physical properties of Rocketdyne propellant. At left is material before tension is applied. At right, under tension. Propellant base is chemically similar to synthetic rubber.



WORKER LINES UP extruded propellant grain for sawing. Actual cutting takes place by remote control, while being sprayed with cooling water. Workers are protected by steel walls from possible fire.



LING'S LIQUID-COOLED SHAKERS DISSIPATE HEAT FAST WITH WATER

Improved system efficiency goes with the improved design of Ling's new series of liquid-cooled shakers. For instance, Model 249 shown above not only offers an impressive 28,000 pound force rating, but a number of other advantages. The new closed-loop cooling system, employing clean raw or distilled water, dissipates heat so efficiently that less is dumped on the testing site. The series also features a new web-design armature of lightweight aluminum. Force is transmitted to the table with maximum rigidity. Finally, special construction details make these liquid-cooled shakers adaptable for environmental chamber testing without special accessories. Tests can be conducted from −100°F to 300°F at any altitude. Field and armature coils are designed to help eliminate corona at altitudes; special thermal barriers can be supplied which control heat flow from the shaker to the chamber. This built-in adaptability and high efficiency grow from Ling research; For details on the liquid-cooled shaker series, write Dept. MR-2 at either address below.

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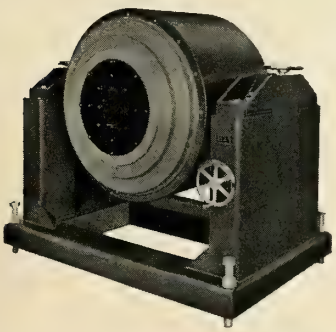
LING ELECTRONICS

The shaker at the left is just one of many design improvements to grow out of Ling's continued research and development program. Its high 28,000 pound force rating—one of the highest force ratings available—is another result of Ling's constant search for better equipment and better methods of vibration testing.

In addition to the special advantages offered by the efficient liquid-cooling system, this new series offers other important features which it has in common with the air-cooled shaker series.

Ling's dual magnetic field structure provides a low stray field and improved force-current linearity. Ling shakers are engineered to operate continuously at maximum force on low input, feature simplified compensation over wide bandwidths.

Check the ratings on the entire liquid-cooled series. The performance of the series is just one more proof that whatever your needs in high power electronics – vibration testing, acoustics or sonar—you can rely on Ling for the most advanced design and practical engineering.



LING'S LIQUID-COOLED SHAKERS cover this useful range of force ratings:
Model 245—2,000 lb. force rating
Model A246—7,500 lb. force rating
Model 275—10,000 lb. force rating
Model 249—28,000 lb. force rating

LING
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HIGH-POWER ELECTRONICS FOR VIBRATION TESTING • ACOUSTICS • SONAR

tadiene propellants, carboxy-modified polybutadiene and polybutadiene acrylic acid (PBAA).

• **One-piece route**—Good physical properties are essential for very large grains, such as that envisioned for Project 3059. With the industry split between advocates of segmented and one-piece casting, Rocketdyne is going the one-piece route. This requires on-site loading and a propellant with particularly good physical properties.

The whole industry recognizes that there are serious problems in making motors that will withstand temperature extremes and in making the very large monolithic grains hang together. Britton says he believes PBAA is a better propellant than others on both counts.

As an example, Britton provided calculations showing maximum dimensions of grains with ordinary PBAA and with the Rocketdyne variety. Holding the inside diameter constant, he said, it is possible with the Rocketdyne PBAA to increase outside web diameter 80 to 100% and at the same time increase inside web thickness more than 325%.

For on-site loading, Rocketdyne is developing a continuous mixing process it calls Quickmix (M/R, Nov. 30, 1959, p. 21). "It is showing excellent progress and we are now certain that Quickmix is a feasible process. The propellants we have produced by the process show improved physical properties and higher specific impulse than those produced by batch mixing and a degree of reproducibility in propellant composition that is fantastically high," he said.

"Quickmix shows several advantages over other continuous mixing methods and the dispersion of ingredients is superior to any other mixing method."

• **Ratio debated**—The industry is also divided on the big booster's propulsion characteristics. Some believe is should generate a very high thrust for a relatively short time. Others prefer low thrust and longer duration. "Personally," Britton said, "I believe a low-thrust, long-duration motor will have a better chance to advance the state of the art. The problems of insulation and long-duration nozzle cooling might be tougher."

Actually, however, the Rocketdyne proposal indicated an intention to look both ways on the thrust-duration question.

"Some believe that polyurethane propellants yield a higher specific impulse," he said. "But Rocketdyne's calculations and measured I_{sp} show no significant difference."

He said the specific impulse attained by Rocketdyne PBAA is at least as high as the propellant going into *Minuteman* and *Polaris*.

To get higher energies, Rocketdyne is conducting research on a broad spectrum. Typical areas of interest are the nitro compounds and borohydrides —which provide higher energy or lower molecular weight—and the encapsulation of such highly reactive ingredients as lithium aluminum hydride.

GE Engineer Proposes Jet-Powered Booster

A General Electric Co. engineer proposes the use of composite air-breathing and ballistic systems for launching space vehicles to gain a payload advantage over a ground-launched system.

Morris A. Zipkin, manager of advanced propulsion systems in GE's Flight Propulsion Laboratory Department, last week suggested that an air-breathing system such as a turbojet might take off and accelerate the vehicle to cruising speed. Then the first stage would separate and the rocket system would take over.

The air-breathing stage could be recovered. Similarly, he said, a second-stage hypersonic ramjet powerplant could take over for long-range transport flight between points on earth.

Development of Skybolt Propulsion Will Cost Less

Aerojet-General says development of the propulsion system for the 1000-mile-range *Skybolt* will cost 20% less than what has been spent in the past for powerplants of comparable size.

The program will benefit from work performed earlier on Army, Navy, Air Force and NASA projects, Aerojet said.

G. William Lothrup, 42, was appointed program manager for Aerojet's part in developing the air-to-ground missile. John Baird, 36, was named project engineer.

Army, Thiokol Open New Facilities at Redstone

The Army and Thiokol Chemical Corp. last week dedicated new solid propellant facilities at Redstone Arsenal, Ala., valued at $4.5 million.

Twelve major operating and engineering buildings have been erected, including mixing buildings, casting buildings, a radiographic inspection building, a motor preparation building, curing ovens and office buildings.

The new equipment includes a 200-gallon mixer and a 300-gallon vertical mixer. Thiokol said that with the additions, Redstone Division is capable of developing motors of any size required by the Army.

Metals Men Discuss Changing Needs

Meteorite penetration hazard is a major problem area; speakers agree on need for space probes with materials tests

by John F. Judge

CINCINNATI—High temperatures, meteorite protection, radiation and vacuum problems were the major topics of discussion at the Tri-Chapter Meeting of the American Society for Metals held here April 27-28.

There was strong sentiment at the gathering in favor of scheduling as soon as possible some space probes including experiments with materials.

Four hundred metals men heard various key experts in all phases of rocketry define their current and future material needs and, in most cases, the expected sources of improved or new materials.

Kurt Stehling, National Aeronautics and Space Administration, began the sessions with a description of the expected problems in the overall civilian space program. The NASA scientist indicated that funding is increasing in this area and, as more and more space penetrations are made, constant changes emerge in problem definition in materials.

Stehling mentioned a growing awareness of the necessity for protection from meteorite penetration, as did several of the other speakers.

• **Solid limitations**—Another session revealed that large solid rockets can be ruled out of heavy payload systems simply because of the long lead time involved in the development of nozzles.

Specifically covering launching systems, Dr. William Harris, Executive Director, Materials Advisory Board, National Academy of Sciences, said the potential in large liquid engines is much greater from a materials standpoint.

In the solid motor case area, Dr. Harris said the future of reinforced plastics appeared promising but that not enough work is being done.

The high-temperature metal coming to the forefront is tungsten, according to the scientist, but its lifetime may be measured in months, as was its predecessor, molybdenum, in this fast-moving field.

• **Trouble at top**—Typically, Dr. Harris finds that some of the materials problem lies in administration. He called for less dissipation of research and development knowledge and programs and more concentrated efforts—small groups capable of processing and fabricating these materials.

The money being spent in this vast area is sufficient—it is the management that leaves something to be desired. Coordination among the Atomic Energy Commission, National Aeronautics and Space Administration and the Department of Defense is poor when it comes to materials problems.

• **The environment**—In space itself, many problems that have preoccupied science in the past may prove to be phantoms—while others yet undiscovered may take their place.

Dr. John C. Simons of the National Research Corp. outlined the materials problems created by the environment of space. He said that many investigative efforts can be conducted in environmental testing on earth—but, as Lockheed's Dr. M. A. Steinburg also pointed out later, some space probes involving experiments with materials will have to be undertaken—and soon.

Simons divided the effects of space into non-destructive, or reversible, where the material acts as an intermediate, and destructive, or irreversible, change.

Among the former is the absence of a conducting medium, the possibility of a charge since the body is isolated, secondary or induced radioactivity, and the radiation disturbances of solid-state devices.

The well-known destructive elements include material evaporation, fatigue, creep rupture, instrument failure due to temperature gradients, erosion and sputtering.

Steinburg outlined a materials space probe consisting of an oriented cube, which could provide a great deal of surface information. In addition, he said, it's hoped that in-flight bearing tests concerning lubrication and bearing torques will be put into effect this year.

The Lockheed scientist pointed out that the synergistic effect of space is not known to any great extent. The only way is to probe with the proper instrumentation. This has not been done to a satisfying degree as yet.

• **Energy conversion**—Dr. Clarence Zener, Director of the Westinghouse Research Laboratories, guided the metals men through the mazes of direct energy conversion systems whose efficiency could be improved with new or better materials.

He said that although many of the problems are unique to metallurgy, it has been chemists who have led the pack in developments.

This is regrettable, he said, because the field of energy conversion is suffering from a lack of the type of background peculiar to metallurgists.

Nuclear space power systems were described in terms of materials needs by Robert Brooks, G.E. Flight Propulsion Department. Improvements in the alkaline metal-refractory alloys relationship must be forthcoming if nuclear power is to be a reality in space.

Brooks anticipated wide use of beryllium in radiators. He mentioned that no reliable method of welding stainless steel and columbium alloys has yet been perfected for reactors.

Russ Edwards of G.E.'s Flight Propulsion Department aptly summed up the materials requirements in electric propulsion by stating that all that is needed is a refractory metal very similar to sponge rubber—to absorb energy without loss and/or for use as an electrode in ion engine systems.

• **Polaris cases**—After a brief description of the utter simplicity of solid rockets, William Cohen, Chief Civilian Engineer, *Polaris* Propulsion System, presented a graphic outline of the state of the art in solid motor cases—at least as far as the *Polaris* program is concerned.

Most of the cases in the *Polaris* are of the roll-and-weld variety which means, according to Cohen, that this aged method of fabrication has incorporated some of the highest quality techniques and inspection methods known to the metalworking industries. Cohen had no answer to offer in the

weld grinding controversy which rages among manufacturers. Briefly, it is a pro and con argument as to the efficacy of grinding weld marks to overall surface smoothness. Cohen says both acceptable cases have been produced with and without grinding.

Hydrospinning, which involves the forming of cases from forged rings, eliminates longitudinal welds and some of the peripheral ones. Cohen again remained objective in his description of this process but did add that a few rings had been rolled and welded before spinning.

Cohen also mentioned that attempts are being made to manufacture cases from strip steel by winding—and binding with either resins or spot welds. Highly difficult to weld, a strip steel cylinder presents some problems in successfully attaching the closures.

Another mild ripple among case manufacturers concerns surface decarburization. According to Cohen, some say it is desirable and do it and others say it might be desirable but how do you control it and do not do it. 6434, H-11, D6A and Tricent are the major steels being used in the *Polaris* program. Cohen anticipates that in about a year, a proven motor case will come out of one of the above, heat treated to the 240,000 to 250,000 psi range.

• **X-15 demands**—A rapid summation of the materials involved in the *X-15* experimental vehicles began with Wayne Reinsch, Materials and Process Engineering supervisor for North American Aviation, concentrating on structural metals.

Maximum speed of Mach 7, metal temperatures up to 1200°F during re-entry and the containment of large quantities of LOX and ammonia determine the general materials requirements of the vehicles.

Iconel X is the main structural material for this design. In the advanced *X-15*, where speeds up to 25,000 ft. per second and temperatures up to 5000°F will be encountered, leading edges will be of a ceramic material, supporting wing structure is designed for molybdenum or columbium alloys and the fuselage design calls for a nickel based alloy. Where temperatures exceed 1500°F, molybdenum or columbium alloys will be used.

• **More re-entry**—Material considerations in re-entry in general were developed by William Pellini, Superintendent of the Metallurgy Division of the Naval Research Laboratory. Two main divisions are possible—lift vehicles and drag vehicles. There is also a combination of both.

Lift vehicles in particular were treated by Wilfred Dukes, Chief of Structures, Aero-Space Department, Bell Aircraft. The critical areas as far as materials are concerned are the lower surface, the leading edge and the fuselage nose.

Refractory materials with radiation cooling will be used in the leading edge applications. Molybdenum and graphite programs are in full swing in this area says Dukes. But even the most refractory materials are of questionable value in the fuselage nose. If the nose is small enough, some sort of heat sink can be employed. The remainder of the airframe will involve the use of insulated and cooled structures.

Solar Cell Weight/Power Ratings May be Cut by NRC

Solar energy conversion units with weight/power ratings of 16 lbs. per kilowatt may be the result of a unique photo-emission technique under investigation by National Research Corp.

Present conversion methods using silicon cells weigh up to 400 lbs. per kilowatt.

In addition, the cost of the new method appears to be competitive because of mechanical simplicity and inexpensive materials.

The theoretical conception of the principle of operation originated with Prof. Thomas Gold of Cornell University, an NRC consultant. Small-scale laboratory demonstrations have been successful.

Hardened Missile Site Parts Testing Expands

Silo shock testing programs, involving one of the largest sand drop towers on the West Coast, are in operation at American Laboratories Division, American Electronics, Inc.

The new drop tower is part of seven different types of test facilities—capable of meeting the requirements of MIL-S-4456, Jan-254, MIL-C-19500A and MIL-A-8421.

The firm's large horizontal shock tower is being modified to test assemblies of 50,000 pounds or more against Zone C requirements of the Air Force's Lowry, Larson and Ellsworth bases.

Rigid shock specifications have been written into these sites because they must remain operational through near-hits by thermonuclear devices. Pumps, valves, regulators and welded structures may be tested, and abnormal requirements such as square wave and saw tooth inputs can be handled.

Solar Mirror Squint



EMPLOYE OF Ryan Aeronautical Co. peers into a solar mirror, cast from plastic for Ryan's advanced research in solar energy and radar dish concentrators.

The ITP Approach: Improve—Then Buy

Extremely high reliability and confidence can be built into an entire space program at less than current costs by applying a systems engineering concept to the testing techniques involved.

Robert H. Hover, Reliability Research Specialist at the Missile Division of North American Aviation, has evolved such a process based on extending established designed experiments to encompass entire programs.

The Integrated Test Program, as it is called by its author, has two objectives: to increase the rate of reliability improvement, and to provide a measure of reliability amenable to direct testing.

Two proposals for advanced weapon systems made by the Missile Division to the Air Force included the Integrated Test Program.

• **Improve—then buy**—If a conventional reliability program is plotted on a reliability vs. calendar scale, a growth similar to a curve designated "Buy, then improve" will be demonstrated. In the ITP, the curve becomes "Improve, then buy" and a rapid growth in reliability is apparent.

Essentially, the customer delays buying until the device is almost matured. This means the "Buying date" may be later than that in the conventional program but the "Useful date" should be significantly earlier. The earlier useful date will result because the supplier will provide a larger portion of the reliability improvement before delivery to the contractor.

In a conventional program the measure of reliability is characterized by Hover as a Poisson distribution—mean-time-between-failures. This function is actually untestable until late in the program; there is some doubt as to its value outside of certain limits. Hover says such a program emphasizes operation to failure.

In the ITP, Hover says, "parameters such as flow, voltage, and pressure are measured in terms of variance about a mean value and, through a testable time, a wearout curve is established so that degradation of this variance can be extrapolated for longer periods." Since a statement of variance can be expressed in terms of probability of success, the measure of reliability is explicit. Thus the program emphasizes successful operation of equipment because an analysis of variance and regression is the purpose of designed experiments.

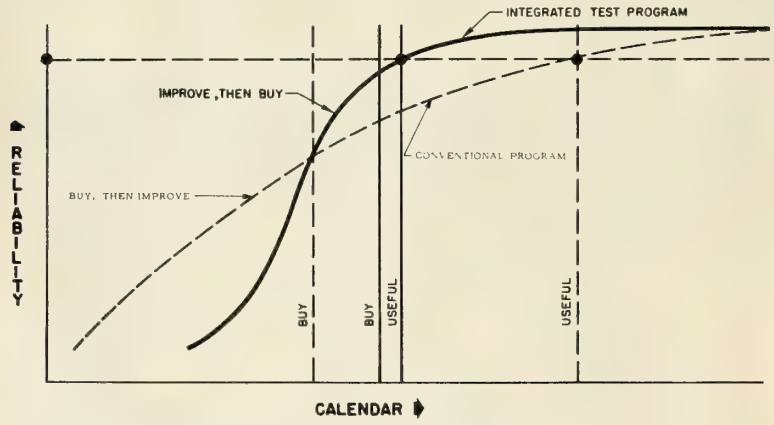
• **Level isolation**—According to Hover, the reason for testing components, systems, combined systems and articles is to isolate the peculiar effects of each level. System testing involves the interaction of components and not the testing of components themselves. The capabilities of each component should be known. Progressively, in combined systems, the interaction of systems, not the particular system, is the testing object. At this point, Hover says, the terms involved should be satellite, booster or missile and not system or component.

The article level means satellite-booster combinations with all the ground support and logistics included. Hover states that this obvious order of testing can seldom be accomplished in a "Buy, then improve" program because it is not known how good, or poor, the components are.

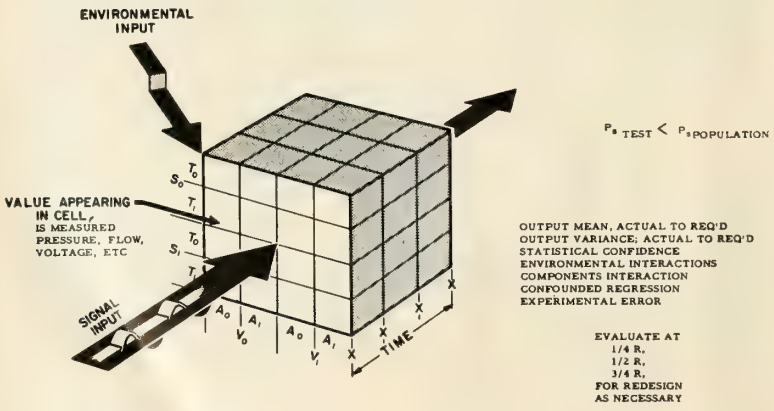
In a component factorial design, the force exerted is composed of input signal and environmental effects. Knowledge of the output signal is the object, during or after exposure to the environmental forces.

Using a 16-cell design, Hover can subject the component to a variety of environments as the component passes through the test. The results may be evaluated after ¼, ½ or full replicate.

Reliability Growth



Component Factorial Design



(A replicate is the filling of all cells in a particular order.)

Following through, it can be seen that if the results after a ¼ replicate are not up to snuff, redesign is indicated. The results are simply the observation of a specific variance about a mean value while the test items are exposed to the four environments singly and in combinations.

• **Acquired information**—According to Hover, if the redesigned component passes a full replicate, the following develops:

• Probability of successful operation within parameter limits can be stated with statistical confidence.

• The influencing environments are discovered.

• Information about component variation is known because 16 components had to be made to successfully pass the factorial test.

Any number of environments greater than two can be utilized. Fractional replicates can be employed to limit total testing but with limitations on information about specific higher order environmental interactions.

In systems and combined systems factorial tests, a minimum number of systems are utilized to reduce cost. For example, four systems are run eight times each with four different environmental inputs, for a specified duration. Then the same statements as were made in the component tests apply. The environmental treatments imposed here would nearly simulate the actual progression of usage through handling, preflight, boost, and—if necessary—the closest simulation of an actual orbital state.

Hover includes an off-design test in this stage to verify that the system is actually operable within the limits set forth in the analysis.

• **Few items**—The number of test items may not be as large as expected from a comparison with conventional programs. In the ITP, all of the items and input-output signals are statistically coordinated. This is not true with conventional approaches. Test progression can be stated in terms of fractional replicates—involving a single record and not a multiplicity of data. Redesign can be applied sooner, thus increasing the number of successful tests within a shorter time.

Hover explains the associated engineering areas by defining in terms of a component and stating that the application can be effectively applied to systems and higher levels.

In planning tests, test equipment and simulated environments, the skills of test engineers, statistical mathematicians, dynamicists and designers are all involved in the factorial design. One or two unfilled cells can be accommo-

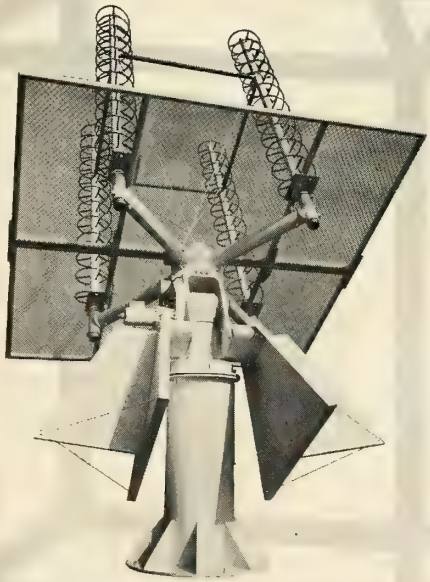
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dated in the ITP to allow for inability to conduct certain multiple combination tests. Operator error is reduced by clear and established procedures and involvement of operator technicians in original generation of the test plan.

• **Fabrication**—Besides engineering, component fabrication represents the beginning of a continuing production of components; the question of quality control must be handled to insure repeatibility. Hover says a survey of suppliers would be based on their ability to conduct the outlined component test plan. Contracts would be on an incentive basis and would provide for redesign before buying. Reliability has always begun with the originator of a component—the ITP merely integrates tests with the originator so that there is a continuation of check points in a manner most applicable to earlier determination of overall reliability.

Hover says the organizational effect of the ITP would begin with the contractor's engineering teams establishing specifications through coordination at each level. This would assure compatibility of inputs and outputs, compatibility of tests at various levels, proper utilization of test equipment, and a continuity of procedures.

The rate of change in reliability is such that by the time a full replicate is completed, a component is through the major improvement phase. This corresponds to the "Buy" point.

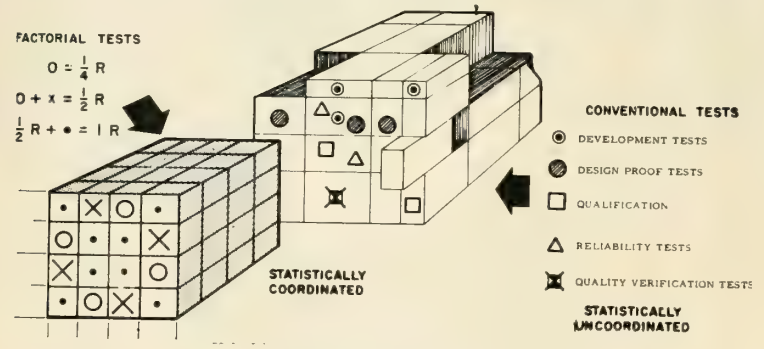
During production, each component, after proper order replicate tests, is diverted to systems, combined systems, articles, etc., for additional improvement information. This information would revert to the component producer and be incorporated at that time. Occasional production components that do not closely duplicate preceding values in the factorial cell are, by definition, failures—and are excluded from delivery.

Because the component improvement is over the hump before "Buy," the remaining improvements are associated with the user's operation. Hover expects that the "Useful time" then will be very close to the "Buy" time.

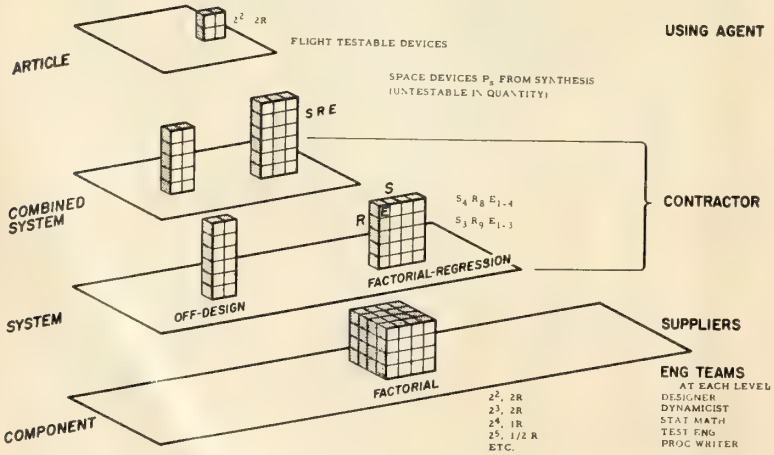
Considering both development and production programs, the total cost of the Integrated Test Program of reliability should be less than that of conventional reliability measures.

If the environment is unknown or cannot be simulated on earth, the ITP provides a high probability-high confidence statement based on the environments that can be measured. Uncertainty as to unknowns can be considerably narrowed.

Simplification of Test Nomenclature



Test Plan Schematic



Gallium Phosphide Crystals Zone-Melted at Bell Labs

Transparent gallium phosphide crystals are being grown at Bell Telephone Laboratories—for the first time allowing visual observations of the effects of varying conditions of doping and electron density.

The knowledge gained from such studies should be applicable to other members of semiconductor materials in the III and V groups of the periodic table. Some of these such as gallium arsenide and indium antimonide have shown promise in point contact and Esaki diodes.

C. J. Frosch and M. Gershenzon prepared the pure single crystals through the floating zone technique. Gallium phosphide decomposes at temperatures just below its melting point unless held under gaseous phosphorous at high pressures. The molten zone is contained within a sealed quartz tube which is in turn enclosed in a steel pressure chamber equipped with viewing ports. Because of the tendency of the walls of the quartz tube to fog over at low temperatures, the entire tube must be held at over 950°C.

Small crystals have been grown by vapor reaction methods using gallium suboxide and phosphorous gas. These crystals show a whisker form or habit and are usually n-type semiconductors —although they can be doped p-type.

Tenney Increases Price On Environmental Chambers

A 7.5% increase in the price of environmental test chambers produced by Tenney Engineering, Inc., Union, N. J., went into effect the first of this month.

Vice President Robert H. Brown blamed the increase on the rising cost of materials and the extreme degree of simulation necessary due to space research. The price change will affect both catalogue and custom items.

Brown said that outstanding quotations would be honored according to the terms of the bid.

SECOR System Will Aid Army Mapping

by Richard van Osten

SAN DIEGO—Future *Transit* satellites will help the Army select "pinpoint" base points for survey and mapping teams.

The Corps of Engineers has signed a contract with the Cubic Corp. San Diego, Calif., for an electronic system which can locate sites on the earth's surface to within 90 ft. over a reference range of 4000 miles.

Portions of the system, named SECOR (SEquential COllation of Range), will be delivered within the next few weeks. Full-scale operation in conjunction with the Navy-sponsored *Transit* navigation satellite will probably not get under way until early 1961.

Basic components of Cubic's SECOR consist of four ground tracking stations and a satellite-borne transponder. Four of the latter are called for in the Army's contract, but only one per satellite is required in the SECOR system. The present transponder is in two versions.

Three SECOR stations, housed in air-transportable shelters, will be set up at Seattle, Salt Lake City, and somewhere in Southern California. The fourth station will be at an unknown point to be surveyed.

In operation, the three stations measure range between ground points and a 5-lb. transponder in the satellite. The satellite ephemeris is computed by the three stations at known locations. Fourth station position is then computed by measuring the station's range to the satellite at several known points of the vehicle's orbit.

• **Heart of system**—SECOR was originally developed by Cubic for the Air Force as a velocity and distance-measuring system for IRBM and ICBM guidance system evaluation. Heart of SECOR is distance-measuring equipment (DME) located in at least three stations which, in turn, are so located as to provide optimum measurements in areas of interest.

Each DME station measures a target's velocity and slant range. This enables the target to be located on a hemisphere of known radium and rate of expansion or contraction. Target position in space and true velocity become the intersections of three or more such hemispheres.

SECOR SPECIFICATIONS

(Geodetic application)

Range: 10,000 mi.
Frequency: 482-512 mc (nominal)
Sequencing: 40 cps, adjustable for optional signaling

TRANSMITTING SYSTEM

Power: 500 watts
Frequency: 512 mc
Antenna gain: 20 db
Modulating signals: 480.234 kc, 60.029 kc, 7.503 kc, 0.938 kc, 0.0938 kc

RECEIVING SYSTEM

Sensitivity: 0:05 μv
Frequency: 482 mc
Antenna gain: 20 db
Output: digital range, analog (dial) range

SYSTEM CHARACTERISTICS

Automatic Ionospheric Refraction: Correction—double frequency method for positive, real time correction
Sequencing: Allows single satellite transponder
Real Time Centralized Data: Three methods —land line transmission Retransmission of range-time values through the transponder Addition of phase memory oscillators at all sites and round trip functioning

To determine range, the ground stations transmit an FM signal to the satellite's transponder, which demodulates the signal and retransmits the same modulation on a new carrier. When this carrier is received and demodulated at the ground stations, target range is determined by the round-trip phase shift. A signal coding system permits DME stations in the SECOR chain to interrogate the transponder in turn.

Radial velocity is measured by doppler techniques. Frequency ratio of the ground-to-air and air-to-ground carriers is kept constant by the transponder. The DME is reported capable of measuring range with a resolution of 1.5 ft. and range velocity with a resolution approaching 0.1 ft. per sec.

In the *Transit* application, the Army says, SECOR will not be used for detailed mapping and charting, but will provide specific "bases" for use by survey teams. An important use will probably be for more precise location of missile launching sites in the U.S. as an aid to greater trajectory accuracy.

• **Knapsackable**—Cubic Corp. is reticent to discuss full military possibilities of the SECOR system, but it has been noted that a DME station could be carried as a back pack by one man. If the miniature station could be located, by an air drop or other means, in an enemy target area, a precise target position could be determined. In this application, signals would be transmitted to the satellite, then relayed on to U.S. ground stations.

Initial use of the Armys' portable system, contained in 5000-lb. "packages," is likely in South Pacific areas where there is little accurate knowledge of distances.

Although the SECOR system as slated for Army use with *Transit* involves a geodetic application, the system also has capabilities and applications in cislunar guidance, translunar navigation and other radio-type long-range radio navigation.

ITT's Star Tracking System Amplifies 2,000,000 Times

An experimental electronic star tracking system for space navigation, developed by International Telephone and Telegraph Corp., uses a photomultiplier tube which transforms a star's optical image into an electrical signal and amplifies it 2,000,000 times.

A similar tube was used in the recent high-altitude observations of Venus which indicated the presence of water vapor on that planet.

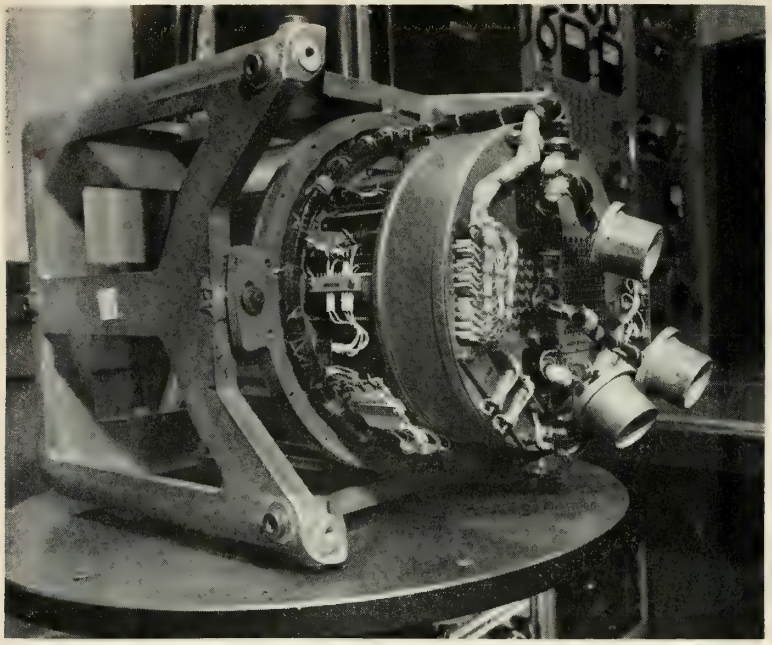
According to ITT, the star tracker can establish star lines to within one-thousandth of a degree for stars of fourth or higher magnitude. It uses magnetic or electrostatic scanning to eliminate undesirable mechanical vibrations of conventional systems.

New Technique Dramatically Improves Radar Sensitivity

A new high-frequency amplifier tube, used in combination with "synchronous pumping," is credited with spectacular improvement of radar receiver sensitivity. Developed by Zenith Radio, the technique is said to give an MTI radar system an equivalent 50% increase in range or a five-fold boost in transmitter power.

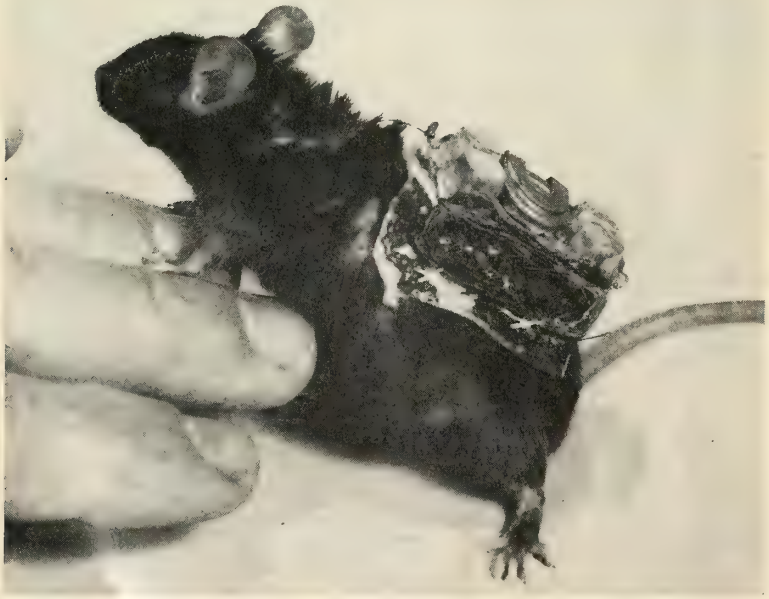
The Zenith electron beam parametric amplifier, described as a "promising newcomer to the vacuum-tube family," provides high signal amplification over a broad frequency band with

Inertial Guidane for Titan



TITAN ICBM will be guided on its first two minutes of flight by this reference system built by Minneapolis-Honeywell. The system is an advanced version of the "strap-down" concept—first used on *Vanguard*—in which the gyros are rigidly attached to the missile frame and react according to preset time signals and external guidance commands. The system consists of three integrating gyros, attitude programer, and electronic timer. It provides three-axis reference and roll-and-pitch programing to guide the missile from launch until radio guidance takes control.

A Rodent-sized Radio



RADIO ATTACHED to mouse's back is powered by a tiny mercury battery, weighs less than 20 grams, and was developed by the USAF School of Aviation Medicine to transmit data on the mouse's physical activities from a bio-satellite in space to earth receiving stations.

extreme stability and very low noise.

Recent tests of the equipment at RADC reportedly confirmed the expected benefits of the synchronous pumping technique. Sensitivity improvement, however, was not as good as the 7db figure expected, probably because of a "noisy" antenna used in the tests.

According to Zenith, the experiments definitely disproved a widely held belief that performance of paramps was inevitably impaired by noise picked up by the idler channel and dumped into the signal channel of the amplifier tube.

Tube vs. Transistor Fact Book Published by Council

A new fact book on tubes and transistors has been published by the Electron Tube Information Council. The 64-page book, "Tubes and Transistors: A Comparative Study," will be mailed this week to electronic engineers, purchasing agents in government and industry, and to electronic parts distributors throughout the country.

The new fact book discusses the advantages and limitations of both components, to help equipment manufacturers and design engineers select the most practical device for specific applications.

The Electron Tube Information Council, composed of representatives of CBS Electronics, General Electric, Radio Corporation of America, Raytheon Company, Sylvania, Tung-Sol Electric Inc., and Westinghouse Electric Products, was formed in March, 1959.

Delco Digital Modules Available for Guidance

Off-the-shelf digital building-block modules for missile guidance and other computer applications has been announced by Delco Radio Division of General Motors.

Modules are available in 10 basic types and 15 variations, each vacuum-encapsulated with epoxy resin. Each module contains up to 35 standard components per cubic inch, averaging more than 50,000 components per cubic foot.

According to Delco, typical applications include computers and digital data systems, digital frequency dividers and frequency standards, telemeter data handling, digital test equipment, timing and pattern generators, logical decision networks, encoding networks, memory test systems, data sampling systems, binary, octal or decimal conversion equipment, data format conversion equipment, counters, shift registers, and adders.

Navy Set to Fight for Existing ASW Organization

by Donald E. Perry

The Navy indicated last week it would fight to the last carrier to keep its present antisubmarine warfare organization as is, even though management has been sharply criticized by the powerful House Appropriations Subcommittee which wants a *Polaris*-type single manager approach.

The Navy "unofficially" took issue with the Mahon committee's findings that "there is no indication of dramatic or dynamic leadership (in ASW)," and that development work should be divorced from control of semi-autonomous bureaus in the Navy Department.

In response to a query by M/R, Navy said it could not comment on the committee's remarks. But it issued an official statement that it considers its present organization "both adequate and appropriate to cope with the ASW problem." Navy added that it considers establishment of a single project office for single management of ASW "not appropriate."

Congress accepted the committee's recommendations last week and passed legislation which adds $321 million to ASW warfare, including $100 million for R&D. Total Navy appropriation for ASW category now amounts to $1.684 billion. The committee had chopped out $293 million for a conventionally-powered aircraft carrier, and approved funds for three, instead of two, nuclear-powered attack-killer submarines. Whether Navy will use these added ASW funds remain to be seen; it can not divert them to some other Navy purpose.

• **There'll be changes**—The committee did not "direct" the Navy to do anything on management of ASW, but it holds the purse strings, and will be asking next year for answers on its recommendations.

Observers believe that Navy before then will come up with new management plans for ASW, which probably would involve strengthening the role of Rear Adm. Howard A. Yeager, Anti-Submarine Warfare Readiness Executive to the Chief of Naval Operations.

Navy takes the position that ASW is organic to all Navy operations and will not lend itself to a single management procedure, such as applied in the *Polaris* system. Rep. George Mahon (D-Tex.), chairman of the committee, told M/R, however, that "the only one who appears to be in charge is the Secretary of the Navy."

Navy wants ASW to be managed as an integral part of the entire Navy management plan because it feels it is a multitude of weapon systems meeting requirements for all phases of Naval warfare—hunter-killer operations, ocean surveillance and patrol, striking force operations, amphibious warfare, and convoy protection.

• **The split of philosophy**—It takes the stand that it has recognized the complexity and importance of the ASW problem and has superimposed on "its regular and well-proved management tools a monitoring and coordinating structure."

At the Secretarial level there is an ASW committee which reviews and decides upon major issues of policy. In the CNO level, Admiral Yeager acts, the Navy said, as "assistant to the President for ASW matters." Navy also established in 1959 a Deputy Chief of Naval Operations (Development) to coordinate all research and development in the Navy, including ASW. Coordinators for ASW matters also were established within each of the technical bureaus—Ships, Weapons, ONR.

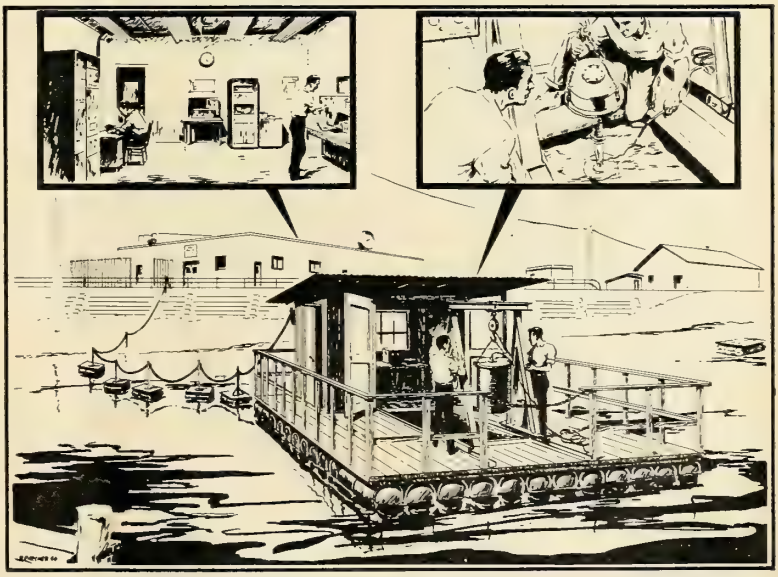
Basically the House subcommittee feels that while the Navy may have coordination between bureaus, a single manager system is still needed. Some quarters in the Navy, on the other hand, maintain that Special Projects Offices are not solutions, and if one were established for ASW, the next move could be one for Mine Warfare and ad infinitum.

Sperry Simulates Sea in Backyard

"Indicative of the importance that we attach to ASW, some 700 engineers in five corporation divisions are involved in antisubmarine warfare work," a Sperry Rand official disclosed last week. "More than 60% of these engineers' activities are oriented towards system development."

To provide a laboratory for such developments, Sperry Gyroscope Division, Great Neck, N.Y., is completing work on a simulated "sea" in the company's backyard. The test basin is 400 ft. long, 200 ft. wide and 25 ft. deep. It is part of the company's ASW Laboratory to be used for evaluating and developing undersea devices.

The "shore facility" is getting an elaborate array of testing consoles, including a 14-channel hi-fi tape recorder which will be transmitting, and in some cases, recording sounds of sea life.



MAIN ILLUSTRATION shows Sperry Gyroscope barge floating in backyard basin used for testing and developing ASW equipment. This 17 by 29 ft. craft will be used as a mount for underwater detection devices, while the floats going from the barge will be used to carry communications channels, linking barge with test laboratory. At upper right is a rotary mechanism used for turning a transducer that will be searching for the sounds of subs. Upper left shows the console room in the shore facility.

sacred cow treatment . . .

Is U.S. Kidding Itself about R&D?

Rand expert says dollar figures give misleading idea of real expansion, calls for new classifications

The United States may be dangerously deluding itself by judging the progress of its research and development programs on a basis of how many dollars are spent on all kinds of R&D.

David Novick, Chief, Cost Analysis Dept., The Rand Corp., says ". . . there is seemingly a blind belief that by doing more research we will outrun our international competitors in the military race or, on the commercial side, make larger and larger profits."

Since billions are being spent on both private and governmental R&D, Novick says, it is time some answer was found to the question of how the money is being spent. "Are we really spending more dollars in essential R&D approaches, or are we merely reclassifying traditional areas?"

The Rand cost expert says he was unable to accurately measure the growth of R&D since 1930 primarily because of the ambiguity of the terms "research" and "development." The demarcation line between development and production is a thin and elusive one, and is often drawn in terms of company or federal policy. Some of this growth is probably due to the new respectability which R&D has attained.

• **Statistical mess**—According to Novick, accounting shifts and blown up "Big Deal" figures are used in an effort to make a research project look more important than it really is.

Then there are conflicting definitions in industry. In the aircraft business, R&D depends on the position of the Department of Defense—costs tend to be classified according to availability of funds in the defense category.

Uncle Sam does the same thing. For example, the cost of the 1960 Census was figured as part of the overall R&D dollar in the federal budget. While the census is an important research function, it is substantially different from any other kinds of research, says Novick, and this feeds fuel to the confusion.

Novick says that we are not ahead of the Russians in production techniques—and we do not hold a significant lead in basic research. The lead times in both countries are about the same. If the Russians are ahead of us in getting the final product, it is simply because they:

• Probably have a more direct approach—more emphasis on early application.

• Are more willing to gamble either on reduced cost or on final performance.

• Seem to freeze design for production and make fewer changes once a decision has been made toward operational use.

• Have continuity in program and personnel in complete systems, components or basic research.

Our handling of nuclear fission, from discovery to bomb, is a classic example of our method of seeking assurance before commitment and then proceeding in a start-stop-stop-start manner.

• **Rand method**—Novick suggests a classification based upon four steps in research and development.

1. Basic or experimental R&D—"Brave New World" type of research where the promise is great but not identified to specific purpose and the possibility of fulfillment is highly uncertain.

2. Applied research, advanced development, basic evaluation and testing—application identified, economy and efficiency uncertain. Promise still high.

3. Product development, testing, evaluation, pilot production—specific devices or methods appear as likely solutions but must be brought reasonably close to final application to determine effectiveness and economy.

4. Product application research, applied testing and evaluation—some success assured because this is evolutionary rather than revolutionary. New uses and applications or modifications of existing uses or applications are sought for existing methods.

Novick estimates that the $10 billion spent on R&D in 1959 might be broken down per area into $100 million for 1, $300 million for 2, $2.6 billion for 3 and $6 billion for 4.

It is obvious that the fundamental object of classical R&D, that of gathering new knowledge, takes approximately 1% of the total R&D figure.

Our present-day assumption that all research contributes to the nation's general welfare confuses the object of research—new knowledge. Under this naive definition, such things as marketing research and other similar projects fit into the scheme—while some basic research activities of real significance may be excluded.

Novick says that the great expansion of R&D cannot be completely attributed to statistical delusion. Price changes in salaries, equipment costs and the value of the dollar over the last 20 years have a significant effect on the supposed expansion. Using this, Novick finds that there was a twenty-five-to-thirty-fold increase in real terms—instead of the sixty-fold expansion derived from dollar figures.

Furthermore, in terms of scientists and engineers directly involved in research, the growth is even slower—roughly twice the number of people in 1952 as in 1941.

• **$$ no measure**—Money is a difficult yardstick. In some cases, substantial basic research can involve a blackboard, a piece of chalk and a brain. Novick says the most fair appraisal of the present rising trend in R&D expenditures is that it is going up because we think it should be going up. How much of it represents needed or even desired contributions cannot be determined until more effective identification and accounting practices are developed.

• **Scientific impetus**—The four major factors in U.S. scientific expansion in the last 50 years, according to Novick, were—World War I, World War II, the Cold War and the mass transplanting of European scientists. Whether or not these provide sufficient basis to accomplish what is needed, possible and valuable for our survival and well-being is not clear.

Novick says he wonders how allocation of R&D funds can be made in the face of all of the currently existing uncertainties. Furthermore, he questions the sufficiency of research aimed at the long-range future—beyond currently identifiable products and methods.

Treating research as a fashionable sacred cow, concludes Novick, may be destroying its effective contribution to national survival.

Saturn Cluster Can Burn Far Longer

by Frank G. McGuire

LOS ANGELES—Concern over melting the flame detector caused an early termination of the first static test of the full eight-engine *Saturn* cluster, the Army revealed last week.

William A. Mrazek, Director of the Structures and Mechanics Laboratory, Army Ballistic Missile Agency, said the cluster could have been burned much longer than the actual eight seconds of the April 29 test.

(It was learned in Washington that the programed goal of 1.32 million lbs. thrust was achieved. When fully loaded, the *Saturn* booster will be capable of burning at that thrust level for 115 seconds.)

Mrazek told the annual meeting of the Aviation/Space Writers Association here that the huge booster is expected to be tested in mid-1961. The first two-stage test will take place in 1962. After several three-stage tests in 1963, the C-1 early model of *Saturn* will become operational in 1964.

• **Composition**—The C-1 will consist of the eight-engine cluster as booster stage, a second stage Douglas S-4 consisting of four 20,000-lb.-thrust Pratt & Whitney hydrogen-oxygen engines, and a modified Convair *Centaur* as third stage consisting of two P&W hydrogen-oxygen engines.

The booster will stand 82 ft. from the exhaust nozzle to the top of the transition section, and will be 21½ ft. in diameter. The S-4 will be 220 in. in diameter. The modified *Centaur* will be 120 in. in diameter.

The booster consists of nine propellant tanks, five for liquid oxygen and four for RP-1 fuel. The 105 in. diameter center tank will contain LOX, and be surrounded by the other eight 70 in. diameter tanks.

All tanks are connected to provide equalization of liquid levels during loading and flight. The total mainstage propellant capacity is 750,000 lbs., but it is not necessary to utilize the total capacity if the mission does not require it.

Tanks are secured to an eight-legged "spider beam" at the top of the booster, and an eight-legged thrust frame assembly at the bottom, to which the engines are mounted.

The four inner engines in the two-square pattern are rigidly mounted in a 3° cant. The outer four, canted at 6°, can be gimballed ±7° for first stage control during flight.

The manifold propellant flow and pressurization system, plus an adequate malfunction detection system, give *Saturn* the capability of completing its mission, even if one engine fails and must be shut down, even at lift-off.

• **Saturn C-2**—The 185-ft. *C-1* configuration will be followed by the *C-2* model, which would use the same basic *Saturn* booster, or a modification thereof, with new upper stages.

A new second stage under consideration would develop about 400,000 lbs. thrust and use two hydrogen/oxygen generating 200,000 lbs. thrust apiece. The four-stage *C-2* would be 230 ft. tall.

Nuclear stages are also being contemplated for future versions of the vehicle.

Payload capabilities for *C-2* would be drastically greater than the *C-1* model. *C-1* could place about 20,000 pounds in a 100-mile orbit, 4500 pounds in a 22,700-mile orbit, and over one ton soft-landed on the moon.

A three-stage *C-2* could double each of these payload figures, and the addition of a fourth stage would triple the 24-hour orbit (22,700 miles) and soft lunar landing capabilities.

A nuclear stage, of appropriate size, would have a high-payload, low-orbit capability and be able to put seven tons in a soft lunar landing.

Each of these figures could be increased by a factor of ten or more if orbital refueling were utilized.

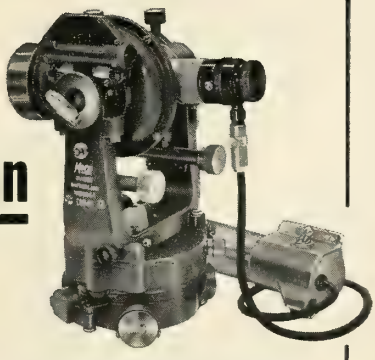
The *Saturn* transporter for overland moving of the vehicle is unique in that the frame of the booster serves as the main carriage of the transporter. The assembled booster and its support cradle are jacked up as a unit, and two wheel/axle assemblies installed.

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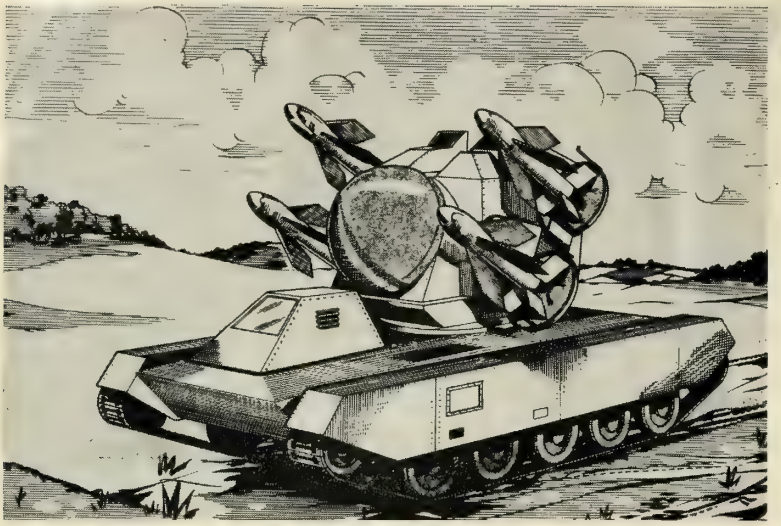
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British Reveal Tigercat

Prototype models of the *Tigercat* —land version of the surface-to-air *Seacat*—reportedly have been fired successfully by British Army personnel.

No design details of the new missile have been disclosed. However, it is to be mounted upon an armored vehicle (see drawing) to include radar and targeting equipment in a self-contained unit. Like its sea-going brother, the *Tigercat* will be solid-fueled, just under 5 ft. long and with a maximum fin span of 2 ft. It would be deployed with forward units for tactical air defense. Manufacturer is Short Brothers & Harland Ltd., Belfast, Northern Ireland. *Seacats* are now deployed aboard four Hampshire-type naval vessels. They have been ordered by Sweden, Australia and New Zealand.

British Study Sharing Blue Streak

LONDON—Great Britain may offer the controversial *Blue Streak* to European and Commonwealth nations for a major joint space venture.

Minister of Aviation Duncan Sandys said at a recent House of Commons meeting that the Government had the idea "under study." At the same meeting a Labor Party motion to censure the Government for delaying the cancellation of the *Blue Streak* weapon system was defeated by a 302 to 225 vote. Labor had contended that the Government had wasted money on the rocket.

Although Conservative leaders Sandys and Harold Watkinson, Minister of Defence, stressed that the Government intended to maintain an independent nuclear deterrent program, the opposition did not seem to be convinced.

Sandys admitted that the Government has tried for a long time to find a substitute for the *Blue Streak*. Indications are that it will be the U.S. *Skybolt*. Sandys said that the decision to cancel *Blue Streak* could not have come sooner because of U.S. security restrictions on release of missiles to other countries.

Skybolt would presumably be chosen for military purposes to replace *Blue Streak* because it can be launched from an aircraft outside the range of enemy defenses. *Blue Streak* must be fired from fixed sites, and Britain's small size makes wide dispersion impossible.

AGARD Committee to Meet On Radio Wave Absorption

PARIS—Athens will be the site of the next meeting of the Ionospheric Research Committee of the NATO Advisory Group for Aeronautical Research and Development (AGARD), June 20-23. The Committee will discuss Ionospheric Research concerned with "Radio Wave Absorption."

Participating scientists will include Prof. Ratcliffe, Cambridge University, (England); Mr. Finn Lied, Director of the Norwegian Defense Research Establishment (Norway); M. Nicolet, Director of the Centre National de Recherches de l'Espace (Belgium); and Prof. Vassy, of the Faculté des Sciences, Université de Paris (France).

Invited papers will cover the following areas:

Studies of Absorption, Ionization and Absorption in Ionospheric D and E regions, Measurements by Artificial Satellites, Correlation of Ionospheric Disturbances with Solar Flares, Polar Cap and Auroral Absorptions.

Although attendance is unclassified, authorization to attend must be procured from either the AGARD National Delegates or by Members of the AGARD Avionics Panel.

Canadian Space Societies Move Nearer a Merger

MONTREAL—A move to establish a central astronautical organization for the study of space sciences is under way in Canada.

Two major astronautical societies have led the move. The Guided Missile Division of the De Havilland Aircraft Corporation of Canada, operating as the Canadian Astronautical Society, and the Astronautical Society of Canada already plan a common official publication in the near future. The two groups have approximately the same number of members—over two hundred—and share a vote in the International Astronautical Federation, each voting on alternate years.

Other Canadian societies being contacted include the Astronautics Section of the Canadian Aeronautical Institute, the Prince Rupert Astronautical Society, the Calgary Student Amateur Rocket and Missile Club, the Acadia Amateur Rocket Society, and the McGill Rocket Society.

Woomera Tracking Range Has Outstanding Record

LONDON—The Woomera tracking range in Australia has maintained over the past two years a measurement of position to an accuracy of within 20 seconds of arc, according to a statement released by A. S. Hulme, Australian Minister of Supply.

The base, also cited by NASA as the best-maintained of the ten existing Minitrack stations, was the first of the world's 12 optical stations to photograph the tracks of four satellites: *Atlas* (1958), *Vanguard II* (1959), the paddlewheel *Explorer VI* (1959), and *Explorer VII* (1959). It took the only

picture of *Discoverer VII* and obtained a good picture of the 6-in.-diam. *Vanguard I* at a distance of 2500 miles and *Explorer VI* at 14,500 miles.

In the latter six months of 1959, Woomera tracked 435 passages of satellites in the southern hemisphere photographically, 657 electronically, and received telemetry information on 717 occasions.

British Offer Germans Use of Hebridean Range

LONDON—The British Ministry of Defence has officially offered training facilities at the South Uist rocket range in the Hebrides to the NATO organization—an offer in which West Germany has expressed considerable interest.

No application has yet been made by Bonn for the range. A spokesman for the British Ministry is reported as commenting on the uselessness of equipping West German forces with rockets without proper training in their use. Present training is concerned primarily with the use of the U.S. *Corporal* missile.

British Outline Plans For Three Symposia

LONDON—Three important symposia on problems of rocketry and outer space travel are planned in England during coming months.

On Sept. 1, 1960, a group of papers on aspects of rocket and satellite instrumentation will be presented at a meeting jointly sponsored by the British Interplanetary Society and the Society of Instrument Technology at Manson House, London. They will include:

The British Satellite Programme, by M. O. Robbins.

A Design Study on a Communication Satellite, by B. V. Somes-Charlton.

An Analyser for Rocket Recording, by Dr. W. R. Beakley.

Transducers for Motor Testing, by W. R. Dean.

An Experiment to be Carried Out in a British Satellite, by Dr. A. P. Willmore.

The Measurement, Transmission and Recording of Data in the *Skylark*, by Dr. E. Dorling.

Space navigation on the moon will be the subject of a meeting jointly planned by the BIS and the Institute of Navigation for Nov. 18. Dr. Herrick, an American guest speaker, will give the opening paper.

A two-day symposium on rocket propulsion, organized by BIS, the College of Aeronautics and the Royal Aeronautical Society will take place at the College of Aeronautics, Cranfield, Jan. 6-7, 1961.

soviet affairs

By DR. ALBERT PARRY

Radiation and magnetic field research

was rewarded recently by Russia's highest prize committee. Four Soviet scientists were given the Lenin Prize, Moscow's equivalent of the Nobel Prize, for "discovery and investigation of the outer-space radiation of the Earth, and investigation of the Earth's and the Moon's magnetic field." The date of the awards, April 22, was chosen because it marked the 90th anniversary of the birth of Vladimir Lenin, the founder of the Soviet state.

The prize winners

are: Sergei N. Vernov, a corresponding member of the Soviet Academy of Sciences, and Alexander E. Chudakov, a doctor of the physics-mathematical sciences, both on the staff of the Academy's Lebedev Physics Institute; Nicholas V. Pushkov, director of the Academy's Institute of Earth Magnetism, Ionosphere, and Radio-Waves; and Shmaya S. Dolginov, chief of the Magnetic Laboratory of the same Institute. The honor carries with it a considerable sum of money for each man. The importance of the work of Vernov's group in official Soviet estimation may be judged from the fact that their names top the list of all the Lenin Prize winners.

No mention of Dr. James Van Allen

of Iowa State University, or his discoveries of the radiation belts now bearing his name, was contained in the official Moscow announcement. The four Russians' achievement was represented as the first and only one in the field. Vernov himself was a little more generous to Van Allen. In an interview in *Komsomolskaya Pravda* he said, among other things: "Until the first Soviet artificial satellites of the Earth appeared in the sky, scientists generally did not know there were around us the so-called belts of radiation, that is, an enormous number of particles with speeds approximating the speed of light. Our *Sputniks*' signals permitted us, first, to discover these belts; secondly, to make our initial steps toward our study of them." He then briefly added: "We must not fail to mention in this connection also the work of our American colleagues, Dr. Van Allen and his collaborators, who have made a large contribution toward the solution of this problem."

The American share

in the study of cosmic radiation, when referred to by Soviet writers and speakers, is acknowledged not as leading but always as merely paralleling the Soviet effort in the field. And when Van Allen's role is discussed at all by the Russians, it is mostly in statements by Soviet scientists and hardly ever by Soviet bureaucrats. Typical is the omission of Van Allen's name in an article in *Izvestia* of April 22 by V. Yelyutin, minister of higher and secondary specialized education of the USSR and vice-chairman of the Lenin Prize Committee. In his praise of Vernov and his group for "the creation of methods and instruments to investigate" radiation and magnetism in outer space and for "processing and theoretical interpretation of the data received," the minister says not a word about Van Allen's pioneer work. On the other hand, Academician A. Severny, who heads the Crimean Observatory, mentions Van Allen along with Vernov in an article on "The Physics of the Sun" in *Yuny Tekhnik* for March, 1960. In fact, his mention of the American's contribution is contained in the very first paragraph of the article.

But even in such statements

by Russian scientists, there is no concession of priority to Dr. Van Allen. In Severny's article, Van Allen is mentioned *after* Vernov. The hidden feeling of inferiority still gnaws at the Russians. Despite their great progress in so many fields, they must claim priority in everything, at whatever cost to objectivity.

Advisors Gather at M/R Dinner

The second annual dinner for members of MISSILES & ROCKETS' advisory Board and Contributing Editors was held in Washington April 25.

Preceding the dinner was a reception at the home of Wayne W. Parrish, President of American Aviation Publications, Inc.

Members of the Advisory Board present were Dr. Peter Castruccio, Director of the Astronautics Institute of the Westinghouse Corp.; Conrad H. Hoeppner, Chief Scientist of Radiation, Inc.; Robert P. Haviland of General Electric's Missile and Space Vehicle Dept.; and Vice Admiral Harry Sanders (Ret.) Director, ASW Engineering, Chance Vought Aircraft.

Contributing Editors of M/R present were Heyward Canney of NASA, James J. Haggerty of Aerospace Industries Association, and Dr. I. M. Levitt of the Franklin Institute.

Distinguished guests at the reception and dinner in addition to those pictured here included Dr. Herbert York, Assistant Secretary of Defense for Research and Engineering; Dr. Joseph V. Charyk, Under Secretary of the Air Force; and Rear Admiral William F. Raborn, Director, Navy Special Projects.



Doug Larsen of General Dynamics Corp. chats with Fred Archibald of General Motors Corp.



Charles LaFond, M/R Associate Editor, listens to James D. Secrest of the Electronics Industries Association.



Together in the Parrish garden are Leonard Eiserer, Executive Vice President and General Manager of AAP; Warren Smith of Fairchild, aerospace writer Jim Haggerty (back to camera), Phil Drotning of Phil Drotning and Associates, and Maj. Gen. Lucas B. Beau (Ret.) of Consolidated Diesel.



Jim Haggerty and Leonard Eiserer have a chat by the Parrish pond.



Gen. Beau talks with Maj. Gen. William W. Quinn, Army Chief of Information, and Joseph M. Rowland, Martin Co.



Conrad E. Hoeppner of Radiation Inc., talks to Dr. Peter Castruccio of Westinghouse and Vice Admiral Harry Sanders (Ret.) of Chance Vought.



J. E. Hadley of the Bendix Aviation Corp. and Mr. Parrish.



EIA's President David Hull of Raytheon chats with EIA's Mr. Secrest.



Walt Brown, Advertising Sales Manager of M/R converses with Kim Hallamore of Hallamore Electronics and T. S. Pendergast of Jack & Heintz.



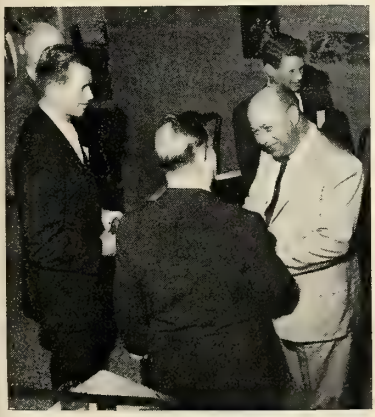
Burt English of AIA chats with Homer Joe Stewart, Director of NASA's Program and Planning Evaluation Office; Bill Beller, Associate Editor of M/R, and Ernie Stout of The Ralph M. Parsons Co.



T. S. Pendergast shares a story with Walt Brown.



Robert P. Haviland of General Electric talks to Hal Gettings, Associate Editor of M/R.



Edward D. Muhlfeld, Publisher of M/R, and Mr. Parrish greet Don Chadwick as Clarke Newlon, Executive Editor of M/R, gets ready to greet the next guest.



Heyward Canney of NASA and John Judge, Associate Editor of M/R, listen to James D. Secrest.



Patio talk among E. R. Field of Gilfillan Corp., William J. Coughlin, chief of M/R's West Coast Bureau, Don Chadwick and Charles LaFond.

ABMA Sets Up R&D Group To Replace Transferred DOP

Army Ballistic Missile Agency is establishing a Research and Development Division at Huntsville to replace the Development Operations Division scheduled for transfer to NASA on July 1. The new division will have cognizance over all Army missile and rocket programs, with an estimated budget for Fiscal Year 1961 of more than $261 million.

Dr. Arthur Rudolph, present *Redstone* and *Pershing* project director, will be director of the new division. Lt. Col. Lee B. James will be deputy and John McDaniel technical director.

Directors of the division's six laboratories announced to date: Gerhard Reisig, Research; Charles Hussey, Analysis and Preliminary Design; Holm Hinrichs, Propulsion; Kurt Lindner, Guidance-Control and Aeroballistics; Lewis Gober, Systems Design and Development; William Grafton, Test, Evaluation, and Firing.

Project officers selected for the various Army missile programs: Carl A. Pinyerd, *Pershing;* Robert Whitley, *Jupiter, Redstone, Sergeant, Corporal* and *Nike-Zeus* target missile; William Rotenberry, *Honest John, Little John, Missiles A* and *B;* Alfred Finzel, Special Weapons, *LAW* (Light Anti-tank Weapon) and Small Rockets.

Approximately 1000 scientific, technical, and administrative personnel will staff the division's laboratories, project offices, and supporting groups when it becomes operational in July. Division management is reportedly interviewing applicants for key positions still unfilled.

Pioneer V Switched to Big Transmitter by Command

Pioneer V's large 150-watt transmitter was turned on Sunday, May 8, while the satellite was streaming through space 8.3 million miles from earth. The sun-orbiting payload has now traveled about 100 million miles through space and has picked up valuable information about solar radiation.

NASA earlier predicted that the transfer would not take place until after May 15. (See M/R, May 9.)

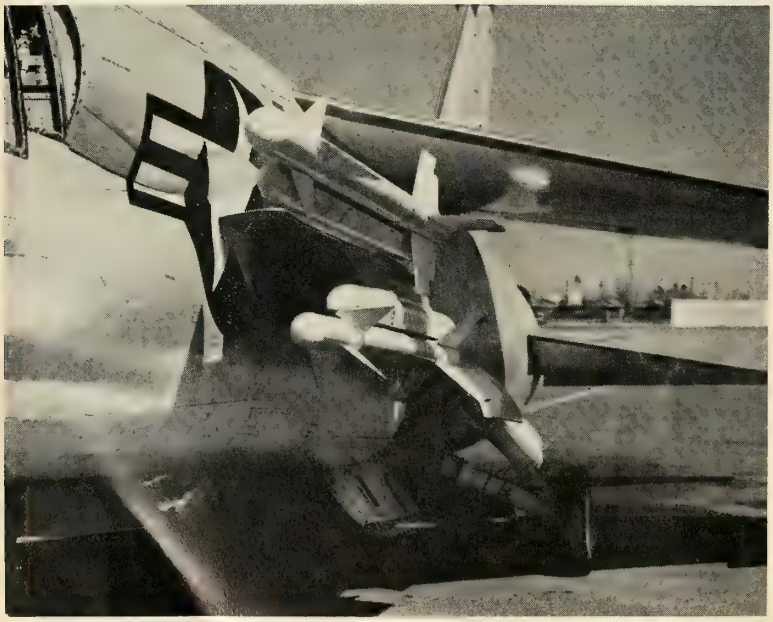
The command signal was sent from the 250-ft. radio telescope at Manchester, England. The probe responded with its first 150-watt transmission one and a half minutes later.

Transferring from the five- to the 150-watt transmitter required a three-step sequence. Early Saturday a signal was sent to the payload putting power into tube filaments through a current-limiting resistor. Later the first step was repeated and a second command removed the current-limiting resistor and supplied full filament heating for several minutes. The final signal energized the 150-watt transmitter as well as the electric signal serving it.

The larger transmitter will allow the 60-ft. parabolic dish at South Point, Hawaii, to command *Pioneer V* at the rate of one bit per second, and Jodrell Bank to command it at 8 or 64 bits per second.

The Jodrell Bank telescope is capable of tracking *Pioneer V* for a distance of 50 to 100 million miles from earth.

Doubling Dose of Sidewinder



ADDED STING will be given Navy's Chance Vought F8U-2N Crusader, now to carry four instead of two GE-Philco air-to-air *Sidewinders*. Doubling up, approved by Navy, is possible through use of new pylon which will hold brace of birds.

Astronauts Will get Hot Meals by Pushing Button

Astronauts while circling the earth will be able to press a button and within the hour get their food presented piping hot, says REF Manufacturing Corp., Mineola, N.Y.

The company quotes the Air Force as believing that "astronaut morale and efficiency will be improved by warm food," and that "heating food to at least 150°F insures destruction of potentially harmful bacteria."

During a recent AF project set up to test survival devices designed for manned space capsules, a subject was sealed in a capsule for seven days. Included in his equipment was a small (14 x 14 x 4 in. deep) REF food warmer which was used to heat strained turkey, mashed potatoes and other food, which were contained in plastic squeeze tubes. Warmed by three resistance-heating elements in the oven, the food was taken to 170°F in little over an hour.

A more exotic food warmer being proposed by REF for outer space missions would use solar energy as a heat source. A magnesium "window" would let solar radiations into an insulated oven, and slides on the window would regulate the unit's temperature.

Congressmen Urge Outside Selection of Rover Chief

Four members of the Joint Congressional Committee on Atomic Energy have stepped into the controversy over Project *Rover* with a proposal that a boss be chosen from outside NASA and the AEC.

The four have asked AEC Chairman John A. McCone and NASA Administrator T. Keith Glennan to clear any such choice with them. Late last week, it was reported that they had received no reply. Rep. Carl T. Durham (D-NC), committee vice-chairman, heads the group. The others are Reps. Chet Holifield (D-Calif.), Melvin Price (D-Ill.) and James E. Van Sandt (R-Pa.).

contracts

NAVY

The Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, has been awarded a contract by **Bendix Aviation, Inc.'s Pacific Division** to supply a highly compact, lightweight auxiliary power unit for the *Eagle* missile. Amount not disclosed.

$600,000—P.I. Steel Corp., Los Angeles, for construction of three buildings at the *Polaris* missile base at Point Mugu.

$435,000—Dorne & Margolin, Inc., Westbury, N.Y., for airborne antennas and related electronic systems. Subcontract from **Grumman Aircraft Engineering Corp.**

AIR FORCE

$2,676,000—Ford Motor Co.'s Aeronutronic Division, Newport Beach, Calif., for system engineer and payload and test contractor on high-altitude rocket-space program known as Hyper-Environmental Test System 609A.

$1,454,703—Bendix Aviation Corp., Teterboro, N.J., for the *Titan* AN/GJQ-9 programing set with spare parts and ground support equipment.

$894,781—Bechtel Corp., Los Angeles, for architectural and engineering services in connection with the *Atlas* silo launching program (three contracts).

$365,180—International Business Machines, New York City, for SAGE data processing equipment.

$300,000—Yardney Electric Corp., Los Angeles, for fabrication of Silvercel silver-zinc batteries for the *Minuteman*.

$223,750—General Motors Corp., AC Spark Plug Division, Flint, Mich., for supplies and services to operate distribution and storage depot for guidance subsystem of Sm-75.

$140,000—CompuDyne Corp., Hatboro, Pa., for instrumentation and control modifications in the operational propellant-loading system of six *Atlas* bases.

ARMY

$6,307,649—General Dynamics Corp., Convair Div., Pomona, Calif., for continued development of the *Redeye* missile.

$5,320,224—Emerson Electric Manufacturing Co., St. Louis, for *Honest John* repairs.

$1,500,000—The Martin Co., Orlando, for *Lacrosse* missile test equipment.

$1,500,000—Minneapolis-Honeywell Regulator Co., Hopkins, Minn., for continuation of a classified project.

$880,000—Chrysler Corp., Detroit, for work on a hypersonic ballistic target missile system.

$525,572—Chrysler Corp., Detroit, for maintenance support of the *Jupiter* system.

$124,011—Ray M. Lee Co., Atlanta, for construction of *Saturn* loading and unloading facility at Redstone Arsenal.

$79,000—Cornell Aeronautical Laboratory, Inc., Buffalo, for wind tunnel testing on contractor furnished models of the *Pershing*.

$58,000—New York University, for basic research entitled "Atom Beam Scattering Studies."

reviews

GRAPHICAL REPRESENTATION OF RE-ENTRY TRANSFER ORBITS, L. E. Wolaver, for WADC. Order PB 151938 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 72 pp., $2.

To analyze the circular orbit of a typical satellite rotating in a vacuum above Earth's spherical orbit, two parameters were studied: the eccentricity *(e)* and semi-latus rectum *(p)*.

Graphs consisting of modified Vertregt diagrams of both direct and apogee routes show loci of reentry angle and velocity retrothrust required, its angle and target lead angle when the thrust is applied, time and range to impact, and the final target-satellite angle upon impact.

Various curves are superimposed upon each other to derive formulae for minimal retrothrust and resultant time to impact at a safe reentry angle. Equations are developed to measure the same criteria with increased retrothrust.

THE PHOTOGRAPHIC EXPOSURE TIME FOR ASTRONOMICAL PICTURES, R. K. H. Gebel, Aeronautical Research Lab. for WADC. Order PB 151939 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. $.50.

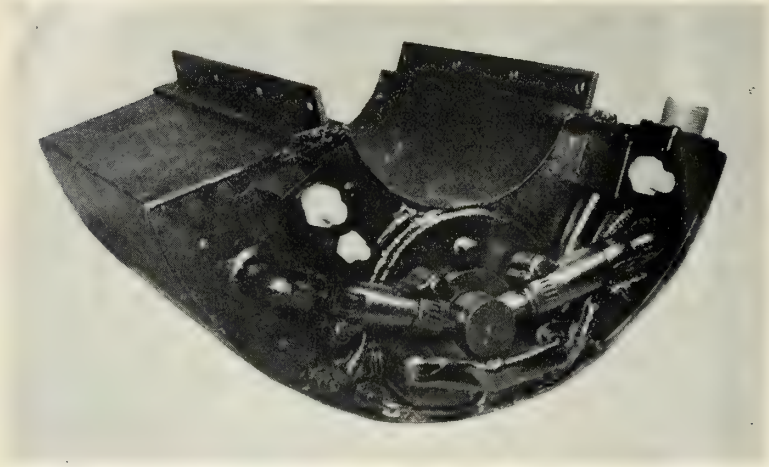
The report contains studies on the minimal number of quanta necessary to secure a recognizable image of a star on photosensitive film. Wave lengths of sunlight were analyzed and allowances were made for absorption and dispersion of light in the atmosphere.

SYSTEMS PRELIMINARY DESIGN, part of Grayson Merrill's "Principles of Guided Missile Design" series, Joseph J. Jerger, Van Nostrand, New York, 625 pp., $14.75.

This text is intended to be a unifying volume in the "Guided Missile Design" series by bringing together for systems analysis the various technologies that go into making a guided missile. For this purpose and also for the added one of preliminary design, the author includes chapters on reliability theory, servomechanisms analysis, heat transfer, static and dynamic stability of aerodynamic and space vehicles, and missiles structures. Also, an analysis of the kinematics of homing, beam riding, and command guidance types of missile-target combinations is included for purposes of getting work equations and data for establishing missile and system design requirements.

The author does succeed in giving the reader a valuable handbook for early design work. He safely and rightly stays away from the more sophisticated problems that come in later design work and that often are unique to the problem at hand.





Curved Battery Fits Missile Skin

A circular segment-shaped silver-zinc battery for use in missile auxiliary power supplies has been developed by Cook Batteries.

The Model P13A battery is designed as a main power supply for missile electronic equipment and instruments, guidance and control systems, telemetry equipment and warhead arming. The 40 dry charged cells in this primary (one-shot) unit are automatically activated by an electrically ignited solid propellant gas generator. The battery may be installed, activated and operated in any position.

Duplicate ignition circuits provide protection against open or shorted wires. The unit is equipped with thermostatically controlled electric heaters to maintain proper operating temperatures. The container is hermetically sealed against leakage, evaporation or contamination.

The P13A produces an output of 11 kw. Current rating is from 180 amps to 1000 plus, with a maximum of 3700 amps. The capacity of the 56 battery is 7.5 ampere-hours, with a discharge (shorting) time of 2.5 min.

The activation signal required is 115 at 4 amp. The battery takes only 0.5 seconds to reach the specified voltage after application of the activation signal. The unit will withstand environmental extremes of temperature from –65°F to ±220°F. It is resistant to vibration forces of 3 g's, shock acceleration to 60 g's. It meets requirements of MIL-E-5272A.

The battery weighs 24.6 lbs. and has a circular segment shape which is designed to fit snugly into the missile's exterior skin. It has 12.3 in. outside diameter by 146°, and is 11.7 in. long. Displacement is 1200 cu. in.

The P13A is completely inert during a storage period of up to five years. It contains no vacuum or pressure storage components and requires no periodic charging or maintenance of any kind prior to actual use.

Circle No. 225 on Subscriber Service Card.

Water Submersion Actuator

A salt water actuator that automatically inflates escape capsule and nose cone flotation bags when submerged is being marketed by the Walter Kidde & Company.

The salt water, acting as an electrolyte in the actuator, completes a circuit—firing a cartridge or explosive squib to open a passage in a valve on the compressed gas container. The released gas, such as carbon dioxide, flows through tubing to inflate the bag.



Circuit voltage can be either AC or DC. Typical is a 24 to 28 volt DC source which will pass a minimum of 8 amperes through the actuator when immersed in a 3 per cent by weight salt water solution. Time to energize circuit upon submersion—1 second or less; weight of actuator—0.3 lb.; envelope dimensions (inches)—4-15/32 x 1-13/32 x 1-13/32.

Circle No. 226 on Subscriber Service Card.

Gas Density Switch

A high temperature, sub-miniature Gas Density Switch, capable of operating in temperatures up to 400°F has been added to the product line of Newark Controls Co.

The switches are designed for use under high shock, vibration and acceleration. The RM-76 is available in actuating pressure ranges of .0026 to .0060 lb. mols/cu. ft. These switches are operable within a temperature range of –45°F to 400°F, and have an accuracy of ±0.5 psi from –85°F to 185°F and 1.5 psi from 185°F to 400°F.

These switches are capable of signaling leakage of insulating gases from closed packages where normal gas pressure varies with temperature; signaling when equipment has been filled to the proper molecular gas density during production or field maintenance. They are also used to detect purposeful discharge applicable to gas filled containers. However, the switch must be at the same temperature as the gas being sensed. The RM-76 actuates along any pressure-temperature line of an ideal gas from 10 psia at –85°F to 55 psia at +400°F.

Weighing less than 1.8 oz. and measuring 1-27/32″ in length and 7/8″ in diameter, RM-76 meets stringent environmental specifications including MIL-E-5272.

Circle No. 227 on Subscriber Service Card.

Continuous Mix Cooler

A heating and cooling unit, developed especially for continuous mixers employed in compounding plastics or processing other materials, where accurate temperature control is a must, has been developed by the Chemical Machinery Division of Baker Perkins Inc.

Presently adapted for the 4-inch size Ko-Kneader type continuous mixer produced by the company, the unit controls temperatures to within ±2°, regardless of the mixer area involved.

Its function is to heat or cool pressurized water which is circulated through the jackets of the mixer and also an extruder, if one is employed. It will control the batch temperature in the mixer and extruder even if it is necessary to add heat in some zones and remove it in others.

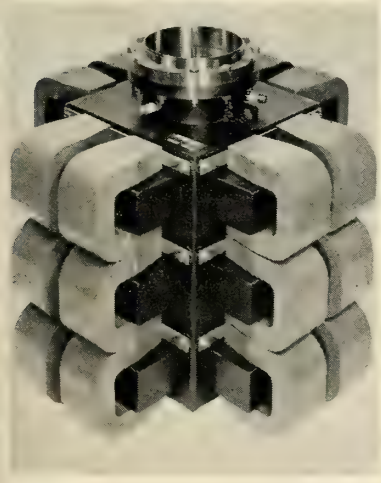
The versatility of the unit is such that if more heat is required without any cooling requirement, the cooling bundle can be used as an additional heater. With slight modification, according to the company, the same unit may be used with heat transfer oil as the circulating medium. This would provide a maximum medium temperature of 600°F, or a total heat to the batch from both circuits of 60,000 Btu per hour.

Circle No. 228 on Subscriber Service Card.

Electronic Vacuum Pump

Designed for systems requiring clean, oil-free vacuums, a new high capacity, ultra-high vacuum pump with no moving parts is now being offered by Ultek Corp. The new pump uses neither fluids nor other contaminants, and achieves a vacuum below 1 x 10^{-9} mm Hg.

The pump, the UlteVac 327,



achieves its vacuum by utilizing a cold-cathode discharge in a magnetic field to remove gas molecules and atoms from circulation by the formation of chemically stable compounds and ion burial.

Invulnerable to power failure, the pump is designed for exceptionally long life through the exclusive use of compact, all metal couplings with rotatable flanges, and rugged, unitized, internal structures to eliminate virtual leaks. The pump is designed to draw current in a linear relationship with pressure, permitting it to double as a vacuum gauge.

Circle No. 229 on Subscriber Service Card.

Induction Melting Unit

The latest in compact, self contained power and control units for high-frequency induction melting and heating has been developed by Inductotherm Corp.

The Integral 100 is a 100 kilowatt motor-generator powered unit and the console measures 72″ wide x 35″ deep x 66″ high, housing the entire power supply, capacitors, control and safety devices necessary to operate one or two high-frequency induction furnaces or coils.

The unit contains an 8-step auto transformer and 30 steps of capacitance values for maximum flexibility in meeting any heating or melting requirement.

Installation requires only a 60-cycle, 440 volt power connection, a cold water connection and a water drain. One or two coils or furnaces with capacities up to 500 lbs. may easily be connected directly to the Integral 100 by means of Inducto water cooled leads that contain conductors inside the water-bearing hoses.

Circle No. 230 on Subscriber Service Card.

Digital Scanning Meters

Transistorized, digital capacity meters for automatically scanning large numbers of capacitors and measuring their capacitance and dissipation factors has been developed by Electro Instruments, Inc. The analog parameters are converted to their digital equivalents, and this data is presented in both visual and 10-line decimal contact closure form.

Important features of the new meter include transistorized design, capacities from 10 mmfd to 999.9 mfd, dissipation factor from .001 to .999, accuracy from 1% and ± 1 digit and automatic and manual ranging.

Circle No. 231 on Subscriber Service Card.

Strike Camera Tester

The quality and reliability of radar film recordings made with radar strike cameras is assured when the cameras have been pretested with the LM-56A Radar Recording Camera Test Set. The LM-56A performs four basic functional tests which completely check shutter, film movement, and control operations of five different radar recording cameras and their related controls.

Designed and built by Mast Development Company, Inc., the LM-56A is primarily for the bench testing of the O-15, O-23, KS-30 (formerly O-20), KS-31 (formerly O-30) and KS-32 (formerly O-32) cameras. The LM-56A is also used for testing the M-1 and M-2 Control Systems and the LD-6 Exposure Frequency Control.

The four basic test phases are



digital computer designers

The Crosley Division of Avco Corporation has openings for electronic engineers with from two to ten years' experience for unusually responsible positions involving digital computer and data processing equipment design.

At Crosley, all projects offer engineers of talent and capability unlimited challenge and definite authority. An alert, aggressive management team provides maximum support and backing to each of the outstanding professional teams working on the frontiers of data processing for industrial systems.

Now is your opportunity to grow your own career in this new and exciting field. Experienced personnel can choose:

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For complete information, write or call:

Mr. P. B. Olney
Manager of Scientific and
Administrative Personnel
Department M-530
Crosley Division
Avco Corporation
1329 Arlington Street
Cincinnati 25, Ohio
Phone: KIrby 1-6600.

Avco/Crosley



facilitated by a series of mechanical-optical displays.

Phase I provides a simulated sweep display which is photographed by the camera being tested to check the shutter operation and to check film shift.

Phase II, similar to Phase I, also involves photographing a display with the camera being tested. The resulting exposures are of a graduated, circular scale with a superimposed light path created by a rotating light spot. The exposures can be read directly to determine the "shutter open" and "shutter closed" time periods with a .001 of a second accuracy.

Phase III utilizes a display of stationary lights to simulate an optical "bombsight." The display is photographed, and the exposed film is inspected to check camera accuracy for alternate photographing of a radar scope display and the target simultaneously viewed through a bombsight.

Phase IV provides electrical pulses which are used to check camera controls. It also provides a means for visually checking camera shutter operation and for checking camera range lights.

Circle No. 232 on Subscriber Service Card.

Magnetic Particle Sprays

Magnetic particle inspection materials are now available in pressurized spray cans and plastic squeeze-bottles, produced by Magnaflux Corp. These materials can be used with any of the magnetic particle inspection equipment or test kits already in operation throughout industry.

The ready-to-use Magnaflux-Magnaglo materials eliminate previous bulky containers, and the problems of mixing to formula, or filling application devices, and reduce set-up time to inspect complex parts. The sealed dispensers keep out dust, moisture, and other contamination during storage.

The No. 14M Fluorescent Magnaglo Bath and No. 9BM Magnaflux Bath are offered in 12 oz. pressure spray cans. The No. 1 Gray Powder is now available in plastic squeeze-bottle dispensers, each containing one full pound of magnetic particles. Perforated top is designed for even powder dispersion with easy hand squeeze.

Circle No. 233 on Subscriber Service Card.

High Loss Foam Blocks

High loss, low weight ceramic foam block, useful in constructing VHF high power loads, is being marketed by Emerson & Cuming, Inc. Suitable designed loads made with the Eccosorb WG are capable of average power dissipation in excess of 2000 watts without forced air or water cooling. Operating temperatures up to 1000°F are possible without permanent deterioration.

Each block has holes drilled through it so that a large surface area is available for heat dissipation. Supplied in blocks 10″ x 15″ x 3″, weighing less than 3 lbs., Eccosorb WG has a useful frequency range from below 100 mc to about 1000 mc.

Circle No. 234 on Subscriber Service Card.

Universal Ear Plugs

A universal size silicone rubber ear plug is being marketed by Sigma Engineering Co. to protect personnel against the growing noise problem in missile work.

Unusually durable, pliable, non-toxic, non-allergenic, resistant to ear wax and skin oils, COM-FIT ear plugs may be boiled and sterilized to make them interchangeable amongst the wearers. They are made with a triple flange to guarantee complete sealing of the ear canal.

Independent laboratory tests proved white noise attenuation of these ear plugs equalled 36.3 decibels. The frequency versus attenuation charts indicated a maximum attenuation of 63 decibels at the frequency of 4000 cycles per second with equally impressive attenuation at various other levels.

Circle No. 235 on Subscriber Service Card.

Quartz Load Cell

A 510 Quartz Load Cell, featuring high capacity, excellent repeatability, and utmost rigidity, in a small package, has just been introduced by Kistler Instrument Corp. for measuring rocket engine thrust.

Measuring less than ¾″ diameter by ¾″ long, the 510 deflects less than .001 inch under a rated maximum load of 5000 lbs. One-hundredth of a pound variation in load can be measured at any level from 0 to 5000 lbs.

Static pressure signals, caused by loads existing before a measurement, can be eliminated by momentarily grounding the signal lead. Basically designed for compression forces, the 501 will measure very small tension forces because of a preload on the crystal. With a special tension adaptor it can be converted readily for measuring large tension forces.

Circle No. 236 on Subscriber Service Card.

new literature

ENCODERS. A 12-page brochure "Shaft Position Digital Encoders With Magnetic Readout" is available from the ASCOP Division of Electro-Mechanical Research, Inc. The literature gives complete specifications for the company's 13-bit, 8-bit, and incremental encoders. In addition, operating principle of the new type of magnetic readout is described in detail with illustrations. Recommended simplified transistor circuity is given for interrogation playback, detection, and amplification of the new magnetic encoders. A conversion table is included for conversion from binary code to decimal or Gray codes.

Circle No. 200 on Subscriber Service Card.

FLIGHT LABORATORY SERVICES. A 16-page illustrated color brochure describing full services for testing airborne equipment quantitatively and qualitatively in flight is available from the RCA Flight Laboratory, Radio Corporation of America. Services include flight-test instrumentation, data reduction and analysis, and aircraft installation, maintenance and modification.

Circle No. 201 on Subscriber Service Card.

BUILDING BLOCKS AND DIGITAL SYSTEMS. A folder which features a quick-reference table showing all 85 Digital Equipment Corp. building blocks and 22 accessory units by type and price. Units are arranged by type —patchcord interconnecting Digital test equipment and plug-in system building blocks—and by speed—500 kilocycle, 5 megacycle, and 10 megacycle. The folder also describes Digital's computers—Programed Data Processors 1 and 3—and DEC Memory Testers which are built from the company's standard line of logic modules.

Circle No. 202 on Subscriber Service Card.

NGINEERS:

A NEW CONCEPT IN PROFESSIONAL JOB SELECTION

New technical tests enable you to calculate your probability for success at LMED – in 1 hour at your own home!

BY GENERAL ELECTRIC'S LIGHT MILITARY ELECTRONICS DEPARTMENT

If you've been thinking of changing your job some day—or in the near future—but have hesitated because of the many uncertainties involved, Light Military's new concept in professional job selection will be of paramount interest to you.

What is it?

The new concept is based on a series of technical tests developed and pretested by Light Military engineers. They are designed to be taken, scored and evaluated by the individual engineer, all in the privacy of his own home. And, because the sole purpose is to provide you with a novel, objective means for self-appraisal, your score need not be divulged to us at any time.

Here's how it works:

First, fill out the coupon below and check off the tests which apply to your training and professional experience. Forward the completed coupon to us and in a few days you will receive the tests, a sealed answer sheet and explanatory material.

During a convenient hour at home, take the test and score it with the answer sheet provided. Then, compare your performance with the criterion group composed of Light Military engineers at all levels who took the same test. In most cases you will be able to relate your score to years of experience, from 2 to more than 10.

What it measures:

If your adjusted score is equal to, or more than the years of experience you possess, the probability is excellent that a significant community of technical interest exists between you and The Light Military Department. In addition, a valid assumption can be made that a high probability for success awaits you here. And remember, your score need not be divulged to us at any time; it is for your own guidance exclusively!

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SPACE COMMUNICATIONS & TELEMETRY • MISSILE & SATELLITE COMPUTERS • SPACE VEHICLE GUIDANCE • UNDERSEA WARFARE SYSTEMS • THERMOPLASTIC DATA STORAGE • SPACE DETECTION & SURVEILLANCE • COMMAND GUIDANCE & INSTRUMENTATION • INFRARED MISSILE APPLICATIONS

Facts about the tests

1 Each technical test is composed of 40 multiple choice questions.

2 To find answers for some questions, mathematics is involved—but only to the degree normally associated with the work.

3 The "mix" of questions includes some easy ones, some bordering on the state of the art.

4 None of our engineers achieved a perfect score.

5 The test for Engineering Administration is psychological, designed to reveal aptitudes and abilities most often found in good engineering managers or administrators.

MAIL THIS COUPON FOR YOUR TESTS

Mr. R. Bach
Light Military Electronics Dept.
General Electric Company, French Road, Utica, New York

Please send me tests (limited to 2 subjects per individual) answer and self-evaluation sheets covering the areas checked:

☐ RADAR ☐ MICROWAVE ☐ ELECTRONIC PACKAGING (ME)
☐ COMMUNICATIONS ☐ ADMINISTRATIVE ENGINEERING

NAME _____

HOME ADDRESS _____ HOME PHONE _____

CITY _____ ZONE _____ STATE _____

DEGREE(S) _____ YEAR(S) RECEIVED _____

73-WT

LMED

LIGHT MILITARY ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

names in the news

Dr. James M. Carter: Appointed director of the Physical Science Division of Space Systems Laboratories, where studies will be directed primarily toward the development of advanced systems capable of operation in space. Dr. Carter will also be responsible for coordination of the division's activities with those of the engineering and life sciences division.



Dr. Marvin Fox: Nuclear physics scientist, joins Hughes Aircraft Co.'s nuclear electronics laboratory as a senior staff physicist. Was formerly director of the sodium reactors department of Atomics International.

Dr. David L. Douglas: Named to the newly created position of manager of fuel cell engineering for General Electric's Aircraft Accessory Turbine Dept. Formerly served as a physical chemist with the firm's Research Laboratory in Schenectady.

William T. Smither: Former vice president and manager of the Los Angeles division of Servomechanisms Inc., promoted to the position of general manager of the corporation, responsible for directing overall operations.



Charles W. Curtis: Named manager of the newly-formed components division of Hughes Aircraft Co., which will develop and market commercial microwave components. Was formerly acting manager of the microwave laboratory.

Dr. David Van Meter: Appointed manager and **John W. Gerdes,** assistant manager of the applied science division of Melpar, Inc.'s Watertown, Mass., facility. Dr. Van Meter, who joined the firm in 1955 as supervisor of the electronics and physics laboratory, was formerly chief of the division's technical planning staff.

Paul F. Pearce: Formerly manager of project engineering at the Lockheed electronics and avionics division in Los Angeles, named manager, systems design, information technology division in Metuchen, N.J.

Noah Dietrich: Elected to the board of directors of Transval Electronics Corp. Currently serves as chairman and director of Houston Fearless Corp. and Tool Research and Engineering Corp.

Richard L. Hoff: Reappointed development metallurgist at Superior Tube Co., after serving a one-year term as a senior engineer at Aerojet-General Corp.

Kenneth A. Waldron: Named marketing manager for government and industrial products, and **Ira Molay**, product manager-audio components, at CBS Electronics, division of Columbia Broadcasting System, Inc.

Lloyd C. Flatt: Project aerodynamicist on assignment at the *Redstone* missile center, named head of Continental Technical Service, Inc.'s newly opened Huntsville, Ala., office.

Melvin Landau: Former supervisor of mechanical design for Bogen-Presto Corp., appointed chief mechanical engineer for ESC Corp.

Simon R. Wagler: Named corporate marketing manager for American Bosch Arma Corp., directing activities for the Arma division. Prior to joining the firm served as assistant director of contract administration for Reeves Instrument Corp.

Fordyce E. Tuttle: Scientific advisor to the general management of Eastman Kodak Co., awarded the Citation of Merit from the U.S. Navy. The unusual peacetime award went to Tuttle for his work as chairman of the Anti-Submarine Warfare Advisory Committee of the National Security Industrial Association.

Vernon M. Welsh: Vice president-communications for General Dynamics Corp., resigns to organize his own communication consultation business. Will continue to be associated with the firm on specific projects.

William F. Schmidt, Jr.: Former West Coast district sales manager, Electronic Products Division, Vickers, Inc., joins the staff of American Electronics, Inc.'s Precision Power Division in the newly created position of field engineer for rotary and static equipment products.

William J. Brackmann: Joins the ASCOP division of Electro - Mechanical Research, Inc., as director of research and engineering. Prior to joining the firm in 1958, he was associated with Norden Laboratories Corp. and its successor, the Norden-Ketay Corp., consecutively as head of the electrical division, assistant director of engineering, assistant director of research and manager of missiles research and engineering.

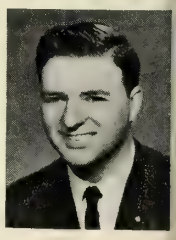


E. H. Urquhard: Named staff sales engineer for Texas Instruments Inc. Geosciences & Instrumentation division's instrumentation product group.

Dr. Charles F. Gell: Joins the Astronautics Division of Chance Vought as chief of life sciences. He will head a team of physiologists, psychologists and engineers specializing in extending man's capability in the environment of space.

Ronald G. Davis: Formerly a design engineer with the electronics division of Curtiss-Wright Corp., appointed senior design engineer with International Resistance Co.

Michael D. Conforti: Appointed technical service representative in the Chicago area for the Specialty Blower Division of The Torrington Manufacturing Co., providing sales and engineering services for special blower units in aircraft, missile and electronic cooling applications.



Dr. Elmer L. Zimmerman: Joins Hughes Aircraft Co.'s nuclear electronics laboratory as head of nuclear circuitry research. Was formerly head of critical experiments units at Atomics International and prior to that at Nuclear Development Associates.

Norman Van Dine: Formerly with MacMillan Industrial Corp. and MacMillan Laboratories as assistant sales manager, appointed director of marketing for Adams-Russell Co., Inc., engaged in research, development and manufacture of electronic equipment, antennas, RF systems and components.

William M. Fautz: Named chief engineer by Acor Inc., and **Henri de Forrest,** manufacturing manager. Fautz was formerly assistant chief engineer for Viking Industries; de Forrest was owner-manager of Forrest Mfg. Co.

Fredric F. Kubias: Elected district sales manager, Western District, for General Electric's Light Military Electronics Dept., with offices in Los Angeles.

James R. Vine: Appointed Chief, Computer Applications, a newly-formed group within the engineering department of Beckman Instruments, Inc. Was formerly manager-data processing services, Electrodata Division of Burroughs Corp.

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MAY

New York University Conference, "The Critical Million—How to Talk to the Nation's Scientists and Engineers . . ." NYU, New York City, May 17.

ASME Production Engineering Conference, Shroeder Hotel, Milwaukee, May 17-19.

Society for Experimental Stress Analysis, 1960 Spring Meeting, Hotel Severin, Indianapolis, May 18-20.

Society of American Military Engineers, National Convention, Washington, D.C., May 19-20.

National Telemetering Conference, ARS, IAS, ISA and AIEE, Miramar Hotel, Santa Monica, Calif., May 23-25.

German Society for Rocket Engineering and Space Flight Research, 12th Annual Meeting, Heidelberg, West Germany, May 23-25.

TAPPI Coating Conference, 11th Annual, Edgewater Beach Hotel, Chicago, May 23-25.

ASME Design Engineering Conference & Show, Statler Hilton Hotel, New York City, May 23-26.

American Society for Quality Control, Annual Convention, Sheraton-Palace Hotel, San Francisco, May 24-26.

Japanese Rocket Society, Second International Symposium on Rocketry and Astronautics, University Club in Tokyo, May 24-28.

IAS Specialists Meeting, Guidance of Aerospace Vehicles, Hotel Somerset, Boston, May 25-27.

The Psychophysiological Aspects of Space Flight, sponsored by the School of Aviation Medicine, ATC, to be held at the Aerospace Medical Center, Southwest Research Institute, San Antonio, May 26-27.

Society of Naval Architects and Marine Engineers, Spring Meeting, Statler Hotel, Washington, D.C., May 26-28.

Fourth International Symposium on the Reactivity of Solids, Amsterdam, May 30-June 4.

JUNE

6th Annual Radar Symposium, University of Michigan, sponsored by Army, Navy, Air Force Willow Run Laboratories, Ann Arbor, June 1-3.

Instrument Society of America, Annual Instrumental Methods of Analysis Symposium, Montreal, June 1-3.

Fourth Annual Summer Conference on Vacuum Metallurgy, New York University College of Engineering, NYU Heights Campus, Bronx, N.Y., June 2-3.

ASME Summer Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, June 5-9.

Society of Automotive Engineers, Summer Meeting, Edgewater Beach Hotel, Chicago, June 5-10.

Machinability Seminar, Pennsylvania State University, University Park, June 6-10.

National Society of Professional Engineers, Annual Meeting, Statler Hotel, Boston, June 8-11.

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 13-15.

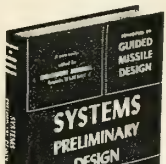
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editorial . . .

Will Satellites be Targets, Too?

Whatever else may come from the shooting down of the American U-2 over the Soviet heartland, one fact is pretty obvious. It could be the last important surreptitious reconnaissance attempt made in peacetime with a manned aircraft.

Future efforts in this line will be made with satellites most probably, or with some form of unmanned missile. This fact in itself points up some brand new problems in space exploration and usage.

The secret of the U-2 operation was remarkably well-kept. The State Department announcement said that the Lockheed broad-winged jets had been operating over Iron Curtain territory for four years. For much of this time the facts of the secret operation have been known to the Pentagon Press corps. Reporters covering the Department of Defense not only went along with the weather reconnaissance cover plan and didn't write the real story—they stopped less well-informed special writers from putting it in print.

There is little doubt that the Russians also have long known about the activities of the U-2 planes. Certainly they must have tracked them by radar. The altitude of the planes protected them from Russian fighter aircraft, as was planned. How many times the Russians shot at them with ground-to-air missiles may never be known. Nor why they weren't hit before, if this one was. The U.S. has missiles which certainly are capable of reaching the U-2's altitude.

Secretary Herter's admission that the U-2 was engaged in espionage must have been as great a shock to the Russians as it was to the U.S. people, and to our European friends. Spies are traditionally expendable. Normal procedure would have been for our State department to have said, in effect: "This guy was drunk or out of his mind or both. He wasn't over Russia on our orders. We disclaim any responsibility for him."

The Russians would have recognized this as playing the game. We've caught their spies red-handed, too. And they've blandly disclaimed any responsibility. It's all very normal in the international espionage business.

Whether we have been incredibly naive or set up a new system of rules—this will take some time to tell.

But some sort of new rules are necessary under espionage by satellite. The U.S. has already launched one *Tiros* satellite which has sent back remarkably clear pictures of cloud formations and the continents beneath them.

From this it is only a short step and a short span of time to *Samos,* which will be able to send back pictures just about as good as those from the U-2.

The only real difference between the concept of *Samos* and the U-2 is altitude. One flies 15 miles high and the other 300. Shooting down a satellite in fixed orbit might actually be easier—or perhaps more certain—than downing the jet plane.

There can't be much of a cover plan for the reconnaissance satellite. We probably won't even attempt one. Under the new rules we've just established to do so would be laughable.

What do we do then? Publicly release our pictures of the dark side of Russia—much as Russia released her pictures of the dark side of the moon? And if Russia objects? Or shoots down our satellites?

It would be pleasant to think we had plans for these eventualities. One thing is certain: any plan will be just as good as our strength to back it up. Wide-eyed naiveté isn't much good in a real crisis.

Clarke Newlon



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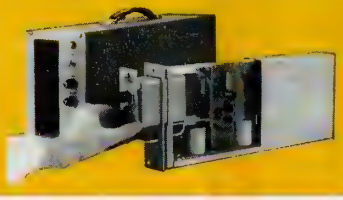
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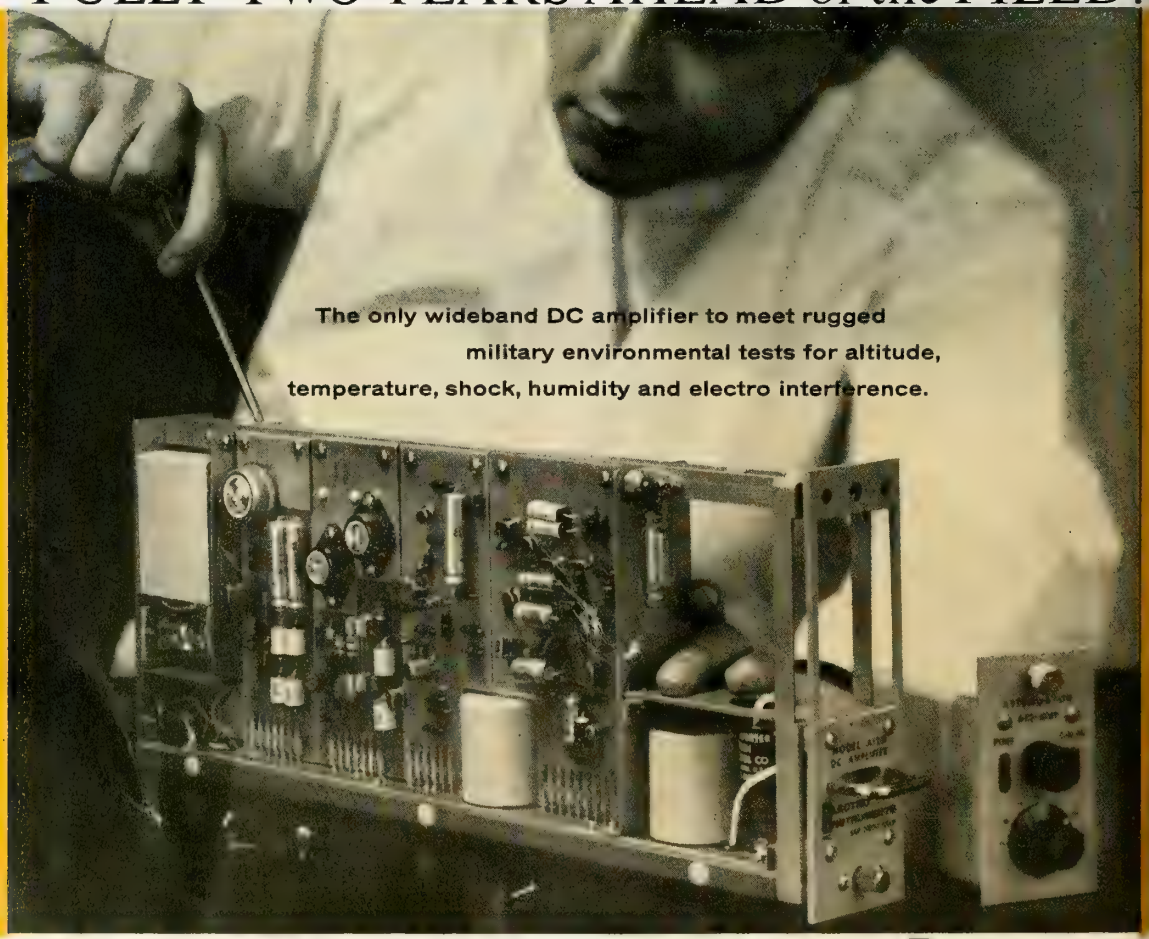
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missiles and rockets

THE MISSILE/SPACE WEEKLY



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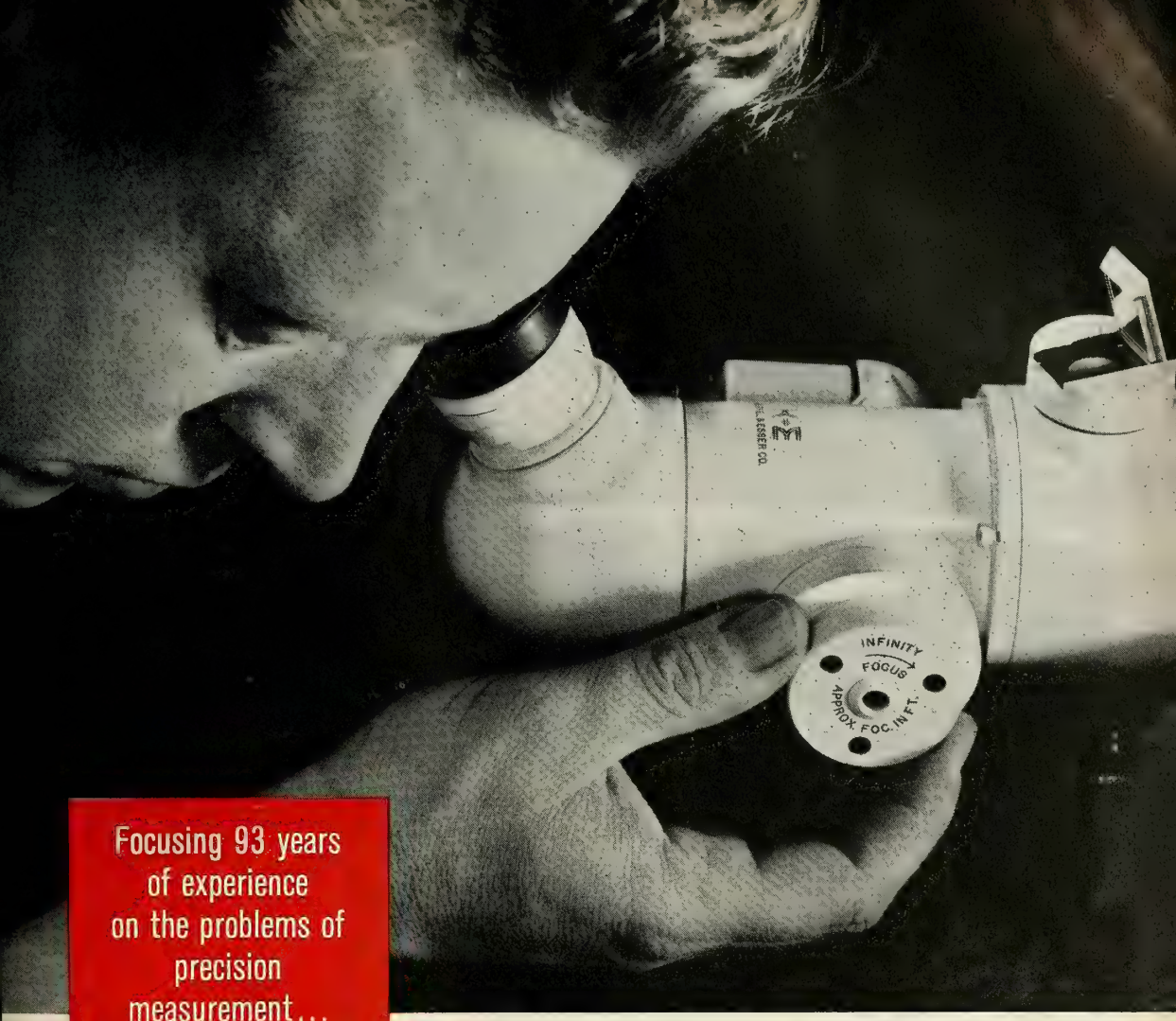
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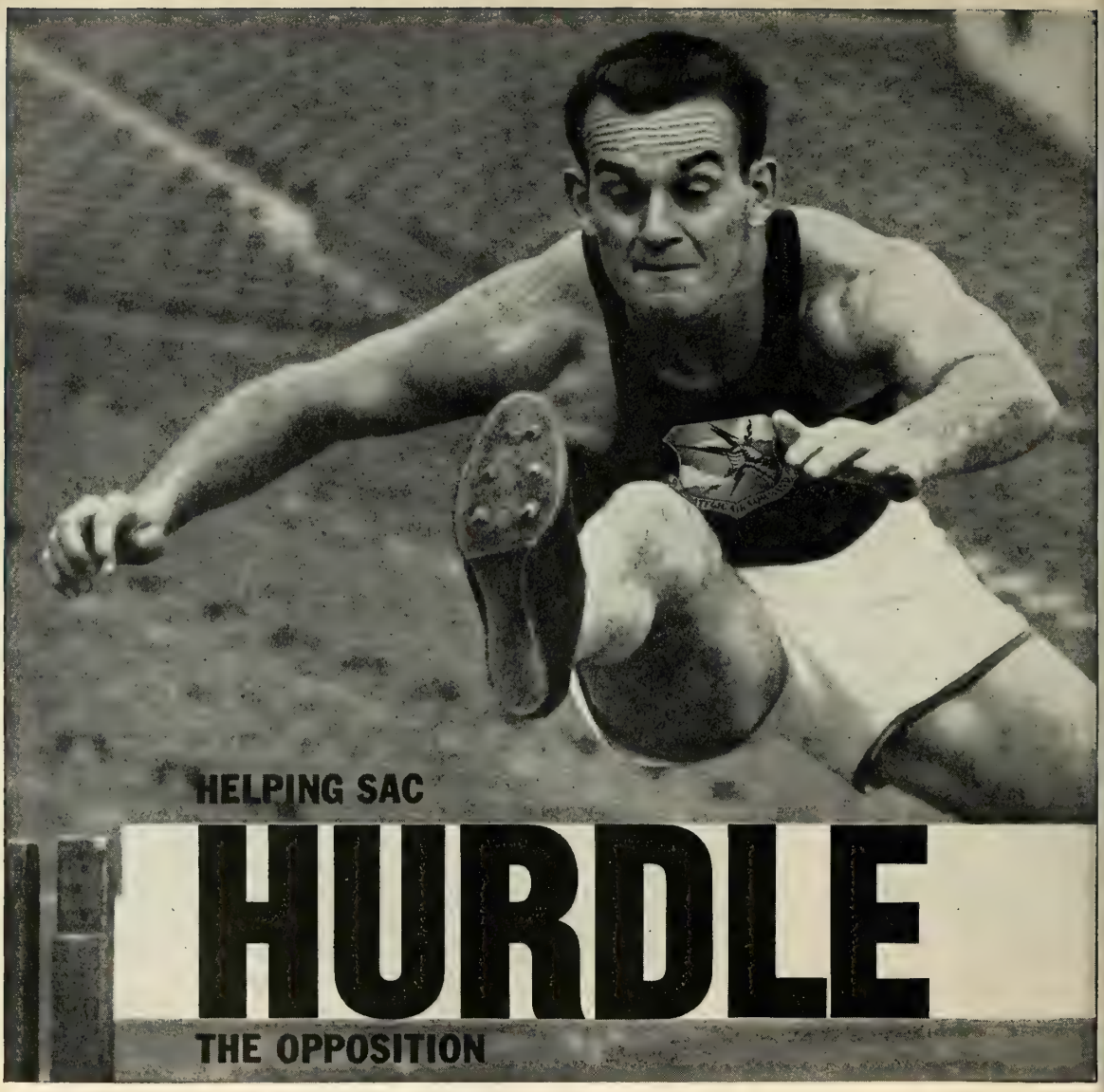
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SAC is now off and running with its new Hound Dog missile. With the supersonic GAM-77 missile, the B-52 bomber can more easily hurdle ground defenses on the way to a target. In the short span of just 30 months, the Hound Dog air-to-surface missile grew from the drawing board to a powerful member of SAC's deterrent team.

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To further confuse the enemy, these inertially-guided missiles can feint at pseudo-targets before turning toward their real objectives. Speed and altitude variations can also be programmed into the GAM-77's target approach.

The Hound Dog missile greatly extends the useful life and striking power of SAC's B-52 bombers—the backbone of America's strategic power. The GAM-77 is being produced by the Missile Division of North American Aviation.

MISSILE DIVISION
NORTH AMERICAN AVIATION, INC.
Downey, California

THE MISSILE / SPACE WEEKLY

missiles and rockets

May 23, 1960 Volume 6, No. 21

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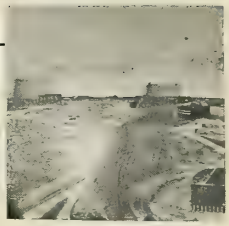
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THE COVER

BMEWS antennas at Thule, Greenland, will radiate fans of multimillion-watt RF energy to detect ICBM's 3000 miles away. The site is nearing completion (see p. 36).

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letters

Vehicle Recovery Coverage

To the Editor:

For the past two years I have read my copies of M/R from cover to cover and have thoroughly enjoyed each and every article.

A subject of prime interest to myself and various colleagues has not, however, been covered in past publications of your magazine.

The subject I refer to is re-entry vehicle recovery systems—in particular the parachute and flotation components of these systems.

I believe that information for an article of this nature might be available from General Electric's Missile and Space Vehicle Department, Space and Recovery Systems, Inc., El Segundo, Calif., and Col. J. Dodge, Director of Re-entry Vehicle Department, USAF.

Ellis W. Hartman, Jr.
Rutherford Heights, Pa.

M/R has already done some preliminary investigation of work in this area and, depending on developments, may carry a story about it in the near future. We appreciate the suggestion and expression of interest.—Ed.

Battery Clarification

To the Editor:

In the May 2, 1960 issue, reference is made to your article "Special Handling Demands are Basic to Launch Success" and, specifically, the part entitled Missile Subsystems. There are apparently some points which need clarification on the primary and secondary battery portions.

It is pointed out that exposure prior to launch of temperatures around 125°F would require special air conditioning equipment to keep the primary battery cool. This would not be necessary on exposures of less than one month at temperatures in the range of 125-130°F. In general the temperatures would not be at the high value continuously but only for short periods of time in cyclic fashion.

With reference to disposal of electrolyte overflow after battery activation, this must be peculiar to only one manufacturer. We are producing batteries for *Atlas, Titan,* various nose cones and other missiles, and most of the torpedoes, where there is no overflow of electrolyte. In fact, our batteries are all enclosed in the battery case, with no exhaust for electrolyte. Primary battery design is of such a nature that extended time after activation up to 12 hours may be obtained before having to use them.

Correspondingly, we are not aware of the necessity to charge the silver-zinc secondary batteries as often as indicated. In one torpedo, we have a six-month charged stand in fleet use, after which the required performance is obtained. The *Bomarc* uses Yardney secondary batteries with a 60-day maintenance check. Practically all the torpedoes are set up on a 90-day charged stand basis and still give the required performance.

We feel that any adverse impression which may have been given on both primary and secondary silver-zinc batteries should be corrected and brought to the attention of your readers. A large number of them are quite familiar with the performance of the Yardney Silvercel described above which has made possible many of the recent advances in the missile and torpedo fields.

Paul L. Howard, Asst. Vice Pres.
Yardney Electric Corp.
New York City

Nowheresville

To the Editor:

I give up. Where is the 60th Air Force based? (M/R, April 25, p. 40).

K. T. Little
Manhattan Beach, Calif.

In a typographical error. The word "60th" should have been "both."—Ed.

reviews

ELECTRONIC COMPUTERS PRINCIPLES AND APPLICATIONS, T. E. Ivall. Philosophical Library, New York. 259 pp. $15.

This book is intended as a non-mathematical introduction to the principles and applications of electronic computers. It is aimed at the technician, engineer, and student with some background in electronics and is a rather general treatment of the broad background of computing.

Except for "valves" and some other British terms and construction, the book is easily read and interesting. It will be especially useful to anyone requiring a general knowledge of computer operation without the mathematics and technicalities of design theory.

This is the second edition of a book first published in 1956 and reprinted a year later. It has been almost entirely rewritten, to bring the information up to date, and three new chapters have been added.

BASIC RESEARCH RESUMES—A SURVEY OF BASIC RESEARCH ACTIVITIES IN THE AIR RESEARCH AND DEVELOPMENT COMMAND. Herner and Co. for ARDC. Order PB 161291 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 342 pp., $5.

Most of the 1400 scientific research projects described in this index are being conducted at leading U.S. colleges and universities. Other projects are the work of industrial laboratories, government facilities, and private, non-profit research institutions. About 14% of the research is assigned to ARDC's own labs, while 20% is done outside the U.S.

All work is listed under 24 subject categories which cover six technical areas: propulsion, materials, electronics, geophysics, biosciences and areomechanics. There are two research sections and three indexes.

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Thiokol Chemical Corporation
Reaction Motors Division

1960, illustrated, 145 pages, $5.50

HERE IS an all-inclusive review of the rocket engine—its history, fundamentals of operation, design of components and methods of application. The book's level is one that bridges the gap between the popular and the highly technical. Chapters advance one step at a time through the basic laws governing rocket engine design; the design and operation of current engines; the need for and probable design of future engines; and the rocket engine's job in space flight and satellite missions. The book fully describes all rocket engine types so that the function and operation of each is clearly understood. All basic rocket formulas derive from algebra, rather than the more difficult calculus. Explanations of new terms and illustrations of uncommon devices abound to further the reader's grasp of the subject. Extensive bibliographies following each chapter lead to additional or more advanced information. The authors use a thorough, easily followed approach throughout. As a result, there is an ideal reference for guidance and electronics engineers, propellant chemists, chemical and mechanical engineers, metallurgists, students, or anyone remotely connected with or interested in rocket propulsion and its future.

CONTENTS: What Is A Rocket Engine? Reaction Propulsion and the Rocket Engine; Generation of the Action Force In A Rocket Engine; Acceleration of the Action Gases; The Liquid Propellant Rocket Engine; The Solid Propellant Rocket Engine; Rocket Engines Tomorrow; Rockets Into Space; List of Symbols; Rocket Engine Formulas; References; Index.

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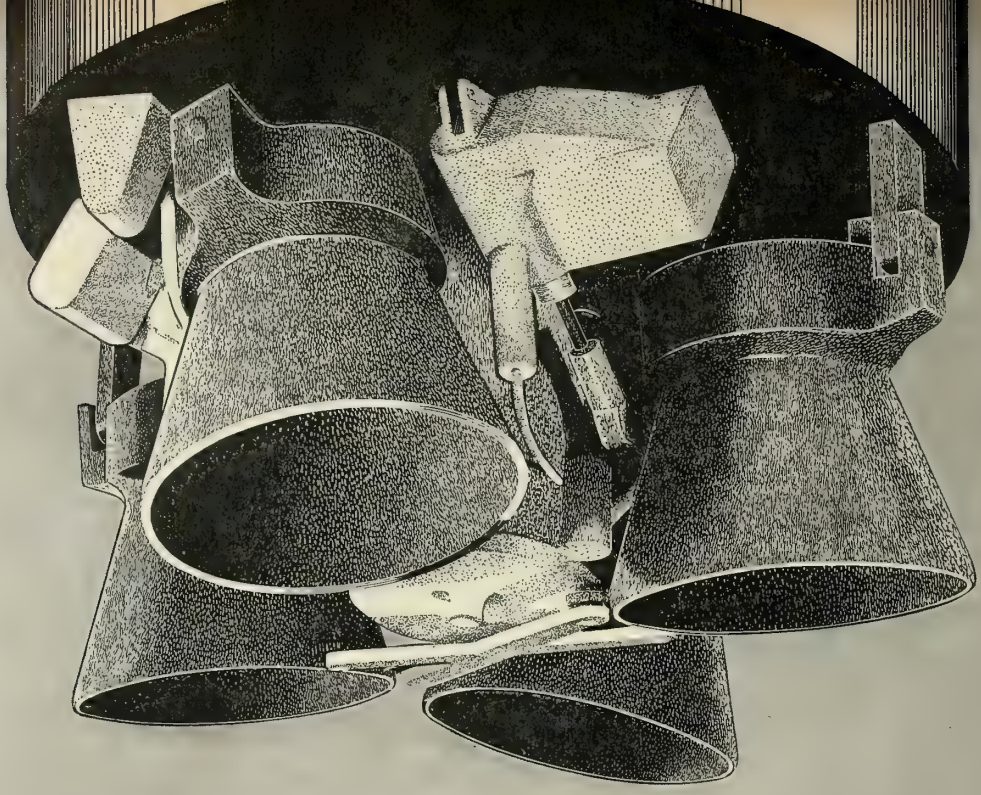
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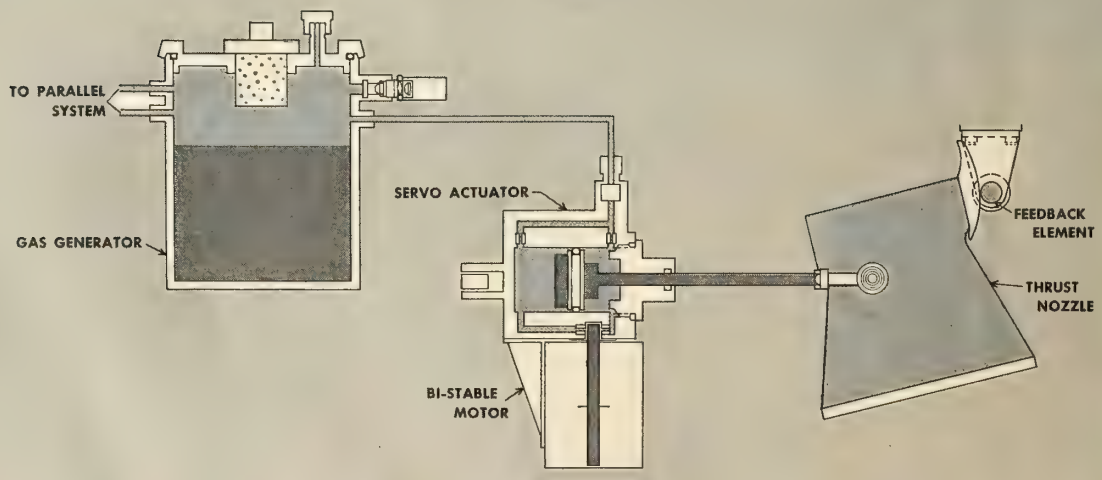
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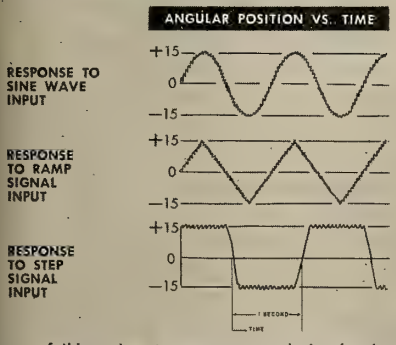
To position a mechanical load in response to an electrical command with minimum error, CECO has developed solid-fueled hot gas actuator systems operating in a bi-stable mode.

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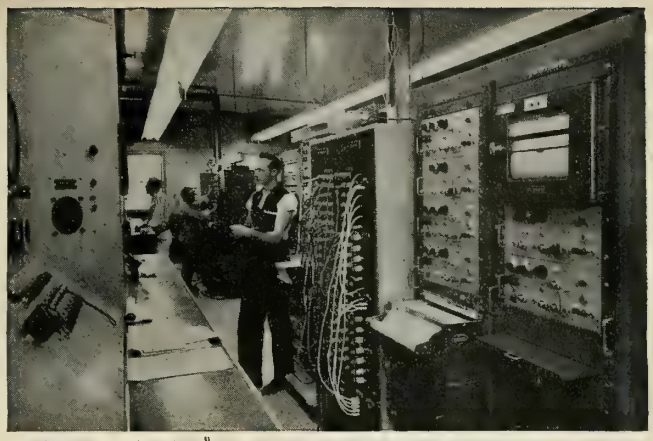
Among applications for CECO's limit-cycle, bi-stable philosophy is *thrust-vector* control. A representative portion of such a system is shown schematically at the left. This design utilizes push-pull actuators. The bi-stable motor, valving and actuators are an integral unit. One large servo-actuator positions the mechanically-linked pitch nozzles, while two smaller actuators position the remaining nozzles in response to yaw and roll commands.

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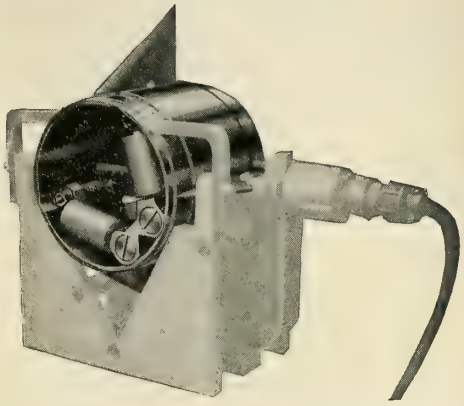
TYPICAL PERFORMANCE OF A BI-STABLE CONTROL



sponse of this system to sine, ramp and step inputs (while ing a conventional torquemotor) is illustrated. With new com nents being readied, limit-cycle amplitudes of one-tenth of one degree are expected.



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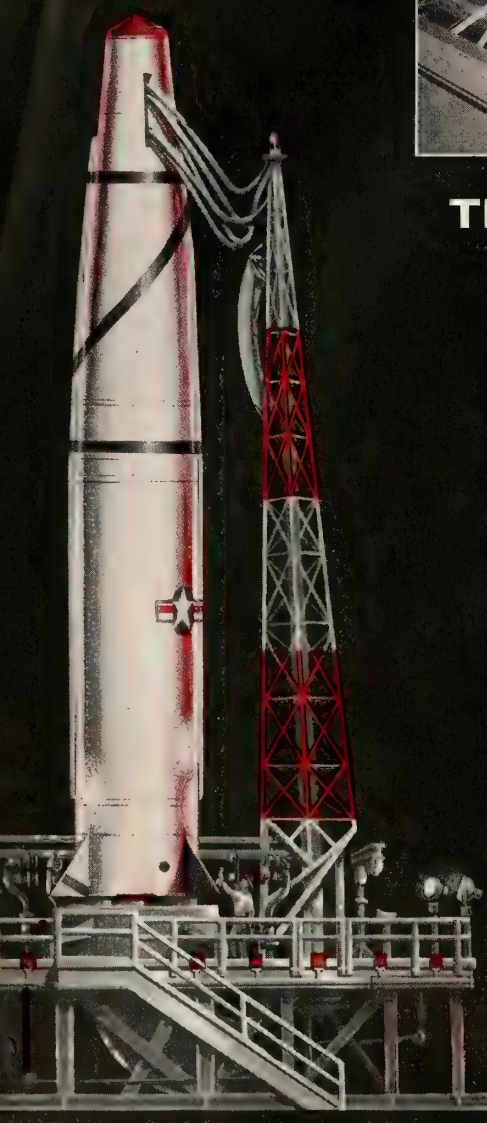
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Second Thoughts on Mercury

Many leading U.S. scientists are growing convinced NASA, in Project *Mercury*, is taking the wrong approach to putting a man in space. Reason: The capsule's environment is too synthetic to obtain good data—even if the astronaut returns alive (which they doubt). They feel instruments will produce more deep space knowledge and that the Air Force *Dyna-Soar* actually is the best means of acquiring useful scientific and engineering data.

Minuteman to Get Tougher

Harder and harder underground *Minuteman* bases are being planned by the Air Force to increase the missiles' chances of survivability. Base specs will be raised soon from 100 psi to 200 psi.

Nuclear submersible hydrofoil?

Most advanced designs for missile-launching hydrofoil ships now being studied by the Navy are not only nuclear-powered, but also submersible. The submersible version would have the advantage of hiding under the ocean. It would pop to the surface to fire its missiles—either against shore installations, ships, subs or sub-launched missiles.

Titan Making Up Time

Big push is on by the Air Force to put the the Martin *Titan* ICBM back on schedule. If present test series continues to make up for time lost by earlier failures, the AF hopes to launch operational model *Titans* in October from Vandenberg AFB—one raised from a silo on an elevator, and a second directly from the silo. The shots would put the 98-ft. missile near operational readiness by the end of the year—the original timetable.

Dust Boating on the Moon?

Just in case the moon turns out to be covered with dust 200 ft. deep, someone has presented the Pentagon with a design for a "dust ship." The vessel is designed to "float" on the surface and is self-propelled.

INDUSTRY

Hot Bidding for Mobile Zeus

More than 80 companies are now in the competition for a $250,000-$450,000 feasibility study contract for a mobile *Nike-Zeus* launcher. Since the hardware potential is so huge, many industry giants have teamed up. One combination is said to be General Electric and Chrysler Missile Division. Bids are due July 5, with the contract award expected in September.

Competition on 1500-mile Polaris

The Navy's Allegany Ballistics Lab—operated by Hercules Powder Co.—and Aerojet-General are competing for the second-stage motor of a 1500-mile *Polaris*. Both have worked on the 1200-mile motors. Field is wide open, however, on the 2500-mile version—which won't come along until 1964-66 and depends upon advances in solid propellant technology being sought under ARPA's Project *Principia*.

Word from the Cape

Chrysler Corp., which lost the *Saturn* second-stage airframe contract to Douglas, has dropped an option on a large tract of land near the AF Missile Test Center at Canaveral . . . Maj. Gen. Leighton Davis is due to take over command of the Cape soon, succeeding Lt. Gen. Donald N. Yates, who has been put in charge of all ranges . . . and the AF is cramped for *Atlas* pads, with two of the four at the Cape now out of action by launching explosions.

Huntsville Watches Agena-B

Modification by Lockheed of the *Agena-B* satellite for NASA uses will be supervised by the Marshall Center at Huntsville.

Front Office Changes

Edward T. Clare has left Convair, where he was manager of support services for the *Atlas* program, to become marketing vice president of Cohu Electronics, San Diego . . . The Martin Co. has appointed Bastian Hello program manager for the rocket booster portion of the *Dyna-Soar* project.

INTERNATIONAL

More from the U-2

U.S. intelligence agents detected three Russian launch failures at their Aral Sea launch base prior to the successful firing of the 5-ton *Sputnik IV* on May 15. The type of vehicles which failed was not determined.

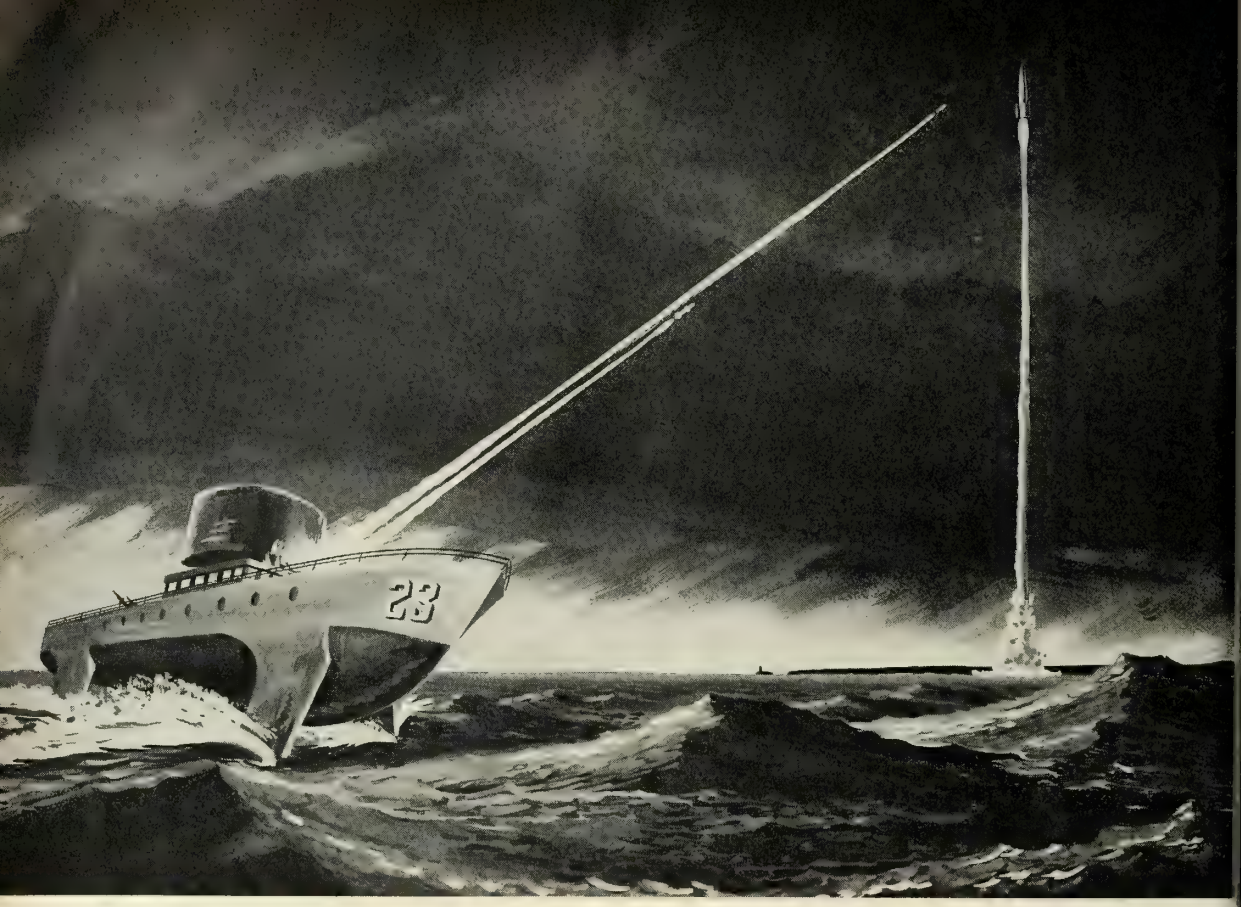
British Missile Makers Merge

Missile and aircraft interests of Vickers-Armstrongs, English Electric and Bristol Aircraft are in the process of being taken over by the new British Aircraft Corp. The new firm, to avoid large tax payments, is being organized as a Vickers subsidiary.

New Hawk Participant

West Germany's Bolkow-Entwicklungen K.G., maker of the *Cobra* antitank missile, is expressing interest in joining the NATO team producing the Raytheon *Hawk* antiaircraft missile under license. Prime for NATO on the *Hawk* is France's SETEL.

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An M/R Artist Conception

Answer to missile subs? . . .

Navy Considers Hydrofoil Fleet

by James Baar

The Navy's answer to the Soviet missile-launching submarine may be an antimissile missile-packing hydrofoil destroyer.

The Navy is seriously considering the development of a hydrofoil destroyer as the first of a great fleet of possibly several hundred.

The Missile Age "greyhounds of the sea" would:

- Carry antimissile missiles that would knock down an enemy missile as it broke from the surface of the sea.
- Carry antisubmarine missiles that would strike at enemy submarines deployed off U.S. coasts.
- Displace between 300 and 500 tons and speed over the sea at between 60 and 100 knots—almost two to three times as fast as any surface warship in the Navy.

The hydrofoil destroyer, if approved by the Navy and Defense Department, would be the follow-on ship to the much smaller and slower hydrofoil subchaser on which the Navy has been taking contract bids. The hydrofoil subchaser—known as the PCH—will displace about 100 tons. Its maximum speed will be about 45 knots.

The fleet of several hundred hydrofoil destroyers could be deployed around the presently soft flanks of the continental United States. This force, in conjunction with other antisubmarine forces and detection systems, would be designed to keep track of enemy subs lurking on station and to cripple any attempt to launch an attack on the mainland.

The hydrofoil destroyer also would have offensive capabilities.

Such ships, all seaworthy and capable of travelling up to 5000 miles without refueling, could launch surface to surface missiles with ranges of several hundred miles. A new missile—possibly a greatly cut-down *Polaris*—would be needed for this mission.

On the other hand, the Navy already is developing the Westinghouse *Typhon* antimissile missile for shipboard use. The *Typhon*—an outgrowth of the Bendix *Talos*—could be adapted to a hydrofoil destroyer.

- **Small target**—Another possibility that has been suggested is the development of a seagoing version of the Convair *Mauler*—the Army's battlefield antimissile missile now under development. The entire *Mauler* system is reported to weigh less than 10 tons.

Besides speed, the hydrofoil destroyer has two other big advantages:

• It would be relatively cheap. The average cost for each of a fleet of 50 is estimated at about $7 million. The Navy's new guided missile destroyers cost about $34 million. Also, a crew of only about 25 officers and men would be needed for a hydrofoil, compared to the some 300 aboard a guided missile destroyer.

• It would present a difficult target. The only target a submarine would have to launch torpedoes at would be the thin foils—moving at better than 60 knots. The hydrofoil destroyer's speed and great maneuverability would make it an equally poor target for a surface- or air-launched missile.

A contract for the PCH prototype is scheduled to be let by July 1. The ship is expected to be completed in about two years. Under normal procedures, the next step would be the development of the first hydrofoil destroyer after test and evaluation of the PCH.

But many experts in the Navy and industry feel that the development cycle of the hydrofoil warship can be accelerated.

They contend hydrofoil technology is sufficiently advanced to move swiftly into the development of the hydrofoil destroyer.

• **500-tonner possible**—Grumman and its affiliate, Dynamic Developments, are already working under a Maritime Administration contract on an 80-ton R&D hydrofoil that would have a maximum speed of about 60 knots. Hydrofoil advocates contend that there is no reason to think that a ship displacing 300 to 500 tons can't be built.

They say the border of present hydrofoil technology is at about 65 knots. Beyond that speed, more development is needed—particularly in materials and the design of supercavitating foils.

Some research in this area is already underway. Several companies also have designs for a second generation hydrofoil destroyer that would operate on nuclear power.

The principal argument for proceeding as rapidly as possible with the development of a hydrofoil destroyer is the expected coming threat from Soviet nuclear-powered submarines. The Russians are expected to begin deploying missile-launching nuclear-powered subs off U.S. coasts by about 1965. Such subs can outrace any conventional warship now afloat.

Moreover, the Russians already have a number of much slower diesel-powered subs capable of launching missiles with ranges up to more than 300 miles.

The Navy sees this threat growing in seriousness in the late 1960's. Therefore, work on the first hydrofoil destroyer would have to be started within about a year in order to have a sizeable fleet of them available in time.

Some of the companies that have shown considerable interest in the Navy's hydrofoil programs:

Arma Division of American Bosch Arma Corp.
Boeing Airplane Co.
Bullard Co.
Convair Division of General Dynamics Corp.
General Electric Co.
Grumman Aircraft Engineering Corp.
Hughes Aircraft Co.
Librascope, Inc.
Lockheed Aircraft Corp.
Loral Electronics Corp.
North American Aviation, Inc.
Pratt & Whitney Aircraft Division of United Aircraft Corp.
Raytheon Co.
Westinghouse Electric Corp.

The hydrofoil, which many in industry predict will have a bright future both commercially and in the Navy, is nothing new. An Italian, Enrico Forlanini, is usually credited with operating the first hydrofoil craft in 1905. Alexander Graham Bell, inventor of the telephone, built a hydrofoil in 1911 after visiting Forlanini.

Large commercial hydrofoil ships have been in operation in Europe for years. Russia operates one of some size on the Volga River. However, these ships are not considered capable of operating in the open ocean.

• **Supercavitation**—However, two developments in recent years have opened the way toward large, ocean-going hydrofoils of great speed:

One is the development of the relatively light gas turbine jet engine which can be converted for powering a hydrofoil ship. A G.E. J-79 will be used on the Maritime Administration ship. Two or three engines of this size would be needed for a hydrofoil destroyer.

Needed for the development of a hydrofoil destroyer weapon system or later advanced systems:

• A seagoing 200-300-mile-range solid-propellant missile—possibly a modified Junior *Polaris*.

• A seagoing antimissile missile—possibly a modified *Typhon* or *Mauler*.

• New materials

• Advanced supercavitating foils

The other key development is the supercavitating foil—a hydrofoil designed so that a water vapor cavity that forms on the top of a foil at high speed does not collapse and create vibration. Without such a foil, speed is limited to not much more than 60 knots.

The supercavitating foil will not be used on the Maritime Administration ship but would presumably be used on a hydrofoil destroyer.

Despite Russian work in the field of hydrofoil, Navy planners generally do not believe the hydrofoil has nearly as much promise as an antisubmarine weapon for the Russians as for the United States. The reason is geography.

The long open coasts of the North American continent could be protected by squadrons of hydrofoil destroyers operating out of home ports or friendly bases in Europe and the Caribbean. Moreover, they would be backed by shore-based and other ASW detection systems. All of these ocean areas are controlled by the United States or friendly powers.

On the other hand, the *Polaris* submarine threat to the Soviet Union is based in the waters surrounding the Eurasian land mass. These waters, except for those off northern Siberia and the Siberian Pacific Coast, are not controlled by Russia. Therefore, ASW surface operations in these uncontrolled areas would be extremely difficult at best.

It is doubtful that the hydrofoil destroyer will be Russia's defense against the missile-launching submarine. But it may very well be America's.

—news briefs—

Second Saturn Static Test Succeeds—The huge *Saturn* booster was ignited for the second full static test of its clustered eight engines May 17 at NASA's Marshall Flight Center. The booster developed more than 1.3 million pounds of thrust for nearly 30 seconds.

Polaris Second Stage "Fix" Works—An all-but operational *Polaris* roared about 1000 nautical miles down the Atlantic Missile Range May 18, proving that a malfunction that had been causing *Polaris* second stages to fall short has been corrected.

Missile Construction Bills Vary—The House Appropriations Committee approved a slashed military construction money bill with $300 million for the Air Force ballistic missile program. The Senate Armed Services Committee authorized $408 million.

Year Was Lost in Dyna-Soar Program

by William J. Coughlin

SEATTLE—Extensive technical re-evaluation now shows clearly the United States has wasted a year in going ahead with the *Dyna-Soar* program.

This conclusion is generally drawn from the final study that preceded the release of funds April 27 to begin the first phase (Phase Alpha) of the huge project. On that date, the Air Force made available $29.7 million for design and ground testing facilities needed to build a boost-glide "aerospace test vehicle."

The program has been delayed by years of haggling over the best approach in vehicle design and a great deal of skepticism in the Eisenhower Administration and the Defense Department.

However, experts connected with the program say today that the United States has possessed the technology to build the *Dyna-Soar* for a full year. The major difficulty, apparently, has been in convincing scientists and officials in Washington to this fact.

• **'Unlimited possibilities'**—Now that it has succeeded in getting the program underway, the Air Force has made it clear to Boeing Airplane Co., which is building the glider vehicle, that *Dyna-Soar* will be a strategic weapon system not only for manned reconnaissance, but for orbital bombing as well. Gen. Thomas S. Power, commander of the Strategic Air Command, emphasized this role for *Dyna-Soar* on a recent visit here, adding that as a weapon it had "unlimited possibilities." His remarks contrasted sharply with the purely scientific emphasis that NASA has placed on *Dyna-Soar* and also underlined the Air Force's determination to utilize it in establishing a strategic mission in space.

George H. Stoner, *Dyna-Soar* program manager, told M/R in an interview last week that there are no major problem areas to be solved in pushing ahead with the *Dyna-Soar* program. Everything which must be accomplished, he said, is within the present state of the art.

• **No changes needed**—Stoner said no major changes had been made in the *Dyna-Soar* configuration or program as a result of the Phase Alpha re-evaluation. Configuration of the *Dyna-Soar* space-glider is that of a modified Delta with a platform which juts out more abruptly toward the wingtips.

Stoner said that the re-evaluation of the program did not change in any way the conclusions that the Air Force, Boeing and The Martin Co., which is modifying the *Titan* ICBM as the booster, came to a year ago.

He made it clear that he felt the program could have been pushed ahead at a faster pace but acknowledged that Phase Alpha had succeeded in transmitting to the scientific community the conclusions reached in secrecy in the competitive stages. These conclusions, he said, now have been accepted.

Detailed specifications for the *Dyna-Soar* vehicle and booster are being drawn up—specifications for the major subsystems also are being defined and contracts will be let in competitions later this year.

A definitive mockup is already in existence here at the Boeing plant.

• **Modifying**—A number of changes are required in the *Titan* missile which will boost the *Dyna-Soar* vehicle. These are intended to handle the structural and stability problems which will result from mounting the aerodynamic shape on the front of the missile.

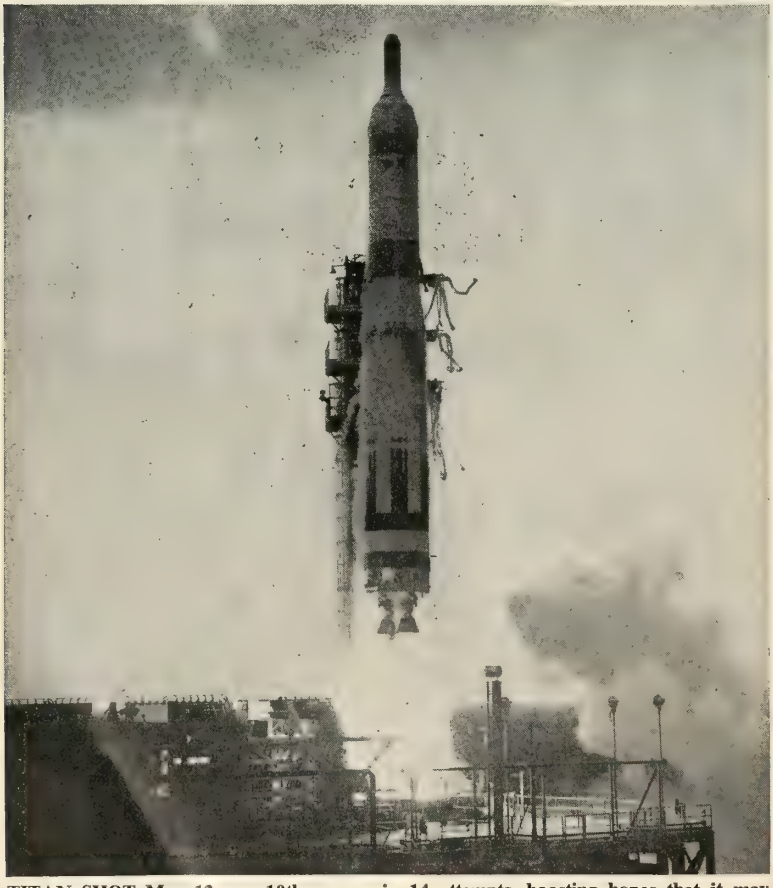
Major change will be the addition of fins in the control system or possible control deflection within the engine arrangement. Final decision on this still is to be made.

Structural requirements in beefing up the *Titan* for its *Dyna-Soar* booster task are relatively modest. Separation techniques will not be unlike those used in present multi-stage ballistic missile configuration.

• **Saturn by '65**—*Dyna-Soar* development program calls first for air-drops of the space-glider from a B-52 at Edwards AFB, Calif., sometime in 1963.

These will be followed by ground-launching of the unmanned glider atop the *Titan* at Cape Canaveral, Fla., and then down-range launching of the manned glider. Next step will be launching of a manned glider from Cape Canaveral around to Edwards AFB, Calif.

By that time—1965—A *Saturn* booster is expected to be available to put the *Dyna-Soar* into orbit.



TITAN SHOT May 13 was 10th success in 14 attempts, boosting hopes that it may be operational this year. Martin is modifying *Titan* as *Dyna-Soar* booster.

Firing of Kiwi A Prime Reactor Nears

AEC now expects to carry out first test firing in July; nuclear ramjet static test may come before November

by Frank G. McGuire

JACKASS FLATS, NEV.—The Atomic Energy Commission expects to test-fire the first *Kiwi A* prime reactor in the *Rover* program by mid-July, using a "real step forward" in nuclear fuel element design.

Following tests of the *Kiwi A* prime, Los Alamos Scientific Laboratory, which has design, development and test responsibility for the *Rover,* will begin tests on *Kiwi A3.*

The two reactors, similar in outward appearance to each other and the original *Kiwi A* series, will be disassembled and examined after their initial runs are completed. AEC has expressed complete satisfaction with the first test of *Kiwi A,* which was operated at full power on July 1, 1959, for "less than ten but more than three minutes." There was reference to an unexplained "fortuitous incident" during the run, which is believed to have contributed to its success.

• **Sacrificial**—In the upcoming tests here, AEC will run *Kiwi A3* to death deliberately, to provide experimental information on the behavior and limitations of materials used. Materials constitute one of the major operating problems presently, and intensive research is being carried out to improve the temperature limitations of the reactor series.

Cold flow experiments are now being conducted on the mockup of *Kiwi A* prime here, in order to check out turbo-machinery and other subsystems, rather than have a minor component cause trouble during hot runs. In these tests, gaseous hydrogen is run through the mockup system to test control instruments, diagnostic sensors and the propellant system. The mockup is identical to the hotreactor with the exception of nuclear fuels, which are absent. Cold flow tests are being conducted at Test Cell A, rather than Cell C, which will utilize liquid hydrogen.

• **Tory tests coming?**—AEC officials also indicated strong possibilities that the nuclear ramjet program, *Pluto,* will be static-tested here by November and possibly sooner. The Tory I reactor is about the size of the *Kiwi* series reactors, but no information is available regarding performance figures. A longer test period is expected for the Tory I than that held for *Kiwi A,* but again, no details were given. The Tory I will be tested in much the same way as the *Kiwi* series, with the exception of horizontal, rather than vertical, mounting on the test bed.

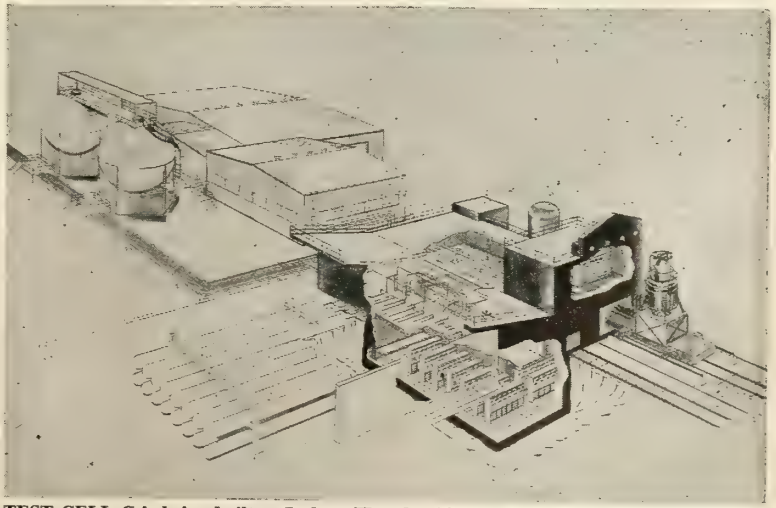
Like the *Kiwi* series, the Tory I Reactor will be completely disassembled and inspected after its firing is complete. LASL scientists here admit a general lack of knowledge about specific effects on a reactor from firing with hydrogen, especially in its liquid form. The "real step forward" cited in fuel element design may have been aimed at learning more in this area. Tests thus far have been with gaseous hydrogen. The disassembly building for Tory I is partially completed. AEC and LASL officials expressed doubt that a *Pluto*-propelled vehicle would cause greater contamination than *Rover.*

Thrust levels for all the nuclear propulsion devices were not revealed and Dr. Keith Boyer, test director for the *Rover* program, emphasized that thrust levels are not the prime objective of any of the *Kiwi* reactors. He indicated that these levels would be the objective of much later tests, and cited the most pressing present problems as: the need for fuel element and materials technology advances; the study of hydrogen on the reactor and associated systems; and engine system problems, such as operation of machinery in a radiation environment.

• **Burden of Ignorance**—Estimating a general timetable for *Rover* flight tests, Dr. Boyer was reluctant to predict any such schedule, but said his group would need "a lot of luck and some stretching of our technical capabilities as a nation to fly one before 1965. The biggest problem we face," he added, "is our own state of ignorance about what the real problems are." He indicated that money alone would not solve all the problems facing *Rover,* and even a crash program would be extremely fortunate to improve much on the 1965 minimum flight test estimate.

To date, there has been only one full-power run of the *Kiwi A* reactor, and it was stressed that nuclear reactors for propulsion do not require the frequent testing needed by chemical rocket engines. During the power run last July 1, the *Kiwi A* was operated at varying power levels for several minutes. Thrust was not measured, and temperatures reached are classified. Future tests may determine the minimum time required for attainment of full power from zero, and also the feasibility of start/stop capability of such propulsion systems.

The control rod assembly and other similar instrumentation was assembled with the *Kiwi A* prime hot reactor on May 17 here, constituting a major step in completion of the device. The control rods in this model are immersed in heavy water as an added protection. The reactor assembly is approximately 12 ft. high and 6 ft. in diameter, exclusive of control devices.



TEST CELL C is being built at Jackass Flats by Air Products, Inc., for liquid hydrogen flow tests next year. Gas will be stored in large tubes at left.

Congress Rejoins Debate Over Gap

The great Missile Gap debate revived this last week over an Administration plea in the teeth of the Summit Conference collapse that Congress cut the House-passed Defense Appropriations Bill.

Deputy Defense Secretary James Douglas asked the Senate Defense Appropriations Subcommittee to slash $1.3 billion House additions to the bill and restore $987 million of House cuts.

Douglas request included:

• Cuts of $241 million for *Polaris;* $54 million for the *Samos, Midas* and *Discoverer* satellite programs; $20.7 million for *Minuteman;* $221 million for ASW subs and surface ships: $115 million for an airborne alert; $100 million for air transports; $215 million for 50 missile-packing F-106 jet interceptors.

• Restoration of $294 million to complete 10 squadrons of *Bomarc B;* $400 million for procurement across the board; $293 million for a diesel-powered aircraft carrier.

• Acceptance of $695 million added by the House including $207 million for Army missiles and other new equipment and $100 million for ASW R&D.

The reception by Senate Leaders was icy. Chairman Richard Russell (D-Ga.) of the Armed Services Committee told Douglas U.S. strength apparently wasn't even sufficient to persuade Soviet Premier Khrushchev to "use the ordinary means of diplomacy." Stressing the need for U.S. strength, Russell said: "I'm afraid that we didn't have it in Paris."

Senate Democratic Leader Lyndon Johnson (D-Tex.) noted caustically on the Senate floor that defense budget outlined by Douglas is just "$500,000 or one thousandth of one per cent below the original budget request."

"The inference is clear," he said. "Once a budget amount is set no one in the Executive Branch is permitted to present military needs that may call for budget increases. The whole world situation may be changed by the Summit Conference and the events of the next few weeks, but the preparedness program must be held to a magic ceiling established by the budget director."

• **Raised eyebrows**—Besides Douglas' call for cuts, the item in his request that raised most congressional eyebrows was the Boeing *Bomarc B.*

The House Appropriations Committee had had little good to say for the missile and had eliminated all funds for it not already firmly committed. It chose to buy more jet interceptors, instead.

Douglas warned that the elimination of *Bomarc B* funding will leave a serious gap in U.S. air defenses. He said the new jet interceptors could not be deployed until a year after the date scheduled for deployment of *Bomarc B.*

His testimony was backed by recent successes in *Bomarc B* tests. A *Bomarc B* soared 270 miles over the Gulf of Mexico 24 hours before Douglas testified. Another of the 400-mile-range missiles was successfully launched last month.

The launchings brought the revised Air Force test score for *Bomarc B* to seven partial successes, two successes and one failure. Five of six *Bomarc A's* fired this month in training exercises scored hits on drones over the Gulf.

AF Cutting Basic Research

Unless there is a quick reversal in policy, the Air Force will begin de-emphasizing its contractual basic research programs early this summer. Personnel and money will be shifted into directed research.

Word of the forthcoming move already has touched off a rumble of discontent among highly-placed civil service scientists. Universities and companies involved in basic research can expect a crimp in funding if the change goes into effect.

Red Astronaut Launch Hinted

Four days after Russia launched a 9988-lb. "space ship" into a nominal 200-mile orbit last week, a top U.S. space scientist conceded the Soviets were "ready for a manned shot."

There was speculation that the new *Sputnik IV* launched May 15 actually held one or more live astronauts rather than a "dummy spaceman" as claimed by the Russians.

Rather than minimizing the latest Soviet shot, as some scientists did immediately after it was launched, ARDC's Brig. Gen. Don Fleckinger said the large space vehicle actually was engineered to solve many re-entry problems.

Fleckinger, who is assistant for bio-astrophysics at ARDC headquarters, said the Russians have the capability to put more than one astronaut aloft. The Russians said the "space ship" included a 5510-lb. pressurized cabin containing a dummy spaceman, instrumentation weighing 3249 lbs. and power supply sources.

Fleckinger said the pressurized cabin inside an outer shell afforded these advantages:

• The cabin with its great amount of instrumentation gives greater reliability in case of deviation from the scheduled flight path.

• During re-entry the heat is contained in the outer shell and when the cabin is ejected it relieves itself of the heat stored in the outer shell. This improves chances of survival.

•There is protection against misalignment of thrust and stabilization which might push the space ship into an eccentric orbit into the Van Allen belts, since the outer shell would receive the radiation exposure. The inner cabin could be ejected from a safer altitude.

Purpose of the launch, according to the Soviet statement, was to "perfect and check the satellite ship's system, insuring its safe flight and controls, its return to the earth and the necessary conditions for the space crew."

"In this case," the Soviet statement said, "it is not planned to retrieve the pressurized cabin, which after due checking of its reliability in operation and separation from the space ship, will as the space ship itself, begin descending on command from the earth, and burn up in the denser layers of the atmosphere."

The launching of *Sputnik IV* also coincided with the beginning of the ill-fated Summit Conference in Paris, and with the second anniversary of the launching of *Sputnik III,* which disintegrated in the atmosphere April 4. *Sputnik III* had held the weight record for an earth satellite, 2925 lbs.

Many leading U.S. scientists were wary of the Soviet announcement that the space vehicle's cargo was a "dummy." Pointing out that it would be illogical to command a vehicle by retro-rockets to burn up in the atmosphere, these scientists theorized that the Soviets may have actually put a man in space but did not intend to announce this fact unless they brought him back alive.

Expansion at Radiation



RADIATION, INC. recently dedicated a $1,450,000 electronics facility at Melbourne, Fla., including this administration building and national headquarters. The headquarters contains 42,900 square feet of floor space. Three "engineering modules," each containing 22,000 square feet of work space, are located adjacent to the headquarters. Construction is first phase of a multimillion-dollar building program to meet expanding needs of the rapidly growing firm.

Missiles Now Develop Faster Than Aircraft

Development time for missile systems has turned out to be less than for aircraft, William B. Bergen, Martin Co. president, declared last week.

Bergen and three other top industry leaders spoke at a luncheon meeting of the Aviation/Space Writers Association in Washington. In other talks:

• Dan Kimball, Aerojet-General president, reported that missile propulsion systems are steadily becoming more reliable. As an example, he cited a recent test of a *Titan* first stage powerplant at Aerojet's Sacramento plant, in which it ran for 27 times the regular burning time without failure. That would be about 54 minutes.

• Buford M. Brown, Westinghouse vice president, predicted that the military electronics market—now $4.7 billion a year—will double in the next decade.

Brown urged missile electronics contractors to hire more mechanical engineers. He said more trouble in electronic systems has come from simple mechanical problems such as vibration and mounting than from the electronic equipment itself.

• Thomas V. Jones, Northrop president, declared that the news of the last two weeks has demonstrated that airframe manufacturing is not dead. However, Jones said the airframe industry must regard itself as an advanced technology industry. In World War II, he said, the airplane represented the most advanced form of technology. Today, there are many other examples.

Bergen reported that the shift from aircraft to missile manufacturing entails more changes in business methods than is generally believed. He gave these examples of differences between the two industries:

For physical facilities, the chief asset of an aircraft company is a plant with a high bay area. In the missile business, an important asset is an area of many square miles of barren desert.

"There were relatively a few companies in the aircraft business," Bergen said, "and we knew everyone in it. But it seems that everyone in the United States is in the missile business to one degree or another."

The missile business, he continued, has a heavier emphasis on science and engineering and less on production. Numbers are no longer as important as quality.

Bergen said he could not see why anyone should be excited about the flying of a reconnaissance airplane over Russia when, either now or very soon, the Russians will be able to obtain equally good photographs from the very large satellites they are able to launch.

financial news

Borg-Warner—Sales totaled $162 million, up 8% from 1959. Profits rose to $8.3 million, up from $7.8 million in the first quarter last year.

Thompson Ramo-Wooldridge—First quarter sales rose to $111.6 million from $92.2 million in the first quarter last year. Sales in electronics, missile and space fields rose about 50% from a year ago.

mergers & expansions

LING-TEMCO ELECTRONICS INC.'s president will be James J. Ling chairman and chief executive officer of Ling-Altec Electronics Inc., instead of Clyde Skeen (M/R, May 2, pg. 18). The switch in leadership of the proposed new company is said to stem from unrest among Ling-Altec stockholders over the earlier arrangement. Ling-Temco will be formed by a merger between Ling-Altec and Temco Aircraft Corp. Skeen, executive vice president of Temco, had originally been picked as head of the new company. Under new arrangements, he will become executive vice president.

AVIEN, INC., Woodside, N.Y. has purchased Colvin Laboratories, Inc. and Pressure Elements, Inc., both located in East Orange, New Jersey. Colvin manufactures electro mechanical instrumentation with applications to missiles and undersea devices. Pressure Elements produces pressure capsules for transducers.

LOCKHEED ELECTRONICS has bought Waldale Research Co., Inc., Pasadena. Waldale is a developer and manufacturer of load cells, strain gauges, position transducers and force gauges primarily for aircraft and missile applications.

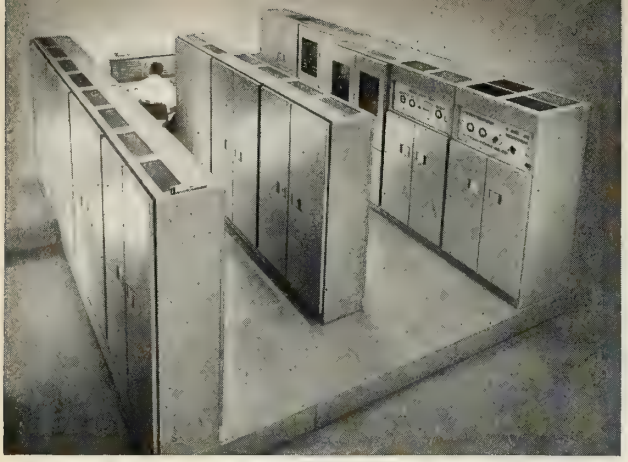
UNITED TESTING LABORATORIES is expanding its testing facilities by 7000 sq. ft. The new section will contain specialized temperature controlled areas and will be largely devoted to proving out electronic components for *Polaris, Titan* and *Atlas* programs.

INTERNATIONAL ELECTRONIC RESEARCH CORPORATION has opened a new 30,000 sq. ft. facility in Burbank, Calif. The company manufactures dissipating shields for electron tubes, electronic instrumentation and does precision machine work for the missile industry

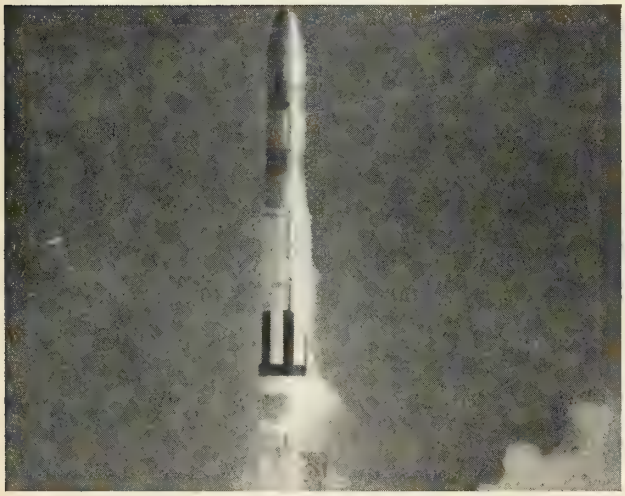
LEACH CORPORATION has created an international subsidiary, Leach International, S.A., keyed to expanding European and world markets. The new subsidiary will start immediately to market company products in the European common market. It also plans to manufacture abroad.

AMERICAN BOSCH ARMA has reorganized its commercial and military sales into two separate activities.

JAEGER-CORDRAY INC. manufacturers' representatives in Orlando, Fla. is now representing such companies as General Bronze and Stromberg-Carlson, San Diego. President of the new company is Jack M. Cordray, formerly with Martin-Baltimore and Martin-Orlando.



Building the Athena called for the development of new and rigorous quality control techniques to insure the reliability of its more than 100,000 components and 120,000 selectively soldered joints. All components were classified by Univac data processing equipment, which also kept permanent records of their performance.



Athena is the ground based guidance computer for the USAF Titan ICBM. The Athena continually computes the speed, elevation, direction, azimuth, and position of the Titan and compares this information with data stored in its magnetic memory. Responding to commands issued by the computer, the missile maintains a course which will put it on target.

From the REMINGTON RAND UNIVAC

Military Division

Ultra-Reliable Athena Computer Guides ICBM Titan to Target 5,000 Miles Away

Recently an ICBM Titan missile was fired from Cape Canaveral by the USAF Ballistic Missile Division. The accuracy of the ground-based guidance system was such that technicians were able to quickly recover a data capsule within a target area 5,000 miles away.

This same system made possible the highly successful launching of TIROS I, America's television-equipped weather-eye satellite. The Athena computer, guiding a three-stage Thor-Able type missile, put TIROS I into the most nearly perfect circular orbit of any satellite, Russian or American, yet launched.

The Athena Digital Guidance computer was designed and produced by Remington Rand Univac to meet unprecedented reliability requirements. Several Athena computers have since been delivered and have logged thousands of operating hours. All have exceeded a reliability rating of 99.992 per cent, a record considered as a major breakthrough in the computer art.

The Athena is now a proud addition to the distinguished series of defense systems developed by the Military Division. In exceeding the contract specifications for reliability and delivering the computer ahead of schedule, the Athena program once more demonstrated the outstanding military capabilities of Remington Rand Univac.

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Control and data systems developed by the Remington Rand Univac Military Division include:

ATHENA, the Ground Guidance Computer for the U.S. Air Force ICBM TITAN.

TACS AN/TSQ-13 (Tactical Air Control System for the U. S. Air Force)

BOMARC Computer for the U. S. Air Force Target Intercept Program

SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.

Technical Countdown

ADVANCED MATERIALS

Strength at Hi-Temp Claimed

Unbelievable strength at temperatures close to the melting point may result from reinforcing metal matrices with ceramic fiber. Horizons Inc. is experimenting with the technique with an eye toward possible nozzle and nose cone applications. Early work was done with 80Ni-20Cr alloy reinforced with Al_2O_3 in sapphire or corundum single crystal form. Technique will be tried with other combinations.

Explosive Forming Studied

Under a contract with the Army's Watertown Arsenal, Ryan Aeronautical will test its explosive forming technique on aluminum, titanium and steel alloys in complex shapes applicable to missile use. Ryan will sink three new explosive forming pits in an uninhabited San Diego canyon area.

Steel Prices Cut

A new round of price cuts has pared an average of 13% from the cost of the specialty steels most widely used in missiles. Ladish D6 went from 85¢ to 74¢/lb. Crucible Steel, the producer, said it was the fourth cut for the one-time die steel, since it was introduced eight months ago at $1.13/lb. Universal-Cyclops cut about 13% from its high-strength low-alloy steels. Allegheny-Ludlum started the round of reductions with a new price list May 2; others followed last week. The cuts may pare as much as $200 from the raw material cost of each *Minuteman*.

NASA Buys Electron Furnace

NASA has bought an electron beam melting furnace for research in Tungsten at its Lewis Research Center in Cleveland. Stauffer Temescal will install the furnace, which will cast ingots 30 in. long and up to 6 in. in diameter.

GROUND SUPPORT EQUIPMENT

Umbilical Cords Protected

An Air Force captain was awarded $40 for a suggestion that missile umbilical cords be covered with flame-resistant materials to protect them from the heat of blastoff. Savings: $200,000.

Oil Rigs Serve as Gantries

The Army is using modified oil-drilling rigs for *Jupiter* launch equipment—with savings claimed in the millions. The gantries were originally modified for use with *Atlas* but were found unsuitable. They have also been used for servicing *Redstone, Jupiter-C* and *Juno II*.

Minuteman Blockhouse Designed

Lockheed Electronics Co. has designed the instrumentation for the *Minuteman* blockhouse and silo under a contract with AFBMD and the Flight Test Center at Edwards AFB. First phase of the program was completed in less than three months.

Rapid Data System Developed

Laboratory for Electronics has developed a high-speed data storage and display system that gives fractional-second access to a capacity of some 55 million alphanumeric characters stored on high-density magnetic file drums. The RASTAD system, which has a read/write bit rate varying from 90 to 400 kc, is for an undisclosed military application.

PROPULSION

AP Plant to Get Surplus Tag

The Navy wants to declare as surplus its ammonium perchlorate plant in Henderson, Nev., now operated by American Potash. Now that several producers are in the field, the Navy feels the industry no longer needs government help. The 18,000-ton-per-year plant would be sold to American Potash. Other AP producers—HEF (owned jointly by Hooker and Foote Mineral), Pennsalt and Pacific Engineering—are watching nervously.

H-E Solid Research Continues

Minnesota Mining & Manufacturing will continue its research into high-energy solid propellants through the end of 1960 at least. Bureau of Naval Weapons administers the contract, one of the first four granted under ARPA's Project *Principia* in 1958. The renewal totals more than $1.5 million.

Minuteman Production Plans Jell

Minuteman first stage will go into production in the summer of 1961. Bulldozers began clearing land earlier this month for the Thiokol production plant at Ogden, Utah.

ELECTRONICS

Solid Circuitry Lag Seen

Despite the ballyhoo about solid circuitry, there is a lead time of at least five years between present laboratory subsystems and large-scale use in complete circuitry, says Dr. Harper Q. North, Pacific Semiconductors' president. Today's proven microminiature semiconductor devices—such as PSI's Micro-Diodes—will fill the gap for some time to come, he told M/R. By 1961, he said, Micro-Diodes will compete in price with standard diodes.

Radar Overload Seen

Flyingdale site for BMEWS will be the most overworked in system. Radars will have to perform for two masters, detection and tracking. Many feel it won't be able to do both well.

ASW ENGINEERING

Mock Naval War Center Planned

Minneapolis-Honeywell's Ordnance Division will develop a $3.6-million nuclear submarine training center that will electronically simulate full-scale undersea battles. The trainer will occupy an entire wing of a three-story building at the Navy's New London, Conn., Submarine School. The heart of the center will be a Honeywell 800 digital data processing system.

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ANNOUNCING A NEW CORPORATE NAME

for The Garlock Packing Company

Garlock Inc. becomes the new name for The Garlock Packing Company, Palmyra, N. Y., to reflect more accurately its broad diversification of products and markets.

Originally established to manufacture mechanical packings, Garlock now produces over 2,000 different styles of packings, gaskets, seals, molded and extruded rubber and plastic products for every major industry.

The new corporate name, Garlock Inc., more closely identifies this 73-year-old company with the growth and development of its product lines. *Today, industry goes to Garlock for such widely diversified products as:*

- Hydraulic-Pneumatic Packings
- Oil and Grease Seals
- Gasketing and Expansion Joints
- Braided Packings
- Molded and Extruded Rubber Parts
- Plastic Stock Shapes and Fabricated Parts
- Mechanical Seals for Rotating Shafts
- Metal Packings
- Leather Packings
- Electronic Components
- Dry Bearing Materials
- Fluorocarbon Tank Linings
- Missile and Rocket Components

To help you in selecting or applying these products, Garlock offers the services of over 126 thoroughly-trained sales engineers, 175 electronic component manufacturers' representatives, 180 authorized bearing distributors and 69 foreign distributors. Conveniently located warehouses and stocking points assure Garlock customers of prompt delivery.

At Garlock Inc., design and development of new or improved products and materials is an ever-present objective. To this end Garlock maintains extensive research and laboratory-test facilities. In addition, Garlock engineers and chemists are always ready to work with you in seeking solutions to tough application problems.

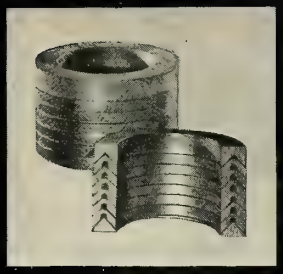
GARLOCK

To find out more about "the new Garlock," call the nearest of our 26 sales offices, or write to Garlock Inc., Palmyra, N. Y. *To assure prompt attention,* please refer to *Garlock Inc.* on all future correspondence and orders.

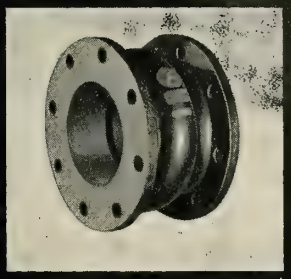
Canadian Div.: Garlock of Canada Ltd.

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

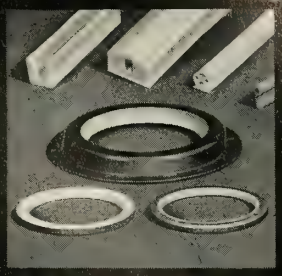
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Hydraulic-Pneumatic Packings



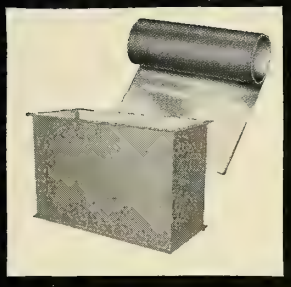
Expansion Joints



Molded and Extruded Rubber Parts



Plastic Stock Shapes
and Fabricated Parts



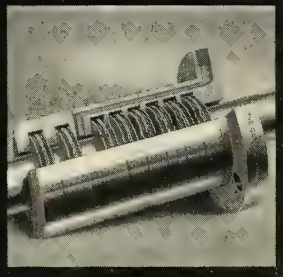
Fluorocarbon Tank Linings



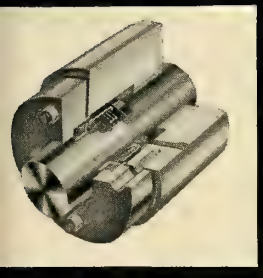
Oil and Grease Seals



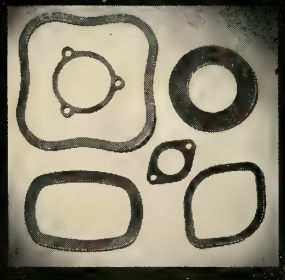
Braided Packings



Metal Packings



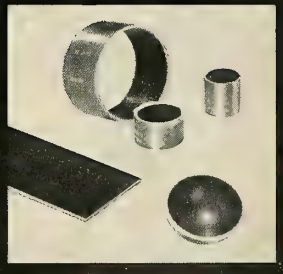
Mechanical Shaft Seals



Gasketing

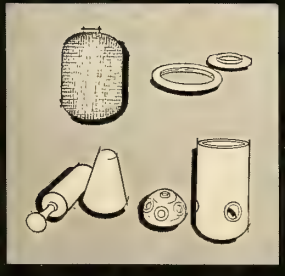


Spiral Wound Gaskets



Dry Bearing Material

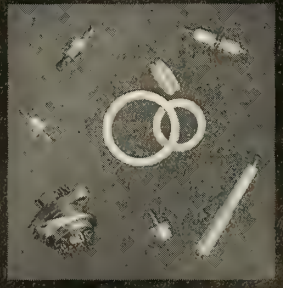
I N C .



Missile and Rocket Components



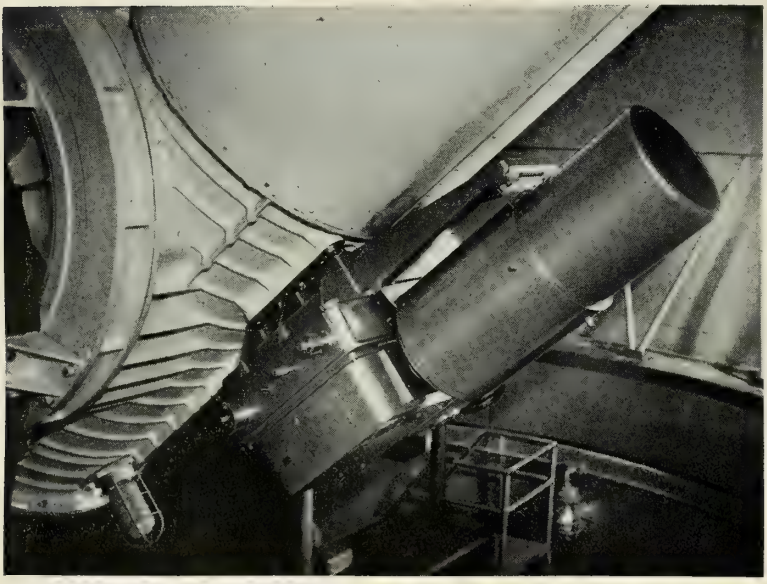
Leather Packings



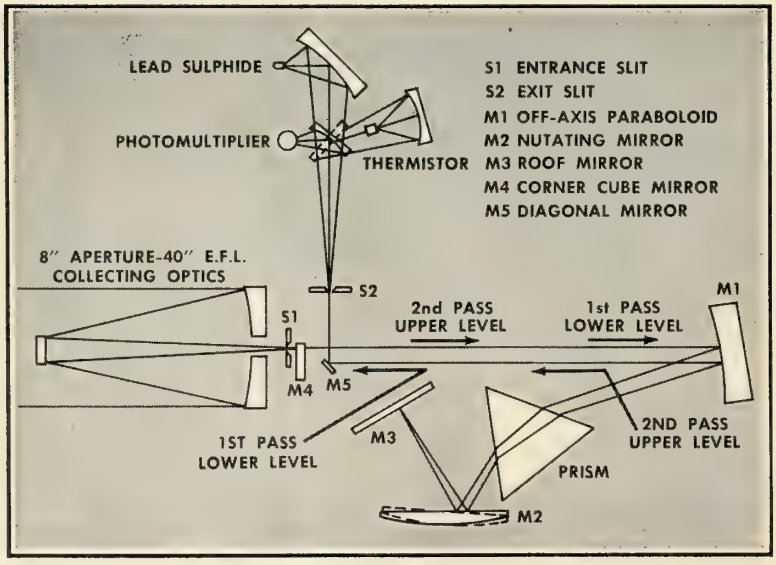
Electronic Components

IR Identifies Missiles by Plumes

Perkin-Elmer work south of Cape, highly classified previously, may lead to a major stride in detection-identification



COLLECTING OPTICS for the rapid-scan unit are contained in this 3-ft. tube mounted under the ROTI missile tracker. An 8-in. aperture and 40-in. effective focal length are employed. IR measurements are correlated with the ROTI photographic record.



FUNCTIONAL DIAGRAM of the collecting optics and monochromatic scanning system used in the IR rapid scan instrument.

by Charles D. LaFond

A major advance in missile detection and identification may be just over the horizon. It is now confirmed (see M/R, May 2, p. 21) that Perkin-Elmer Corp., Norwalk, Conn., is making infrared studies of missile-exhaust plume characteristics at the Air Force Missile Test Center, Cape Canaveral.

Through these spectrometric measurements during powered flight, missile performance data is being accumulated for use in identifying each bird by its exhaust-plume "signature."

IR measurement techniques for missile plumes, midcourse projectiles, and re-entry vehicles are still in their infancy. Nevertheless, results already indicate data will be very useful for missile detection, advanced IR homing systems for *Zeus*-type anti-missile missiles, development of decoy tactics, satellite tracking and detection and even nose cone improvements.

Technical details of the project have been highly classified until now, but Perkin-Elmer has just been able to release some of them.

The company is using its 8-in. "Rapid Scan"' IR system in conjunction with AFMTC's recording optical tracking instrument, ROTI Mark II. The tracking installation is at Melbourne Beach, about 30 miles south of the launching area at Cape Canaveral.

ROTI photographically records missile flights at great distances, and the data are used for correlation with the infrared measurements.

The study, being performed under an AF Cambridge Research Center contract, is another phase of the Interservice Radiation Measurement Program (IRMP 59/60), sponsored by the Advanced Research Projects Agency.

The Perkin-Elmer rapid scan equipment is used during all IRMP measurement periods. IRMP data for this and other ground and airbrone sources and channelled to the University of Michigan for classification and central filing.

• **Infrared recording**—Heart of P-E's IR system is the device called a rapid-scan monochromator. This unit records IR radiation intensity over a

particular waveband. Recording is continuous.

Wavelength range of the monochromator is from 0.3 to 3.6 microns; scanning frequencies are between 2.5 and 180 cps.

Collection optics in the modified ROTI Mark II system include a 40-in. effective focal length Cassegrainian telescope with an 8-in. clear aperture.

• **Scanning system**—The monochromator scanning system is composed basically of a plane mirror spinning about an axial shaft. Because the mirror surface is not perpendicular to the shaft, a scanning motion is achieved. Incident light is reflected from the mirror in a conical pattern.

The nutating mirror system thus functions as a Lithow mirror, except that reflected light components move in two directions—parallel and perpendicular to the dispersion plane.

To translate the rotary light motion into lateral motion, parallel to the dispersion plane, a "roof" mirror is employed. A light beam is reflected from the roof mirror whose edge is parallel to the dispersion or horizontal plane. It therefore serves as a plane mirror for light motion in the horizontal plane and eliminates vertical plane light motion by directing the light back on itself.

Wavelength scan interval is determined by the nutating-mirror tilt angle; wavelength scan midpoint is controlled by the roof-mirror tilt; instantaneous wavelength is a function of both angles.

In describing its system, P-E said that only rotational movement of elements is used. All forms of mechanical reciprocating motion were avoided in the design configuration. Scan frequency is not limited by mechanical resonance and dynamic balance is maintained constantly, regardless of tilt angle.

Because of this, said P-E, the scanning mechanism is capable of high frequencies and large wavelength intervals without noise and vibration.

• **Earlier work**—Actually, first work on this program started with a 50-day trial operation, following development and installation of the rapid scan system under a 1957 Air Force contract.

Results of the data reduction led to a one-year contract in July, 1959, for operation and data reduction of the system. (P-E also is training Radio Corporation of America personnel operating the AFMTC range in system use and maintenance.)

A new and larger rapid-scan unit will soon be used with a modified mobile ROTI Mark II facility. A 16-in. aperture is used and simultaneous radiometric and spectrometric measurements can be made.

THE GRAND CENTRAL REPORT

"NITRASOL" GOES INTO PRODUCTION

Performance and Safety Proven

Scientists at Grand Central Rocket Co. have enormously widened the margin of advantage of the solid propellant over liquid, in *practical* application, with development of a new high-energy nitrocellulose - aluminum perchlorate solid propellant named Nitrasol—now in pilot production at GCR.

In March a completely case-bonded, cast-in-place missile motor of Nitrasol was temperature-cycled repeatedly from minus 75°F to plus 165°F and then successfully fired at minus 68°F. Such motors have excellent storage characteristics. They can be stored for extensive periods, then fired at an instant's notice.

These qualifications adequately fulfill the conditions of environmental storing, handling and tactical deployment which the military services would ideally hope to specify but which until now have not been realized in any high-energy propellant.

High production rates in a low cost facility make Nitrasol even more attractive. The four ingredients are easily and safely combined; organic nitrate plasticizer-stabilizer solution, fine-particle nitrocellulose, ammonium perchlorate and aluminum particles.

The feasibility of mixing Nitrasol in GCR's Redlands plant and transporting it to any location in the U.S. for subsequent casting in large-volume solid motors is yet another possibility of Nitrasol—perhaps the most promising propellant in existence today.

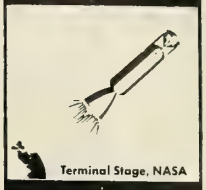
Positions open for chemists, engineers and solid rocket production specialists.

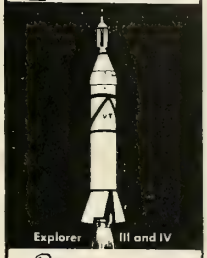
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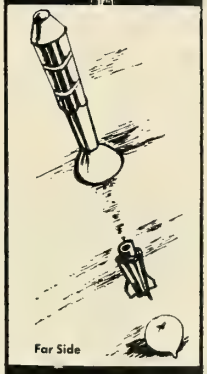
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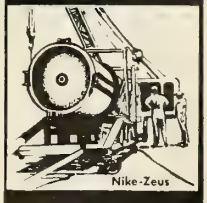

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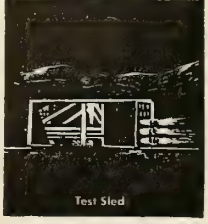

Terminal Stage, NASA


Explorer III and IV


For Side


Vanguard


Nike-Zeus


Test Sled

Saturn Successor—Moon Roundtripper

NASA vehicle chief reports Nova remains top prospect, but nuclear upper-stage studies are being pushed

The vehicle to follow *Saturn* will have the mission of landing a manned 10,000-lb. spacecraft on the moon, reentering through the earth's atmosphere and landing safely.

This was disclosed by Maj. Gen. Don R. Ostrander, director of launch vehicles for the National Aeronautics and Space Administration, at the American Rocket Society Semi-Annual Meeting in Los Angeles last week.

Although *Nova* is still the leading possibility for the vehicle to follow *Saturn*, Ostrander said, the concept "is beginning to face increasing competition from vehicle studies with nuclear upper-stage rockets." For this reason, Ostrander continued, the Project *Rover* nuclear rocket is being accelerated, with the aim of an orbital flight test of a prototype by 1965, atop *Saturn* as a launch vehicle.

Ostrander's statement indicated support of the position of Harold B. Finger, NASA chief of nuclear engines, in the dispute over how the first *Rover* flight should be conducted. Finger favors first flight from orbit; Col. Jack L. Armstrong of the Atomic Energy Commission prefers a ground launching for the first test. However, Ostrander's statement did not rule out a ground-launched flight test in advance of the 1965 orbital flight.

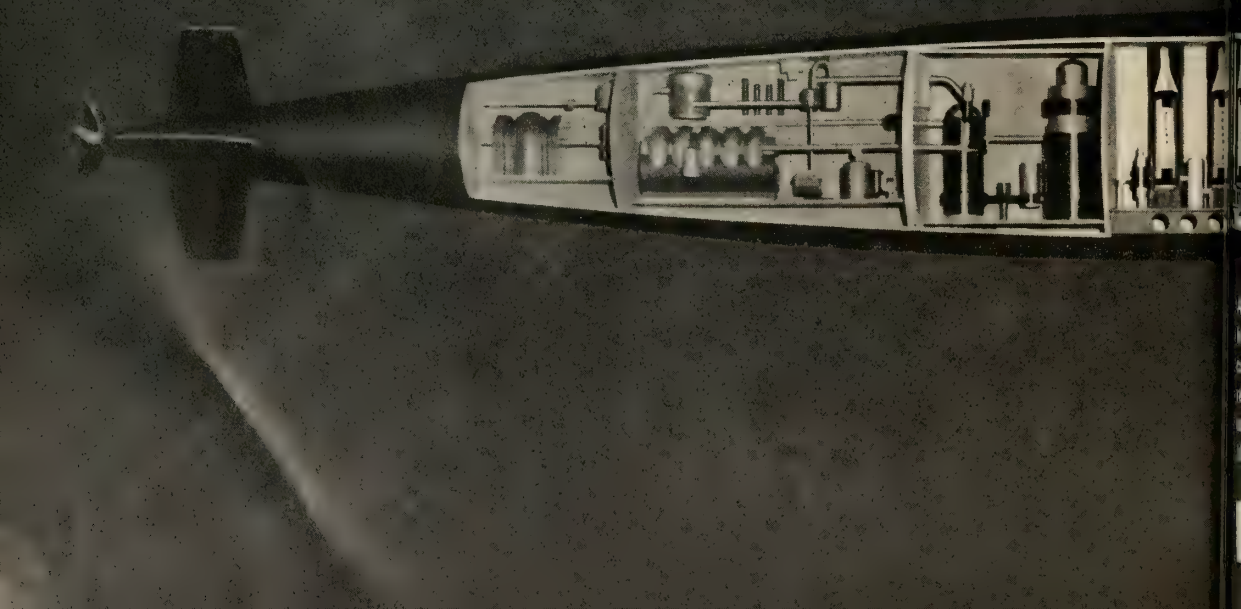
NASA expects to contract with an industry group for a detailed study of all the factors involved in the test program question. A bidders' conference on the contract was held early this month. The study is expected to take about a year.

• **Permutations**—Ostrander emphasized that the *Nova* vehicle configuration has not yet been established. Several concepts based on the Rocketdyne 1½-million-lb.-thrust single-chamber engine are under consideration, he said. As one example, he mentioned the "brute force" approach of clustering six F-1's to produce nine million lbs. of thrust. "Four hydrogen-oxygen stages could be piled on top of this to give us the 10,000-lb. lunar return package that we need," he remarked.

Also known to be under consideration is a central F-1 surrounded by a circle of smaller H-1 engines, which might generate up to three million lbs. of thrust and be developed sooner. Other combinations of F-1 and H-1 engines obviously are possible.

On the other hand, Ostrander declared, the encouraging results from the *Kiwi-A* last summer "have stimulated our hopes that the large increase

Undersea launch pad for sixteen Polari



in efficiency which we get from using one or more nuclear upper stages, with weights less than one-third that of the *Nova* for the same mission capability, can be acquired by the time our program has reached the point where we need something beyond *Saturn*."

• **According to plan**—As for *Saturn* itself, Ostrander declared that the second stage of the second *C-2* model will be a cluster of four 200,000-lb.-thrust hydrogen-oxygen engines. Apparently, NASA plans to stick with its original plan on the *C-2* stage. There had been some talk in recent weeks that the stage would consist of only two 200K engines.

Ostrander raised doubt whether the 2x200K stage would ever be built. He mentioned previously announced plans to use such a stage in the third model of *Saturn*—designated *C-3*—"if we decide to build it."

Centaur, the first vehicle to utilize a hydrogen upper stage, will be launched late in 1961, Ostrander declared. Atop an *Atlas*, *Centaur* will be able to put a payload of almost 8000 lbs. in low orbit, about 50% more than the *Atlas* with *Agena-B*, an upper stage of comparable size with more conventional propellants.

Centaur will have three times as much payload as *Atlas-Agena B* when used as a lunar probe, "which is one of its principal missions in the NASA program. For the first time, in *Centaur*, the U.S. has a launch vehicle able to duplicate the payload capability of the *Sputnik* vehicle."

Apparently, the U.S. will be able to duplicate *Sputnik's* lifting power just about four years after *Sputnik I*.

Ostrander recalled that *Centaur* is of prime interest to the Department of Defense as well as NASA, since the *Centaur* performance objectives stemmed originally from DOD requirements for a 24-hour communications satellite. NASA is interested especially because the *Centaur*, slightly modified, becomes the final stage of *Saturn*.

Vehicle Schedule

Vehicle	Time in use	Payload (300-mi. orbit)
Jupiter-C	1958	25 lbs.
Vanguard	1958-59	25 lbs.
Juno II	1959-60	100 lbs.
Thor-Able	1958-60	200 lbs.
Thor-Delta	1960-62	480 lbs.
Scout	1960-69	200 lbs.
Thor Agena B	1961-69	1250 lbs.
Atlas Agena B	1961-66	5300 lbs.
Atlas-Centaur	1961-69	8000 lbs.
Saturn C-1	1963-?	22,000 lbs.
Saturn C-2	1966-?	45,000 lbs.
Saturn-nuclear	?	72,000 lbs.
Nova (9,000,000-lb.-thrust version)	1968-?	150,000 lbs.

'Blasts' in Lab

High-altitude Nuclear Shots Simulated by AF

High-altitude nuclear detonations have moved into the laboratory at Kirtland Air Force Base, N.M.

Certain aspects of such detonations can be studied by "dumping" electrical energy into test material specimens at the ARDC facility. Four low inductance condensors store as much as 16,000 joules of electrical energy at 125,000 volts. The chamber can be evacuated to simulate various altitudes.

One minute is required to charge the condensers which can then discharge in about one half a microsecond. Peak power during this instant of time is estimated to reach 10 billion watts. High-speed cameras, a Kerr cell camera and a streak camera record certain phenomena which the Air Force can correlate with high-altitude weapon detonations.

Spectral measurements of the test material and the heated air in the vicinity are made by an optically fast spectrograph. The $250,000 facility was constructed by Edgerton, Germeshausen and Grier, Inc., Boston, Mass.

issiles



A U. S. Navy Polaris submarine is a self-sufficient missile base. It provides comfortable quarters for its hundred-man crew and carries supplies for several months. In its launching tubes—eight on each side, as shown in this cutaway model—will nest 16 Polaris missiles. But a Polaris sub differs from all other missile bases in one important respect: it can disappear from the face of the earth for weeks at a time. Though its position in ocean depths will be unknown, its presence will be felt. For—should America ever be attacked—each Polaris sub could launch its 16 Polaris missiles in as many minutes. Lockheed is prime contractor and system manager for the Polaris missile.

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Avco Reports Promising Two-day Test of Arc-Jet

WILMINGTON, MASS.—A 30-kw arc-jet engine, developing enough thrust to keep a communication satellite on station or to shift orbital altitude, has just undergone a 47-hour test at Avco's Research and Advanced Development Division.

The experimental space engine—about the size of a quart bottle—operated in a near vacuum using helium as a working fluid. It produced nearly ¾ lb. of thrust at specific impulse of 1000 sec. Total velocity increase for a 1000-lb. orbiting space vehicle was calculated to be about 4000 ft./sec.

According to James R. Kerr, president of Avco RAD, "the results of this test indicate that a reliable long-duration, one-pound-thrust, thermal arc engine can be made, and soon."

A complete propulsion system would consist of the engine, an electric power supply, and a tank of liquid hydrogen. A propulsion system of this sort lifted into satellite orbit by chemical rockets has a variety of possible applications in the exploration of space.

Thrust and acceleration of the arc-jet engine is small. They may operate continuously for hours or days, however, to provide a continuous force on a satellite that would result in steady acceleration and eventual very high speeds. Operation for short periods of time would be sufficient to make corrective changes in the attitude or position of communication satellites. Hundreds of hours' operation might carry the satellite from a low-altitude earth orbit into an orbit around the moon in constantly expanding spiral.

The recent 47-hour test is part of an Avco program to explore problems of a long-duration run, such as electrode erosion and cooling of the nozzle in a space environment. Reliability of components and simplicity of the system are the primary goals.

Say 3-Man Space Station Can Be Built in 6 Years

A space station manned by three men could be placed in orbit in six years at a total cost of $900 million, according to studies by two Chance Vought engineers.

Robert H. Lundberg and Tom E. Dolan last week outlined a program for orbiting a 4340-lb. satellite laboratory coupled with a 5750-lb. re-entry vehicle for the return trip to earth. The station would carry 673 lbs. of test payload and 583 lbs. of provisions, in addition to the three men. Two arrays of solar cells would provide 5.5 kilowatts of electrical power.

The two said the plan could be carried out within a balanced national budget. The cost would not be more than $300 million in any one year.

They named the space station "Satellab." Both Satellab and re-entry vehicle would be propelled by a *Saturn* launch vehicle into a 300-mile orbit. The re-entry vehicle would return to earth after the crew had completed the work of setting up an automatic station. For a subsequent manned mission, the crew would be sent up in an entry vehicle to rendezvous with the Satellab.

Lundberg and Dolan said the preparations leading to the first mission would require six *Atlas* boosters for sub-orbital qualification of the re-entry vehicle and pilot training, 11 *Atlas-Centaur* vehicles for orbital qualification of the entry vehicle and Satellab as separate elements and four *Saturns* for testing and launching the entire assembly. Altogether, 17 entry vehicles and nine Satellabs would be needed for the entire program, they said.

Nearly three-fourths of the overall expenditure would be in non-recurring costs, Lundberg and Dolan said.

Small Arms Fire Fails To Detonate Propellant

Nitrasol propellant will not detonate when struck by small arms fire, Grand Central Rocket Co. reported last week.

The company reported this conclusion from a series of gun-fire and concussion tests. Armor-piercing and soft-nosed bullets were fired into about 4 lbs. of uncontained propellant. Then the projectiles were fired into Nitrasol in a steel container. No detonation took place in any of the cases, the company said.

"These sensitivity and concussion tests assure that for the first time a high-energy propellant may be used by military troops with the same degree of safety as they now have with conventional explosives and ammunition," said G. R. Makepeace, GCR vice president for research and engineering. "Tactical missiles of the *Redeye* and *Mauler* type, *ICBM's* and very large solid propellant boosters loaded with Nitrasol may be employed safely by field commands."

Electronic Control Seen For Continuous Mixing

Rocketdyne is studying the possible tie-in of its Quickmix continuous solid-propellant processing system and electronic data equipment.

R. S. Dobyns, general supervisor of operations and methods at Rocketdyne's McGregor, Tex., plant, reported this last week at the 11th annual conference of the American Institute of Industrial Engineers in Dallas. He said such a system would offer completely automated control of processing and make possible improvements in uniformity.

NASA's

2nd, 3rd, 4th generation space rockets

To go vastly greater distances . . . to send heavier payloads . . . NASA scientists and engineers are working on the Centaur, Saturn and the Nova type vehicle. As the curve of scientific progress approaches the vertical, these advanced rocket boosters may bring significant breakthroughs in space exploration.

CENTAUR—the first rocket booster to be fueled with liquid hydrogen—will enable NASA scientists and engineers to put four-ton payloads into 300-mile orbits around the earth.

SATURN—initiated by Defense Department and now transferred to NASA, the 1.5 million pound thrust booster will place 15-ton payloads in orbit. Such a payload could be a manned space observatory.

NOVA TYPE—a cluster of single chamber 1.5 million pound thrust engines now being developed to launch multi-ton space stations or to send manned expeditions to the moon.

Scientists and Engineers:

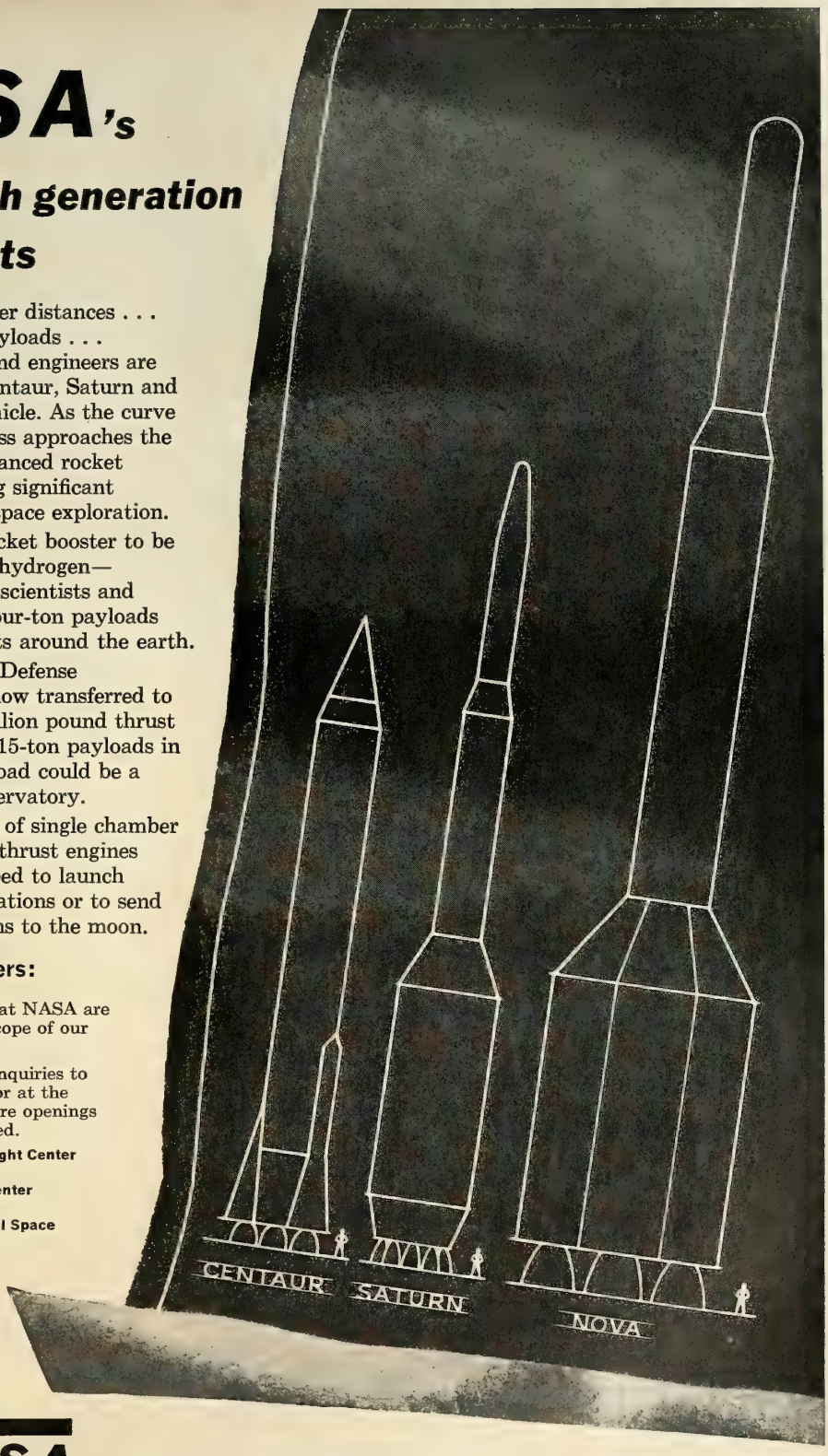
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Space Stations May be Made of Spheres

by John F. Judge

PHILADELPHIA—Space stations may well be constructed from a series of intersecting spheres rather than the cylindrical doughnut configurations being advanced today.

Norris F. Dow, structural specialist at General Electric's Missile and Space Vehicle Department, says that from the standpoint of weight savings and structural efficiency, spheres or a series of them are the logical components of a space station.

Dow says the main design considerations are: internal pressure, meteoroid impacts, explosive decompression and radiation shielding.

If, as has been indicated, rocket fuel tanks double as space cabins, pressure vessel design may be the most important single structural aspect. Using the fact that the ratio of weight of a pressure vessel to the enclosed volume is a constant, for given stress and pressure levels and for geometrically similar vessels, Dow says that the weight of wall material to enclose a given volume at a given pressure in one sphere, or a multiplicity of spheres, is the same.

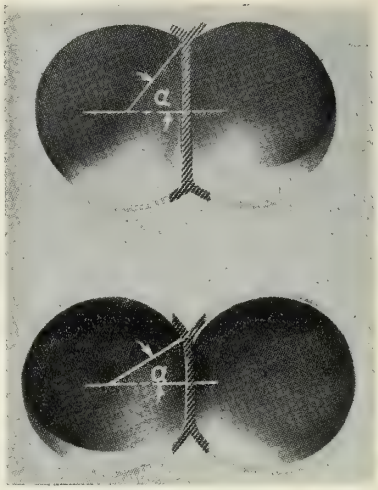
It has been shown that the weight of a long, thin-walled cylinder approaches 1.33 times that of the sphere as the length approaches infinity. Dow points out that the potential efficiency of intersecting spheres may be as much as 1.33 times that of a cylinder.

• **How to exploit**—To take advantage of the possible weight saving in spheres, the weight of the intersectional bulkheads, the geometrical relationships (diameters, frontal areas, surface areas) and the effects of bi-axial stresses must be examined.

Dow says that if the angle of intersection is kept to less than 30°, about 66% of the weight savings associated with single spheres may be achieved with intersecting spheres. The amount of material in the intersection is governed by the angle of intersection.

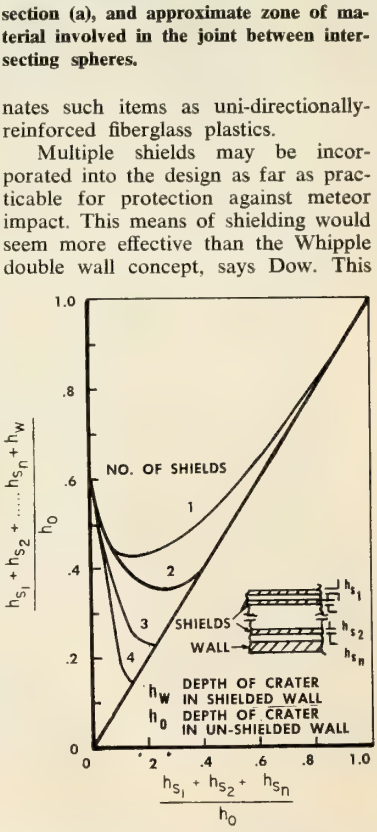
If outside diameter, frontal area and surface area are critical, the intersecting sphere concept should not be used, says Dow. But these factors are much less crucial than the weight in space stations.

No material prone to weakness from bi-axial stress conditions can be used. This, according to Dow, eliminates such items as uni-directionally-reinforced fiberglass plastics.



REPRESENTATION of angle of intersection (a), and approximate zone of material involved in the joint between intersecting spheres.

Multiple shields may be incorporated into the design as far as practicable for protection against meteor impact. This means of shielding would seem more effective than the Whipple double wall concept, says Dow. This area needs more experimental analysis before firm conclusions can be drawn.



EFFECTIVENESS of multiple walls against meteoroid penetration.

• **Meteor hits**—The possibility of penetration by a large meteor must also be taken into consideration. One way to avoid explosive decompression in such a case is to design the wall so thick that stress levels introduced by a puncture would not be critical. Another approach is to include stiffening rings.

Dow says that if the vehicle is to be designed for the lowest possible static safety factor with the least weight, then stiffening rings are the answer. But conservative design on a static strength basis would mean utilizing the inherent overstrength of the shield itself to prevent crack propagation from meteors—instead of stiffening rings.

Dow says data indicates that the use of adequate rings will make the size of the puncture non-critical, whereas a big enough hole will burst any unstiffened shell. In addition, no consideration has been given to the possibility of a ring being pierced. This factor must be accounted for in the final analysis.

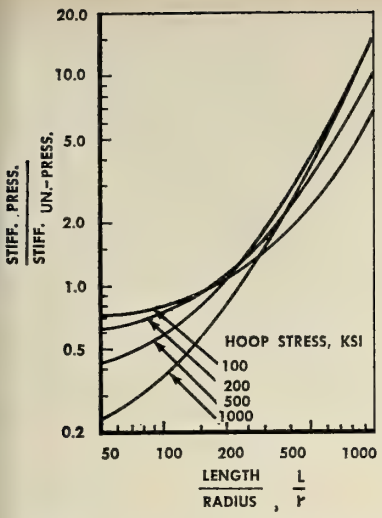
• **Lead satellites?**—According to Dow, if radiation shielding requirements degenerate to walls weighing about 25 lbs. per square foot—weight savings could be attained by reducing the surface area or putting everything on board against the walls.

A sphere has the least surface area for a given volume and thus would contain the greatest volume with the least wall weight if the wall material is fixed.

The toroid seems to be the most popular configuration for space stations. Dow says that spheres lend themselves to toroidal shapes without losing any of their inherent advantages. Spheres can be intersected to complete a toroid or a single sphere can be counterweighted (sphere on a string) and revolved to provide artificial gravity.

The counterweight concept is not prohibitive, says Dow. If nuclear reactors are used, its placement at the end of a cable, far from the cabin, would serve the dual purpose of providing counterweight and distance from the reactor's radiation.

In the matter of supporting antennas, reflectors or other members



RATIOS OF stiffness of air pressurized Al-alloy, cantilever beams of circular cross-section to ratios of stiffness for similar unpressurized beams.

extended from space vehicles Dow advocates the use of pressurized tapered beams. The internal pressure of a gas will increase the stiffness of an "outrigger"—by an order of magnitude for very long beams.

Dow says the extent of the influence of structural consideration in over-all space vehicle configurations is readily appreciated if the design is aimed at space environments rather than simply load supporting members.

Latest Univac Called Lowest-cost Computer

"The lowest-cost computing system available in terms of cost per unit of output," is how Remington Rand's Univac Division describes its new Univac III.

Renting for from $15-30 thousand/month, depending on user requirements the system is all solid-state and reported to be nine times faster than its predecessor. Operating efficiency is up 25% over existing EDP systems, said the company.

Other vital statistics include: 200,000-digit/sec. processing rate; 16384-word magnetic core memories; magnetic-tape or punched-card operation with a 700-card/min. reader; 700-line/min. printer. A program-interrupt feature indicates to the computer that its peripheral equipment has performed a particular task and is then ready to accept another.

Input and output of data is five times faster than that of Univac II, said the company, and reading, writing, and computing operations are performed simultaneously.

Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*



Report No. 6

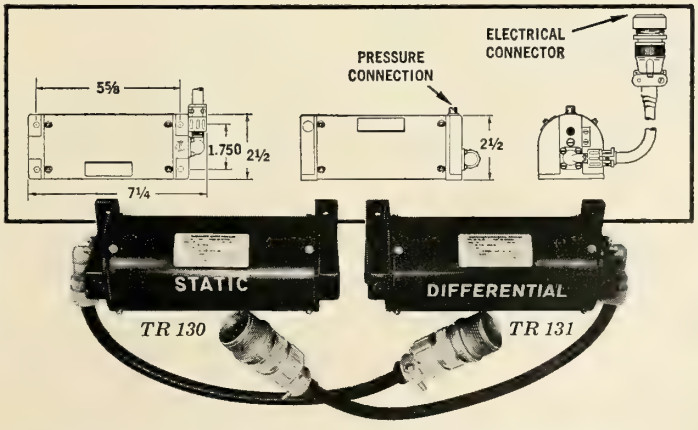
TR 130 Absolute Pressure Transducer and TR 131 Differential Pressure Transducer

These SM/I pressure transducers are precision built 400-cycle instruments using a cruciform cross-section helically twisted Bourdon tube with an electromagnetic pick-off to generate an electrical signal proportional to absolute pressure (TR 130) or differential pressure (TR 131) for use by computers and precision instrumentation. The design completely eliminates any mechanical friction or stiction and reduces hysteresis to an absolute minimum. The relation between output voltage and input pressure is linear.

They are particularly well adapted for use in aircraft because of high accuracy, low threshold, rugged, compact design and inherent repeatability of performance. The units have a mean time to failure of over 5,000 hours logged in in-flight operations. They meet the requirements of military specification MIL-E-5400.

Typical Performance Specifications

Scale Factor	0.0001487 volt/volt/mm Hg.
Applied pres. range	0 to 787 mm Hg. (absolute)
Damping (Restoration time)	0.1 second from full scale deflection to zero scale
Ambient temp. range	−65°F. to +175°F. (continuous duty)
Acceleration	Will withstand 30g without damage
Output voltage	0 volt to 3.50 volts for 30 volts of 400 cycles power applied and at load impedance of 20,000 ± 2% ohms
Frequency range	380 to 420 cps
Size	2½"x 2½"x 7¼"



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NBS Moves to Develop Ultraprecise Gage Blocks

The National Bureau of Standards is acting to meet the ever-stricter demands of the Space Age by developing gage blocks which can provide measurements precise to 1 part per million over extended time periods.

These blocks are used to monitor manufacturing processes in mass production of interchangeable machined parts in tools, ball bearings and missile control mechanisms. The extremely high dimensional accuracy required by missile/space technology means that gage blocks certified to 1 or 2 parts in 10 million will have to be available soon—and on a regular basis.

Under a special program at NBS, supported by major missile/space manufacturers, M. R. Meyerson of the Bureau's metallurgical laboratories has produced blocks with dimensional stability considerably greater than commercial blocks, but work is continuing to develop standards that will retain their calibrated lengths to extreme accuracy over long periods.

• **Problems & approaches**—Besides shrinkage and growth problems, the development program must cope with such complicating factors as appropriate coeffecient of thermal expansion, high degrees of surface finish, flatness of surface, parallelism of opposite gaging faces, resistance to wear, deformation, and atmospheric and fingerprint corrosion.

Metallurgical methods employed in the improvement studies included elimination of unstable constituents in hardened steels and reduction of fabrication stresses. Other techniques involved nitriding, chrome-plating, tungsten carbide and aluminum oxide coatings, spraying with nickel-chromium-boron alloy and case hardening through processes of carbonitriding, carburizing and cyanide hardening.

Annealed 410 stainless steel blocks with nitrided surfaces have been made which exhibit a growth of only 0.0000002 in. per in. per year during the first year of observation. 52100 steel gage blocks displaying a shrinkage of 0.0000004 in. per in. per year have been produced through special stabilizing and stress relieving treatments.

Stability evaluations at the Bureau involve two types of measurements—static comparisons carried out interferometrically and dynamic comparisons which rely on a mechanical electronic technique.

A block must pass rigid surface flatness and gaging face parallelism tests before it is admitted to the stability runs.



UNSYMMETRICAL thermal effects were produced when gage blocks were gripped as in the top illustration. NBS experts found that this was eliminated when the non-gaging edges were facing the palm as in the lower photo.

The measurement data taken is reduced by least squares to provide a calculated value for each comparison. The probable precision of results is determined by plotting the magnitude of each residual (the difference between the calculated and the observed value) against the number of times it occurred. This procedure, termed frequency distribution, is used in establishing the relationship between calculated probable error and actually realized precision, in demonstrating the successful elimination of bias from comparison procedures and in locating sources of systematic error.

• **Palm reading**—The Bureau found that residual frequency was effective in prescribing a handling procedure. In the manual handling of blocks by operators wearing insulated gloves, the blocks were picked up by their non-gaging ends in comparison pairs and positioned in the comparator in what was thought to be symmetrical handling. But it was found that the handling was producing an unsymmetrical thermal effect—the blocks were held perpendicularly so that one was nearer the operator's palm than the other. When the blocks were picked up with their non-gaging ends facing the palm, the statistical distributions showed the expected symmetry.

Blocks of 410 stainless and 52100 modified steel have been observed for a year. There are 14 other materials under study at the bureau. The most stable blocks were of nitrided 410, ground, stress relieved and lapped. The 52100 blocks were not quite as stable but most of the variations occurred during the first six months of observation. These blocks were processed through heat and chill treatments and stress relieved.

Commercial (AA grade) blocks, purchased from various manufacturers were run through the stability tests. They became shorter, averaging 0.0000011 in. per in. per year.

The importance of this program is illustrated by the support of firms such as General Electric, du Pont, Hughes Aircraft, Pratt & Whitney, Link Aviation, IBM, Brown & Sharp, New Departure, The Sheffield Corp., Timken Roller Bearing and others.

High Temperature Al Parts Impact Extruded at ALCOA

Precision aluminum parts useful up to 900°F—almost 400 degrees higher than the usual operating temperatures—is the result of a powder metallurgy impact extrusion development at Aluminum Company of America.

The parts are formed through a series of operations that begin with powdered aluminum. The powder is compacted and sintered into a billet which is in turn, hydraulically extruded as a rod. The rod is then cut into slugs for the impact extrusion process.

The working of the metal in the impact extrusion adds significantly to the physical properties of the part. A small ¼ in.-diameter finned tube has been impacted in lengths up to 14 ft. at ALCOA's Edgewater, N.J., works. This finned prototype is being evaluated for an atomic energy application.

Company spokesmen add that other small parts are undergoing examination for missile purposes. Secondary metal components such as actuating cylinders and collector caps for hydraulic cylinders are examples of the areas of elevated temperature environments in which impacted parts may be useful.

The range of applicability of the APM impact method is as wide as the basic impact process itself. Normal maximum and minimum size limits for impacts apply and tolerances within 0.0025 in. have been achieved.

Synthesis Best for Long O_2 Recovery

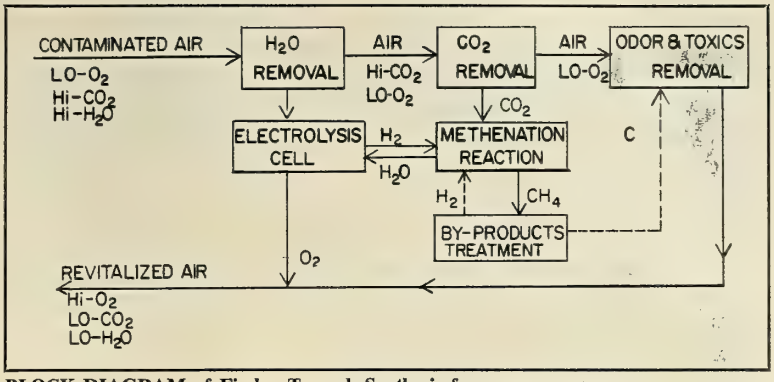
The "Fischer-Tropsch Synthesis" ystem rates tops among the feasible ays to supply man with purified air n an extended space flight, according o John Konikoff, of General Electric's Missile and Space Vehicle department.

Konikoff told the Aerospace Medial Association Meeting in Miami each earlier this month that such a ystem would be better than a stored-xygen system for space flights of ore than 26 days.

In this synthesis system, carbon dixide is reduced by hydrogen to form ater and methane. The water is then ecomposed electrically to release oxyen for re-use by man. Weighing as litle as 120 pounds, the system could be uilt to supply one man's oxygen needs space indefinitely, according to Koikoff.

Other advantages stated are that he methane produced could be used s a fuel; that all reactions in the system are at atmospheric pressure; and that the energy needed to operate the system could be supplied by the sun, a fuel cell, or by other devices being developed.

On the basis of weight and simplicity, a stored-oxygen system would be best for a space flight up to 16 days, said Konikoff. A superoxide system would be best for from 16 to about 18 days. A liquid oxygen system would operate best from 18 to 26 days, and the regenerative Fischer-Tropsch would be best indefinitely after 26 days.



BLOCK DIAGRAM of Fischer-Tropsch Synthesis for oxygen recovery.

Man Lives on Algae-derived Oxygen

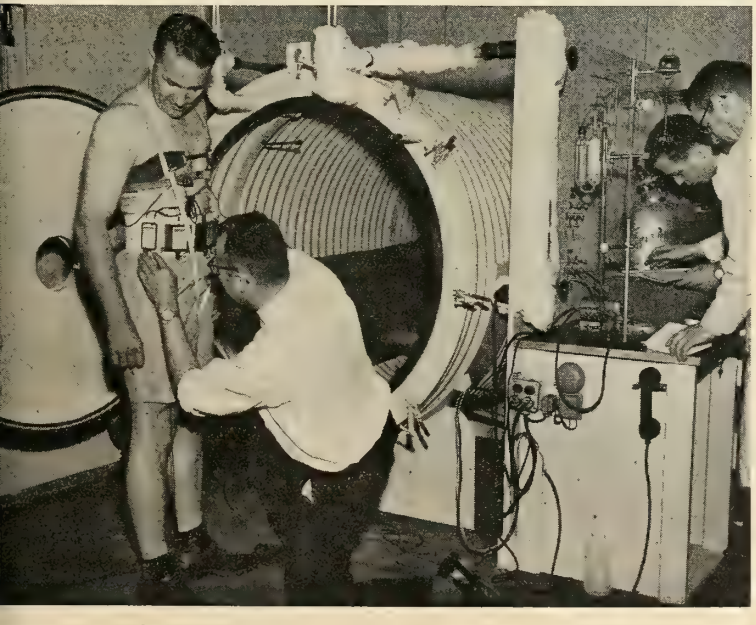
For six hours Boeing scientist omney H. Lowry, M.D., worked in a ealed capsule where his only oxygen ame from growing green algae, the ompany reported recently. The man's eactions were monitored by Boeing-eveloped miniature instruments which were worn on a belt around his waist and powered by a miniature battery.

Ultimate aim of the experiment is to create a packaged closed circuit environment for space travelers.

Lowry is said to be the first man who has ever spent several hours in an environment whose oxygen was totally regenerated by algae. Without the help of this microscopic water plant, the scientist would shortly have been asphixiated by his own exhaled carbon dioxide.

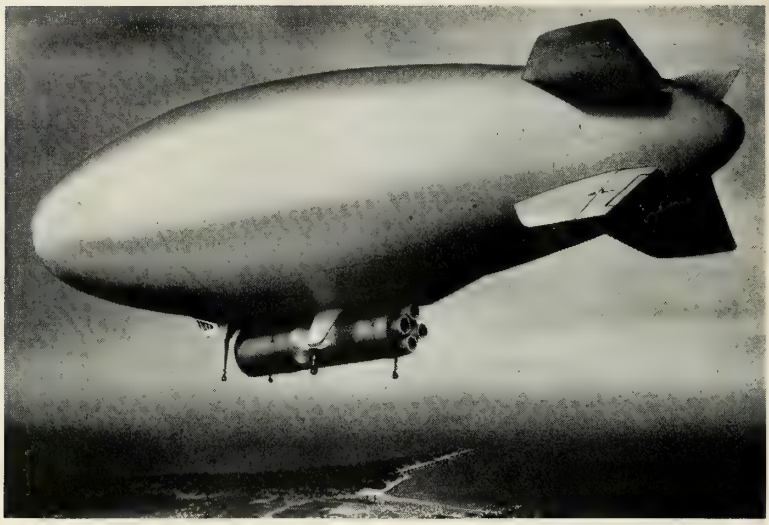
Belt-worn physiological instruments, each occupying a volume about equal to that of a package of cigarettes, include miniature electrocardiographs, phonocardiographs, respirometers, electroencephalographs and electronic equipment for measuring body temperature. Results are said to be equivalent to those of standard size instruments. Other physiological equipment Boeing says it is developing will measure blood pressure and autonomic responses.

Boeing emphasizes that its present instruments are designed for laboratory work. They are packaged to operate with temperatures ranging between –40°F and 110°F, with static acceleration up to 1g and vibration up to 5g and 500 cps.



← **BOEING RESEARCHER Romney H. Lowry, M.D., watches last-minute adjustment of physiological sensors before he enters sealed capsule for six-hour stay in atmosphere whose oxygen comes only from algae.**

Blimps Can Haul Huge Boosters



Non-rigid airships could easily solve the problem of transporting huge rocket boosters from factory to launch pads, contends Goodyear Aircraft Corp.

Following up on earlier claims for the blimp carrier, GAC recently concluded a feasibility study of the logistics problem involved in the increasing size of boosters being developed for space exploration.

It now reports that airships ranging in size from 1.5 to 5 million cubic feet could haul present and future boosters without difficulty. One capable of handling the *Saturn* booster would be 563 ft. long and is considered to be well within present state of the art.

Advantages of blimp transport stressed by the GAC study:

- Operation independent of tunnels, trestles, waterways and highway clearances.
- Point-to-point deliveries out of and into small fields.
- Elimination of the necessity for tractor-trailers, ships, and barges.
- Smooth operation with little possibility of damage to sensitive components.
- Practically unlimited range within U.S. or even overseas.

By modification of the cabin structure and addition of a cargo suspension system, existing models could carry boosters 25 ft. in diameter, 80 ft. long, and weighing 15 tons. A 5-million cubic foot airship—of *Saturn*-booster capacity—would be only 40% larger than present types. According to Goodyear, such a craft could transport a 55-ton load 2000 miles nonstop.

Ground facilities for the airships could be very simple. Only a relatively smooth field less than a half-mile in length, two tractors, and a portable mooring mast would be required.

The Goodyear report cited the difficulties already being experienced in hauling boosters over highways. Even those only 10 ft. in diameter require trailers that almost cover a two-lane highway. Those now in the planning stage will be too big for existing highways, railroads, and airplanes to handle. Railroads and trucks are limited by roadway clearances, airplanes by size of cargo compartments, and ships and barges by lack of waterways to factories and launch sites.

Largest TE Generator Built by Westinghouse

A five-kilowatt thermoelectric (TE) generator—The most powerful ever built—has been developed by Westinghouse Electric Corp. for the Navy's Bureau of Ships.

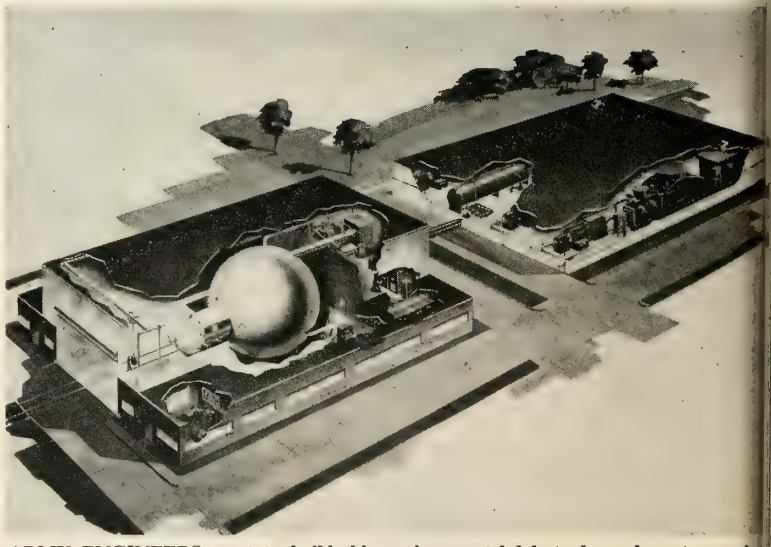
The generator directly converts heat into electricity without any major moving parts. It is 50 times more powerful than any previous TE powerplant, and delivers enough electricity to light eight to ten average homes at the same time.

The new development is an experimental unit intended for evaluation of power-generating materials and fabrication techniques produced under a Navy-sponsored TE materials research program.

New Materials developed by this program have reportedly tripled in the last three years the efficiency with which heat may be directly converted to electricity.

In announcing that the generator had undergone its first full-power tests, Dr. S. W. Herwald, Westinghouse vice president in charge of research, described its development as "a significant advance in the thermoelectric art."

Army Lunar Simulator Concept



ARMY ENGINEERS want to build this environmental lab to learn how to survive on the moon. Lab would reproduce temperatures, radiation and vacuum conditions



TWO DECADES OF LEADERSHIP IN CRYOGENICS

1945

Development of first low-pressure helium liquefier. The ADL-Collins Helium Cryostat is the prime tool for 95% of the free world's research in cryogenic science.[1]

1947

Development of the first high capacity air-transportable liquid oxygen generator for missile application.

1958

World's first superconducting computer built and operated at ADL's Acorn Park Laboratory.[2]

Arthur D. Little, Inc.

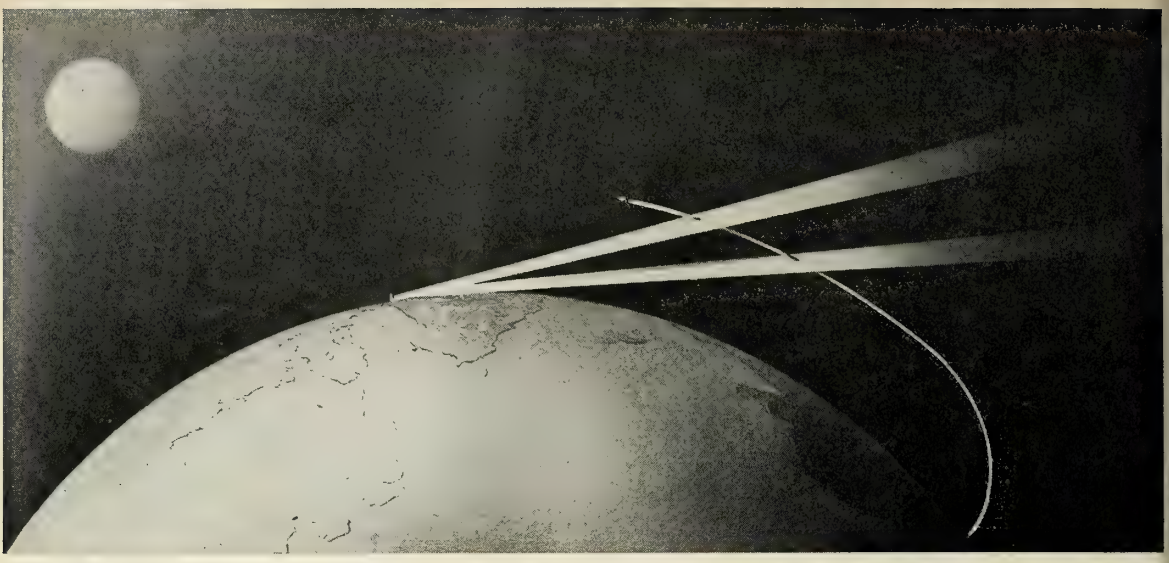
CAMBRIDGE, MASSACHUSETTS

Chicago • San Francisco • New York • Washington • Santa Monica
Toronto • San Juan • Edinburgh • Zurich

Copies of the literature below may be obtained from Director of Public Relations, 74 Acorn Park, Cambridge, Mass., or from ADL Santa Monica Engineering, 1424 Fourth Street, Santa Monica, California

- ☐ [1]The ADL-Collins Helium Cryostat
- ☐ "Cryogenics — Fertile Fields Ahead," A. Latham, Jr., D. C. Bowersock, and B. M. Bailey, *Chemical and Engineering News*, August, 1959
- ☐ "A New Low-Temperature Gas Expansion Cycle" (Parts I and II) H. O. McMahon and W. E. Gifford, 1959 Cryogenic Engineering Conference
- ☐ [2]"A Cryotron Catalog Memory System," A. E. Slade and H. O. McMahon, Eastern Joint Computer Conference, 1957
- ☐ "Test-Tube Titan," J. R. Elliott, *Barron's*, December, 1959

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BMEWS WILL DETECT oncoming ICBM's by sending R-F energy out into space at two and five degrees.

First BMEWS Site Nears Operation

by Donald E. Perry

THULE, GREENLAND—Construction of the first of three sites of the ballistic missile early warning system (474L) here is virtually complete, and the station is due to start radiating energy into space on fully operational status this fall.

Testing of equipment and marriage of subsystems of this, the free world's largest radar installation, began in April and is on schedule. Full power from one transmitter module was beamed into space for the first time in early April and has been on the air "several" times to date.

The nearly $1-billion BMEWS Program, designed to give southern Canada and the United States 15-24 minutes warning in event of a mass ballistic missile attack from the Soviet Union, will have two other stations. One will be at Clear, Alaska, and the other at Fylingdales Moor, in Yorkshire, England. The Clear station, already under construction with foundations and other basic work complete, will become operational in the summer of 1961. The U.K. station should follow in 1962.

U.K. station will cost about $115 million, with the British assuming $25 to $30 million (mostly brick and mortar) and the U.S. furnishing electronic equipment. Clear station will cost about $328 million. Cost of the Thule station, opened for the first press inspection last week, will be $500 million. Total program outlay will be $952 million, including $9 million for a world-wide program equipment display at North American Air Defense Command (NORAD) in Colorado Springs. Yearly system operating costs will approximate $110 million.

Each site ultimately will include radars, a missile impact prediction computer, checkout and switching equipment, checkout and monitoring equipment, a data link to NORAD, plus monitoring equipment at Strategic Air Command (SAC) headquarters in Omaha.

• **Organization**—This cooperative effort involves not only four governments—the U.S., Canada, Great Britain and Denmark—but the Air Force, Army, Navy and an industrial team of 2900 large and small missile/space industry suppliers located in 29 states. Some 66% of BMEWS is subcontracted with about 36% going to small business.

Army Corps of Engineers is responsible for site construction and Navy's Transport Service is shipping major portions of equipment and construction materials.

While the AF BMEWS project office at Lawrence G. Hanscom Field in Bedford, Mass., directs the entire project in its electronic systems center of Air Materiel Command, Radio Corporation of America is prime system contractor. RCA last week was awarded a continuation contract for implementation of the Yorkshire site.

The Project office contains elements of AMC acting as executive agent, and Air Research and Development Command to achieve proper phasing of actions in development, procurement, production, maintenance and supply. The Electronic Systems Center is not building up technical in-house capability but is strengthening its management position, relying on industry as the backbone for this electronic gargantua.

Reliability in all equipment has been the by-word since the start of the program, carried on with urgency since *Sputnik I*. It is being achieved in three ways. First, equipment is being designed to require minimum repairs and still allow the fastest possible maintenance. Second, duplicate equipment is being installed in many areas to compensate for anticipated down time and to insure round-the-clock operation. Finally, an elaborate system of control and switching equipment and checkout and automatic monitoring equipment is permitting a thorough analysis and flexible interchange of units during operation. Such analysis should allow preventive maintenance to forestall serious down time following an equipment failure. Components are allowed to work only at 40% maximum military specs.

• **Special problem**—Arctic elements have posed innumerable problems. Four 165-ft. high, 400-ft. long antennas of nickel steel (for ductility) have to withstand 185-mph winds, temperatures that can dip below —65°F, and ice six inches in thickness which can dou-

ble the weight of the 1500-ton D.S. Kennedy & Co. reflectors.

There is nothing simple about construction in Thule, where excavations must be drilled and shot to penetrate permafrost known to reach a depth of 1200 ft. Even refrigeration coils have to be placed in the ground beneath some buildings to prevent melting of the active top-five-foot permafrost layer and subsequent settling of the buildings either during curing of the concrete floors or later while they are in operational use.

One of the biggest problems RCA had to face in this installation was the technical integration of thousands of components into subsystems and tying those in overall, while at the same time building in fault-finding equipment to keep the site under continuous operation. (See table.)

To accomplish its system contractor task, RCA has kept close coordination over more than 10,000 people employed in the industrial team. RCA alone has some 800 systems management-type personnel working with AF BMEWS project office. Some 850 well-trained BMEWS engineers, technicians, administrative and other personnel of RCA, its subcontractors and AF, now are at Thule. RCA personnel are scheduled to man this site for at least another year until AF technicians now in training will take over. Contractor personnel have a 70-hour work week (time and a half for over 40 hours) and get incentive pay, free lodging and meals. While incentive pay varies, it approximates 30%.

• **Concurrency demand**—Scheduling has been a formidable task, not only because of its size and the tremendous number of people involved, but because development and production has had to be carried on concurrently.

Added to this has been the burdensome logistics and support factor with equipment having to be shipped at precisely the correct time because of the limited sea access to Thule. Waterways are open only three months a year and air shipments cost 10 times more than those by sea. In the face of this, however, military sea transport has sea-carried some 26,400 short tons of electronic equipment. A total of 150,082 measurement tons of all kinds of material have been transported to the site by sea and 3126 short tons by air since the Thule project got underway in early 1958.

While the Lincoln Laboratory-conceived BMEWS concept has been referred to as an "electronic Maginot line," it nevertheless today stands as a monument to teamwork with the military and industry welded together for a common defense goal: pushing the electronics state of the art and delivery of an operational system on schedule. To do it, design, assembly and testing have been almost parallel.

• **Limitations**—BMEWS will give no protection against the submarine-launched ballistic missile. It is questionable whether it is immune to jamming and even if it were, whether such jamming could be considered as a hostile act. It will, however, buy precious time in event of a mass missile attack. Time which can be used in getting SAC bombers into the air and alerting the civil populace. It later will complement the *Midas* infrared detecting satellite system, adding more minutes to our response time.

It lacks a lot of things. It's big. It's costly. It lacks precision tracking which would give more than just a regional indication of impact area. It's suffering from the perennial budget squeeze too.

Plans for two tracking radars each at Thule and Clear at a cost of $75 to $100 million have been shelved, at least temporarily. The U.K. site, however, will include three radar installations with 85-ft. diameter "dish"-style reflecting antennas performing both tracking and detection functions. Construction of this site is to begin shortly.

Prototypes of tracking radars are undergoing tests at RCA's Moorestown, N.J., facility. Goodyear Aircraft Corp., contractor for antennae and radomes, is putting another prototype through 24-hour life tests at its Akron facility.

• **Dimensions**—Tracking radar and its pedestal weighs nearly 375,000 pounds. The hydraulic, servo-driven rotating section comprises 200,000 pounds of this weight. It's designed for a 10-year Arctic life. The radome with a diameter of 140 ft., is seven stories high, has 1646 hexagonal sections each with a six-in. thickness of design-impregnated paper between fiberglass walls. The antenna is within ¼-in. of a true parabola. It can be slewed in azimuth at extremely high velocity.

Continental Electronics Manufacturing Co. is supplying tracking radar transmitters, although a parallel development program was carried out by RCA.

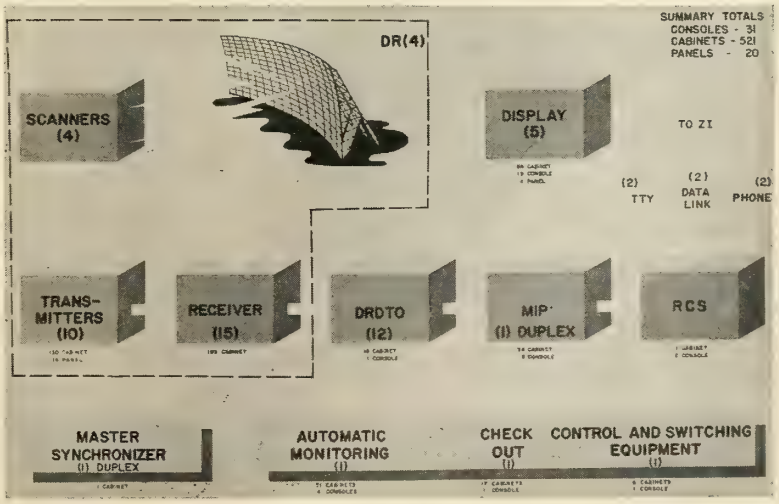
The BMEWS site is located on a 1200-ft. cliff about 12 miles northeast of Thule air base overlooking three glaciers. The 80% solid-state electronics facility receives prime power—69 kv—from a Navy power ship in Thule harbor. An alternate power system will be completed this summer. Overall facilities to house equipment were designed by Metcalf & Eddy, Boston A&E firm.

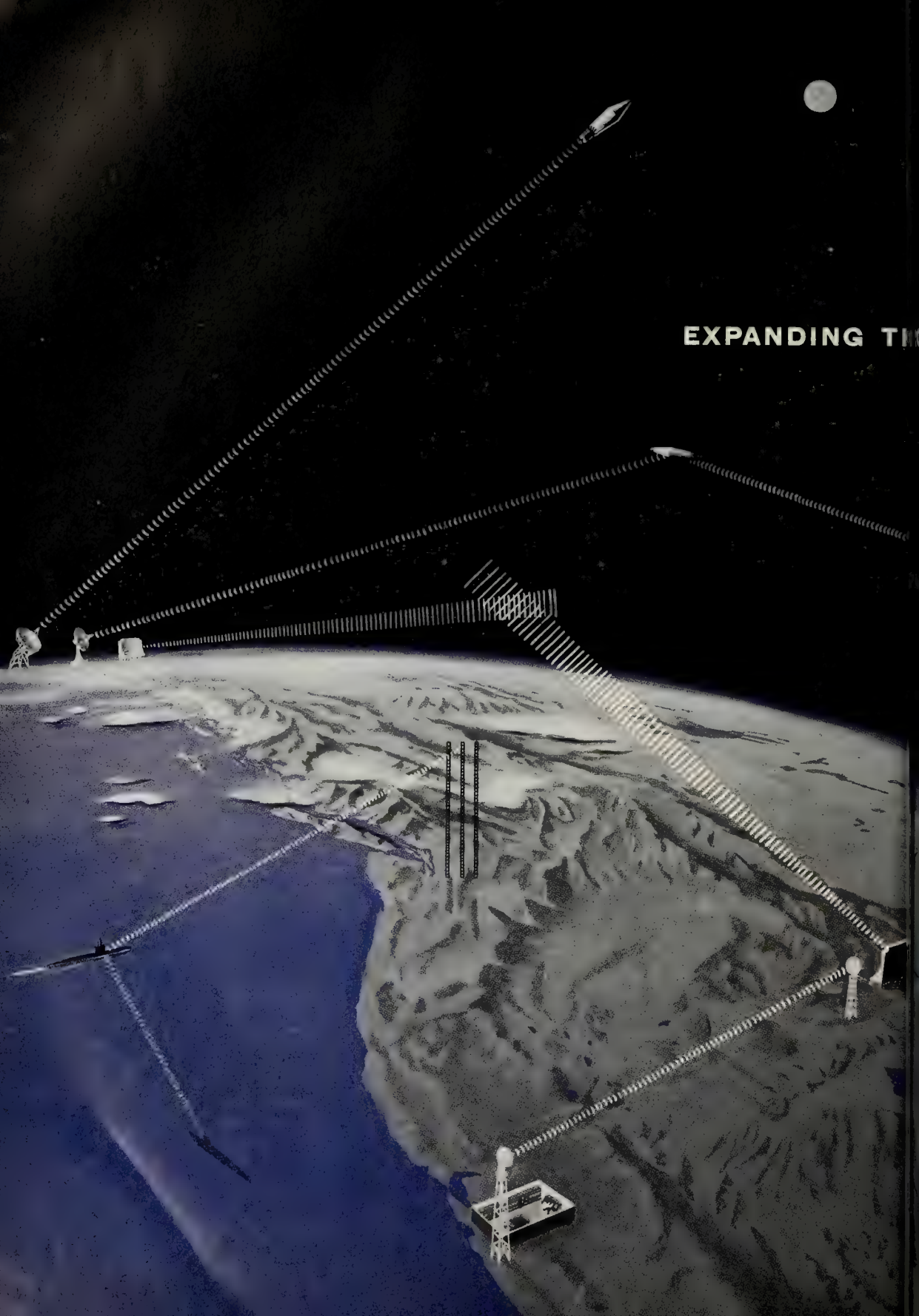
Four General Electric Heavy Military Electronics Department AN/FPS-50 pulsed doppler detection radars with a range of 3000 nautical miles each scan about 38 degrees for a total field coverage of about 150 degrees, including overlap. Each torus-shaped radar reflector radiates two horizontal fan-shaped beams at elevations of approximately two and ten degrees, forming two detection fans, one above the other. Impact prediction can be obtained by extrapolating the missile's path from the range, azimuth, bearing and time sequence data recorded as the missile passes through each of fans.

• **Discrimination**—The system has some discrimination capability such as distinguishing between satellites, missiles, meteors, auroral disturbances, solar and intra-terrestrial noise. GE made an examination of 191,500 separate trajectory coordinates and their relationships to establish discrimination parameters.

Some 290 cabinets are required to house radar equipment at the site. Ten transmitters are required for the RF

BMEWS Signal Flow at Site 1 (Thule)




EXPANDING TI



Herodotus, the historian, records (490 B.C.) the use of burnished shields for military signaling. This was the forerunner of the heliograph, invented by Sir Henry C. Mance, which came into wide use centuries later.

ONTIERS OF SPACE TECHNOLOGY IN

COMMUNICATIONS

Lockheed's interest in developing the science of communications extends from the depths of the oceans to deep space. Its Missiles and Space Division research programs deal with the development and application of statistical communication and decision theory in such areas as countermeasures; telemetry multiplexing and modulation; scatter communications; multiple vehicle tracking; millimeter wave generation and utilization; sonic signal detection and processing; avoidance of multipath degradation; and interference avoidance.

Associated research and development efforts are directed toward propagation studies and advanced antenna design; low noise amplifiers; vehicle borne signal transmission and reception, data storage and processing; solid state materials and devices.

The scope of such activities extends from advanced studies of naval communication problems on and under the oceans; the many applications to satellite vehicles; on to the specialized communication problems of deep space explorations. Latter needs are exemplified by high frequencies, low weight and power, high stability, low effective bandwidth, extreme reliability and basic simplicity requirements.

Engineers and Scientists: Investigating the entire spectrum of communications is typical of Lockheed Missiles and Space Division's broad diversification. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; communications; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; man in space; materials and processes; applied mathematics; oceanography; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sonics; space medicine; space navigation; and space physics.

If you are experienced in work related to any of the above areas, you are invited to inquire into the interesting programs being conducted and planned at Lockheed. Write: Research and Development Staff, Dept. E-29B, 962 W.El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

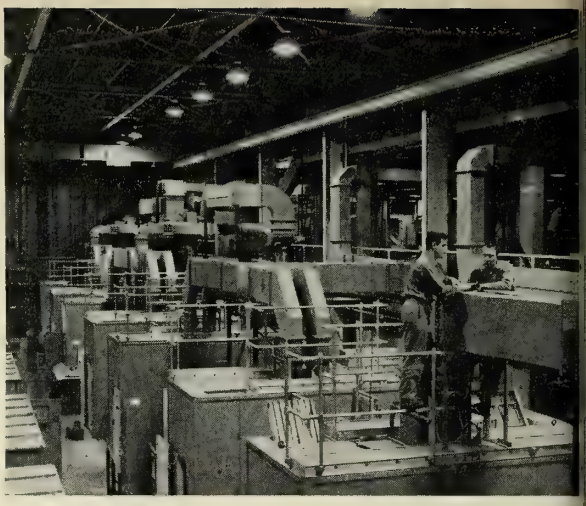
Systems Manager for the Navy POLARIS FBM;
the Air Force AGENA Satellite in the DISCOVERER,
MIDAS and SAMOS Programs; Air Force X-7; and Army KINGFISHER

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO • HAWAII

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SOME 40 back stays and trusses each weighing seven tons are required to support surveillance radar at BMEWS Site 1.



GE TECHNICIANS inspect wave guides which carry R-F energy from transmitters to the scanner building at Thule site.

energy. Rectifiers each weigh 27 tons and provide over 100,000 volts DC.

A number of Varian Associates and Eitel-McCullough super-power klystrons are employed in the final amplification stage of the transmitter. Since they are some 10 ft. long and weigh around 600 pounds, chain hoists are provided in the transmitter buildings. There are some 440 miles of connecting cables. Reynolds Aluminum furnished 12 miles and Andrew Corp. the remainder of the wave guides. Eight high-powered General Bronze Co. scanning switches receive the radar energy which has been piped through the waveguides from the transmitter. They switch this power sequentially into other waveguide paths arranged around the switches.

Energy is directed through this array into a pattern resembling a church organ to some 704 Andrew Corp. feedhorns on the scanner buildings.

When a target passes through a radar fan, a signal measured in millimicro-microwatts of energy is reflected back to the antennas. Signals are then switched to receivers and amplified to a usable level. Next stop is the data cabinets where measurements are made to determine the exact points on the trajectory of the missile's path from the fans. Categorized data is channeled to the appropriate computer input circuit where differentiation of the target object is made.

• **DRDTO**—Detection radar data take-off (DRDTO) equipment supplied by Sylvania Electric products operates in conjunction with the radars. This equipment transforms analog radar returns into digital data for processing by two 7090 computers, first military operation for this commercial version. The equipment performs 200,000 mathematical operations per second, feeding the digital information into a missile impact prediction set (MIPS) computer for analysis. DRDTO also provides target discrimination by separating simultaneously observed objects so that target data may be recorded sequentially.

Tracking radar take off (TRDTO), when and if installed, will perform the intermediate data processing functions between each tracking radar and the MIPS computer. System will take advantage of RCA's development work on the AF *Wizard* project.

Checkout and automatic monitoring equipment should insure reliability through continuous monitoring mode and fast detection of trouble areas.

Western Electric Co., under a separate prime AF contract, is constructing the $84 million rearward communications system over some 45,000 route miles to NORAD and SAC combat operations centers. Design work was done by Bell Telephone Labs.

• **Combined methods**—Multiple communications methods — submarine cable, landcable, line-of-site microwave radio relay and advanced tropospheric scatter radio—are being used. A new tropo system has three sizes of transmitters, the largest to meet different conditions. Blaw-Knox and Canadian Vickers are supplying antennas of 60 and 120 ft.

One signal carries 63 separate pieces of information gleaned from the antennas. Each communication system transmits over two routes simultaneously as a safeguard against interruption due to deliberate or accidental damage to the circuits. Voice and teletypewriter circuits are available for backup.

As part of the program, Western Electric has laid the first dual (out and in) submarine cable in the Arctic circle. It links Thule with Cape Dyer, Baffin Island, 700 miles to the southeast across icy Baffin Bay. Submarine cable soon will be placed in the Davis Strait and the Atlantic Ocean, bridging a 1250-mile gap between Cape Dyer and Newfoundland. Repeaters, to amplify signals, are located about every 40 miles along the cable.

Seventeen commercial communications and government or military agencies in three countries are providing the rearward communications at more than 400 locations of which some 350 are on routes of commercial communications companies.

BMEWS Component Equipment Statistics (Estimated)

ITEM	SITE I	SITE II	SITE III	ZI	TOTAL
WAVEGUIDE	109,000 FT. (21 MILES)	81,000 FT. (15 MILES)	1,200 FT.	.....	191,000 FT. (36 MILES)
TRANSISTORS	315,000	297,000	139,000	30,000	780,000
TUBES	33,000	32,000	100,000	110	165,000
CAPACITORS	267,000	260,000	310,000	12,000	849,000
RESISTORS	1,080,000	978,000	429,000	33,000	2,520,100
EQUIPMENT RACKS	818	664	590	27	2,099
CABLING	1,580,000 (300 MILES)	1,360,000 (260 MILES)	1,260,000 (240 MILES)	60,000 (12 MILES)	4,260,100 (800 MILES)
INTERNAL WIRING	1,375 MILES	1,090 MILES	750 MILES	45 MILES	3,260 MILES
SOLDERED AND CRIMPED CONNECTIONS	14,000,000	11,500,000	10,000,000	500,000	36,000,000
TONNAGE OF EQUIPMENT	26,400 S/T	17,300 S/T	6,500 S/T	1,400 S/T	51,600 S/T

Echo Failure Sets Program Back Six Months to a Year

The United States' passive communication satellite program has been set back six months to a year, with the May 13 failure of an *Echo* launch.

As with many NASA projects, the *Echo* attempt had no backup, and the next scheduled *Echo* shot, according to NASA testimony before Congress, will be next summer. Certain NASA spokesmen said this week, however, that the space agency's launching schedule may be revised so that another *Echo* sphere can be launched later this year.

The first attempt to launch *Echo* flopped when the second-stage attitude control jets failed to function.

The failure came after more than 10 frustrating days on the launch pad. Problems with the first- and second-stage guidance systems of the *Thor Delta* launching vehicle thwarted earlier attempts to place the 100-ft.-diameter inflatable sphere into orbit.

Purpose of the experiment was to place the large sphere into a 1000-mile circular orbit where ground stations could bounce signals between the East and West Coasts in communications experiments.

The first and second stages of the three-stage *Delta* vehicle apparently performed as planned. Telemetry data indicated that about halfway through the vehicle's coast period the attitude control jets in the second stage failed.

• **Sphere's composition**—The sphere to have been orbited was made of 82 separate flat gores of DuPont Myler Polyester film by the G. T. Schjeldahl Co. The shell was covered with vapor-deposited aluminum to provide radio wave reflectivity of 98%, up to frequencies of 20,000 mc.

Before launching, about 30 lbs. of sublimating powders were inserted in the sphere. It was then folded accordian-fashion and placed inside a 26½-in.-diameter magnesium container made by Kaiser-Fleetwings, Inc.

The satellite carried no instrumentation. Had the satellite been placed in orbit, its position would have been determined by the telemetry signals emanating from the third stage. These signals would also have revealed the instant of payload separation.

About two minutes after the payload would have been injected into orbit, the magnesium container was designed to have been split open by an explosive charged placed around its middle. After release from the container, the sphere would begin to inflate with the 10 lbs. of benzoid acid plus 20 lbs. of anthraquinone.

• **Experiment plans**—The two primary stations to have taken part in the experiment were NASA-JPL's Goldstone station in California and Bell Telephone Laboratories' facility at Holmdel, N.J.

During the experiment, BTL would have transmitted on a frequency of 960 mc/s for reception at Goldstone. JPL would have transmitted at 2390 mc/s to BTL. The NASA Goddard Space Flight Computing Center would have sent orbital calculations to both stations.

To set up the communication link, BTL would have illuminated the sphere with a 960 mc/s signal. This signal would have bounced off the satellite in all directions. A portion of the scattered energy would have been picked up by the Goldstone station where the receiver is pointed toward the satellite. To complete the communication link, Goldstone would have transmitted in the same manner at 2390 mc/s for reception at BTL. Transmitted power would have averaged about 10 kw.

• **Launch vehicle**—The first launch attempt of the *Delta* vehicle, though a failure, came just a little more than a year after NASA signed a contract with Douglas for its development.

The *Thor*-based vehicle stands 92 ft. high and has a maximum diameter of 8 ft. Its fueled weight is a little less than 112,000 lbs.

Similar in configuration to the *Thor-Able*, the *Delta* features an improved autopilot and radio guidance system for the first- and second-stage powered flight and precise attitude control for a longer coast period between second-stage burnout and third-stage ignition.

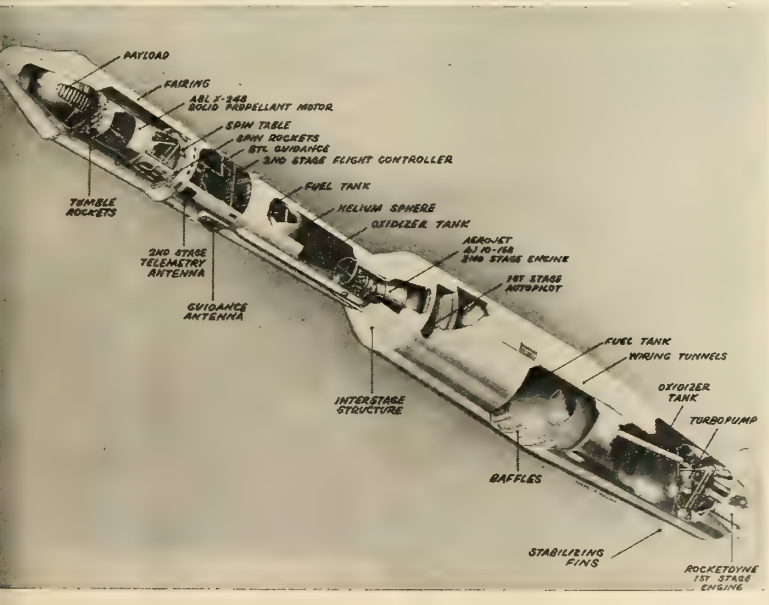
In the firing sequence, the Douglas SM-75 *Thor* first stage provides about 160 seconds of powered flight during which the rocket is guided by BTL's guidance system and roll and pitch programers.

The second stage Aerojet-General AJ10-118 engine ignites almost immediately after first stage cut-off. The 4000-lb., 7500-lb.-thrust vehicle burns for 20 seconds while the nose fairing protecting the payload and third stage jettisons. Then it fires for about 115 seconds while being steered by the BTL guidance system.

With the second stage still attached, the vehicle coasts for about 15 minutes until the vehicle is about 800 miles high and 2300 miles down range. Its attitude is controlled by the jets which failed to ignite in last week's firing.

After coast, in rapid sequence, the Allegany Ballistics Laboratory ABL-248 third stage is spunup to 120 rpm by small spin rockets to stabilize its flight. The third stage ignites, and the second stage is separated by explosive bolts. The 500-lb., 3000-lb.-thrust third stage burns for about 40 seconds.

After third-stage burnout, de-spin rockets slow the rotation. The empty third-staging casing, weight about 50 lbs., is separated from the payload by a spring which retards its velocity and is tumbled by a lateral rocket so that it will not interfere with the payload.



ASW engineering

Drones to Explore Ocean Bottom Down to Five Miles

A helicopter-type rotor appendage will be "flying" drone bathyscapes over sea bottoms up to five miles deep where the craft will be seeking scientific finds, according to the Office of Naval Research (ONR) and Hughes Aircraft Co.

The "flying" version of the bathyscape is to be a follow-on development of an underseas tracked vehicle developed for ONR by the Marine Physical Laboratory of Scripps Institution of Oceanography, La Jolla, Calif. The engineering and design studies of these drones are part of the Navy's RUM (Remote Underwater Manipulator) program.

In its second sea venture, the present drone was successfully demonstrated earlier this month at La Jolla. The device comprised the hull and track assembly of the ONTOS Marine Corps tank, outfitted with a rotating boom and mechanical arm. At the arm's end was a two-pronged mechanical hand, similar to ones seen in radioactive laboratories for handling "hot" products, which would be used for plucking up items from the sea bottom. Another use would be for installing scientific equipment on the sea's floor, and possibly ASW hydrophones.

The vehicle is reportedly able on the ocean bottom to mount foot-high objects, climb a 60% grade, and reach a speed of 3 mph. Four television cameras for observing the sea floor are in the craft. Control signals and electrical power are said to come from a shore-to-vehicle cable and also from a sonic link.

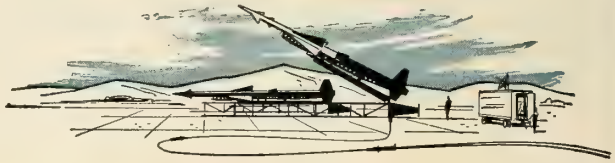
The Hughes-developed lift appendage "will handle an immersed weight up to 8000 pounds, propel it in any direction and stay submerged in salt water for months without damage to its material," according to Dr. John Clark, manager of the company's nuclear electronics laboratory.

To energize the appendage, power from a generator on land is transmitted at high voltage over a coaxial cable to the underwater tracked vehicle. Here, the power is stepped down by transformers. These supply the power needed to drive the appendage's large rotors, which revolve at low speed to create minimum disturbance in the water. Vanes on the appendage control yaw, velocity and position.

review

MAGNESIUM AND ITS ALLOYS, C. Sheldon Roberts, John Wiley & Sons, New York, 230 pp.

The extraction, refining and casting of the metal as well as its physical and chemical properties, alone and alloyed are treated. The work is designed to be an authoritative reference and the duplication of commercial literature has been avoided. In the words of the author, the book is an effort to present the latest scientific properties and technology, to emphasize uncertainties which need to be resolved and a definite relationship between the two.





Why it pays you to specify

Bendix QWL Electrical Connectors for use with Multi-conductor Cable

For use with multi-conductor cable on missile launching, ground radar, and other equipment, the Bendix* QWL Electrical Connector meets the highest standards of design and performance.

A heavy-duty waterproof power and control connector, the QWL Series provides outstanding features: • The strength of machined bar stock aluminum with shock resistance and pressurization of resilient inserts. • The fast mating and disconnecting of a modified double stub thread. • The resistance to loosening under vibration provided by special tapered cross-section thread design. (Easily hand cleaned when contaminated with mud or sand.) • The outstanding resistance to corrosion and abrasion of an aluminum surface with the case hardening effect of Alumilite 225 anodic finish. • The firm anchoring of cable and effective waterproofing provided by the cable-compressing gland used within the cable accessory. • The watertight connector assembly assured by neoprene sealing gaskets. • The additional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip. • Prevention of inadvertent loosening insured by a left-hand accessory thread. • The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time. *TRADEMARK

Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Scintilla Division
Sidney, New York

Bendix AVIATION CORPORATION

Circle No. 14 on Subscriber Service Card.

contracts

NAVY

$1,500,000—Minnesota Mining & Manufacturing Co., St. Paul, for research into high-energy solid-rocket fuels.

$98,854—Develco, Inc., Belmont, Calif., for design and construction of thirty VLF satellite receivers and ground station receivers.

$58,139—Broadview Research Corp., Burlingame, Calif., for research on generation of surface waves.

$50,000—University of Michigan, Ann Arbor, for research on acoustic signal processing.

$49,550—Cleveland Pneumatic Industries, Inc., Washington, D.C., for study of the stability and control of ground effect machines operating in amphibious environments.

$48,846—University of Chicago, for research on the reactions of diazoxides.

$25,000—Melpar, Inc., Watertown, Mass., for research to determine effects of correlation processing.

AIR FORCE

$500,000—Federal Pacific Electric Co., Newark, N.J., for electrical equipment for the *Atlas* installation at Warren AFB.

$486,000—Chance Vought Aeronautics Division, Dallas, for a metal-forming study which will provide a guide to use of the newer metals in defense and space research vehicles.

$290,000—University of Southern California, Los Angeles, for research on "Theoretical-Experimental Studies in Hypersonic Low Density Flow."

$83,988—Electro-Optical Systems, Inc., Pasadena, Calif., for research and development of a molecular tunable amplifier.

$83,205—Rias, Inc., Baltimore, for continuation of research in non-linear mechanics.

$79,915—General Dynamics Corp., San Diego, for continuation of work on "Chemical Reactions using Modulated Atomic and Molecular Beams."

$67,808—Aerojet-General Corp., Azusa, Calif., for continuation of research on "Recombination Processes in Advanced Propulsion Systems."

$59,284—University of North Carolina, Chapel Hill, for research on "Investigation of Imperfections in Ionic Crystalline Solids."

$44,775—Armour Research Foundation of Illinois, Chicago, for study of "Structure of Defect Clusters in Solids."

$43,925—Columbia University, New York City, for research on "Molecular Collision Processes at Low Pressures."

$39,112—University of California, Berkeley, for continuation of research on "Theoretical Study in Nuclear Structure, Nuclear Models and Elementary Particle Interactions."

$31,000—Massachusetts Institute of Technology, Cambridge, for research on "Heat Transfer in a Plasma."

$30,000—Columbia University, for review and evaluation services in the field of solid state sciences.

$28,860—American Institute of Physics Inc., New York City, for continuation of research on "Physics of Fluids Information Exchange."

ARMY

$3,067,568—Chrysler Corp., Detroit, for *Jupiter* missiles (two contracts).

$2,000,000—International Telephone & Telegraph Corp., for building a microwave communication span designed to bridge an ocean expanse of some 500 miles.

$1,178,000—Jas. W. Glover, Ltd., Honolulu, for construction of a dual-Hercules Launches, Sites Nos. 3 and 4, Oahu, Hawaii.

$307,776—Southern Waldrip & Harvick Co., Long Beach, Calif., for construction of an operations auxiliary building.

$143,273—Douglas Aircraft Co., Santa Monica, Calif., for spare parts for the *Nike* System.

$115,885—RCA, for a computer study in connection with Project Press.

$110,436—Dynatronics, Inc., Orlando, Fla., for services and materials necessary to design, develop, fabricate and deliver to the Government camera timing equipment for use in Ballistic Missile Systems, Supplement.

$98,872—Martin Construction Co., Cocoa Beach, Fla., for construction of a maintenance building for technical instrumentation in connection with the Azusa tracking system.

$62,000—Hayes Aircraft Corp., Birmingham, for engineering design, fabrication, modification, and re-work, ground services equipment, *Saturn*, Supplement.

$38,500—Firestone Tire & Rubber Co., Los Angeles, for spare parts for *Corporal* Missile System.

MISCELLANEOUS

Transco Products, Inc., Los Angeles, received a contract from **Boeing Airplane Co.** for the design and manufacture of a 30 KW, K-band delay line with a choice of delay time remotely controlled for use with a ground check-out system.

Western Scientific Instrument Co. has been awarded a contract for programed maintenance, repair and calibration of vital laboratory test equipment in the La Jolla plant of the Control Systems Division of Daystrom, Inc.

Allison Div., General Motors Corp., received a contract from Atomic Energy Commission to begin preliminary design and development of a compact nuclear powerplant for military applications.

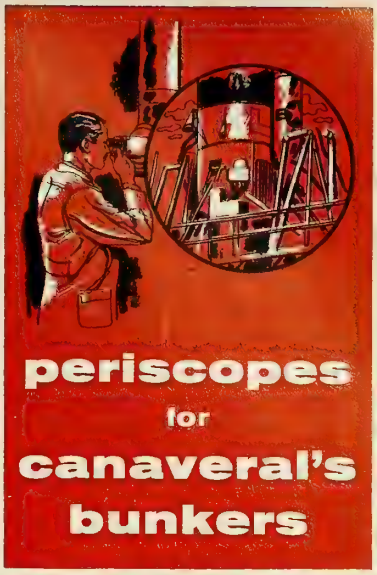
Ryan Aeronautical Co. has received a contract with Watertown Arsenal under which Ryan engineers will conduct experiments in explosive forming of standard and "exotic" metals.

$120,000—P. I. Steel Corp., Los Angeles, for construction of a missile fuel processing building.

NASA

$303,000—Hermes Electronics Co., Cambridge, Mass., for master timing and countdown systems to be installed at Wallops Island, Va.

$300,000—J. W. Fecker Division of American Optical Co., for installation of a long-focal-length tracking facility with specially designed and rotating telescope shelter tower at Wallops Island, Va.



With their viewing heads protruding from the domed bunkers at Cape Canaveral, Kollmorgen bunkerscopes provide a vital visual link between the launching pad and the observer. These instruments, used during launching operations and static tests, present images in true color, offer dual magnification and allow detailed observation in complete safety. They are ruggedly constructed to resist blast forces. Easy to operate, personnel need little if any special training in their use. Bunkerscopes require virtually no maintenance. Also, initial costs are generally lower than with other types of remote viewing systems. These instruments are easily adapted to photography and television purposes.

Working with optics, mechanics and electronics, the Kollmorgen Optical Corporation designs and manufactures many different types of remote viewing, inspection and testing instruments and systems. For a new illustrated brochure write Dept. 105.

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Circle No. 13 on Subscriber Service Card

British, Aussies Doubt Value of Man in Space

MELBOURNE—Three leading British and Australian scientists have agreed that American and Russian plans to shoot men into space were political stunts rather than scientific research.

Sir Harrie Massey, Australian-born Chairman of the British National Committee on Space Research, said at the Space Research Symposium of the Australian Academy of Sciences that it was relatively unimportant to put a man into space because instruments in rockets and satellites could supply better scientific observation.

"In his first future flights the spaceman will be concentrating only on the button which will send him back to earth," he added.

"Man in space does not seem a very good way to do scientific experiments. The justification for putting a man into space must be based on other grounds. The United Kingdom Space Programme does not provide for putting a man into space, but this is a vital part of the Russian and American programmes."

• **Long view**—Massey said the United Kingdom had the advantage of a good launching range at Woomera. The United Kingdom Space Research Programme was considerable, he pointed out, involving plans for one launching a month.

"This sort of work is not the kind which can be completed in a few years. There is no limit to the amount of study which can be profitable in the scientific sense," he said.

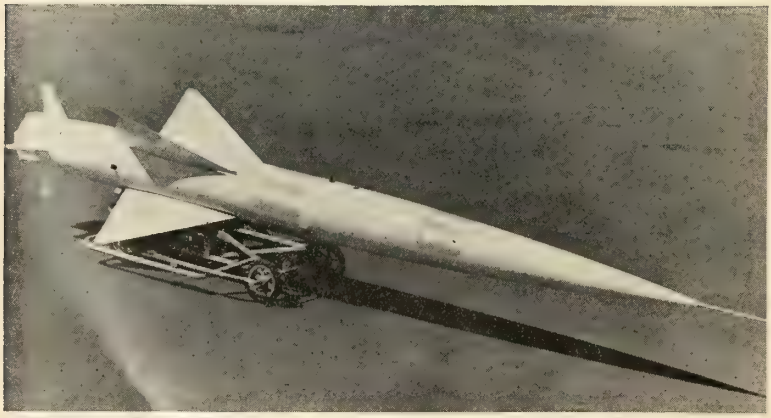
"The issue of whether the United Kingdom will engage in satellite shots is still being considered. It is something which has been actively considered and is getting very close to the final stages of decision."

Sir Harrie said that late next year the U.S. would launch a satellite in America carrying British instruments. Six to nine months later a similar cooperative launching would be made and a third was planned for a later date.

• **No strain**—The head of the Upper Atmosphere Section of the Commonwealth Scientific and Industrial Research Organisation, Dr. D. F. Martyn, said instruments put into space could provide much better information than a man because they did not suffer the strain, psychological and otherwise, that a man would undergo. There were enormous difficulties in space travel projects which had doubtful benefits except scientific. He did not believe there would be commercial space travel of people to the moon or the planets during our lifetime. However, America or Russia would probably place a man in orbit round the earth within a year or two.

The President of the Academy, Sir John Eccles, described the man-in-space project as being a kind of political demonstration rather than a scientific experiment.

Swiss Bird Widely Tested



SWITZERLAND'S RSD-58 has been tested in the United States, Italy and Japan. 19.7 ft. long, the missile develops 2200 lbs. of thrust, with a maximum range of 20 miles. It was developed by Oerlikon Co. and its electronic subdivision, Contraves.

Farnborough Show Slated To Be One-third Larger

The missile exhibit area at the British Farnborough Air Show this year will be about a third larger than last year's. Staged by the Society of British Aircraft Constructors, the Show will be held from September 5 to 11.

Although the floor space of the main building will be the same as in 1959, the actual stand space, including the equipment display, will be larger than ever before. Equipment manufacturers will get an increase of about a third; missile, airframe and engine manufacturers will be allotted an extra 8000 square feet.

The two big missile and aircraft manufacturing groups, Hawker Siddeley and British Aircraft Corporation, will each have consolidated stands covering 7500 sq. ft., while Westland, the helicopter group, will have 2000 sq. ft. The total, 17,000 sq. ft., will be 7000 sq. ft. more than the companies which comprise the new groups had last year. The main powerplant companies, Bristol Siddeley and Rolls-Royce, will each have 2000 sq. ft., the total of 4000 sq. ft., being 1000 sq. ft. more than in 1959.

French Now Probing Upper Atmosphere with Veronique

Biological and geophysical upper atmosphere test probes using *Veronique* rockets are being carried out by the Comité d'Action Scientifique de la Défense Nationale at Colomb-Bechar and Kerguelan Island test ranges.

Mice, carried in the rocket's nose cone and parachuted back to earth, will be used for the biological studies.

Veronique is now considered reliable. During early testing, only four complete successes were obtained out of 15 launchings; but since scientific experiments have begun, reliability has been in the ratio of two successes for three launchings. An advanced version of the *Veronique* will permit investigation up to about 435 miles.

Two-Stage Skylark Rocket Launched at Woomera

A two-stage *Skylark* research rocket recently launched at Woomera reached a height of 136 miles. Single-stage versions of the rocket have reached about 100 miles.

In making the announcement, R. L. Cartwright, Principal Scientific Officer of the Weapons Research Establishment, said it was hoped higher shots would be made with two-stage *Skylarks* when the second-stage engine was more fully developed.



Screw Lock Inserts Cut Costs

Supports for securing electrical wiring bundles, hydraulic tubing, plumbing lines and heater ducts in aircraft and missiles have been improved and installation costs reduced by 30% with Western Sky Industries' self-locking fasteners incorporating Heli-Coil (R) Screw-Lock inserts. WSI locking brackets reduce space requirements and increase rigidity and vibration resistance in aircraft and missiles.

WSI forged aluminum single and double fasteners are available in various lengths in increments of 0.1 in. The new fasteners replace combinations of nut plates, tube spacers and attachment lugs and do not require a clearance hole that penetrates and weakens the structural member. This type is also used in missile packaging, with or without shock absorbers, to attach delicate equipment to mounting plates which in turn are attached to the packing case. These cases must withstand high impact loads.

Circle No. 225 on Subscriber Service Card.

Electron Beam Furnace

A production-type electron beam furnace capable of alloying and refining ingots up to diameters of 4 in. and lengths of 14 in. has been developed by NRC Equipment Corp., Newton, Mass.

Designed for use by trained technicians as well as research scientists, the furnace operates in a vacuum of 10^{-6} mm Hg. Exceptionally pure ingots of tantalum, molybdenum, niobium, tungsten, cobalt, thorium, nickel and hafnium are easily produced without danger of contamination from electrodes or crucibles.

Model 2460 is divided into two separate chambers—one containing the electron gun and the other the mold and feeding mechanism. Each has a pumping system. The electron gun is protected from gas bursts by the separating shield.

The melting rate can be varied over a wide range, exposing the melt to a high vacuum for as long as desired. The main power supply delivers up to 3 amps at voltages up to 20,000.

Circle No. 226 on Subscriber Service Card.

Damping Compound Spray

A viscoelastic material which, when sprayed or trowelled onto metal plate, drastically reduces structurally borne noise and vibration has been announced by The Korfund Company, Inc.

Designated Korfund VIBRODAMPER compound, this damping material solves the problems of noise transmitted along structural paths thru sheet metal, and of the drumming noise created by vibration or thermal movements of metal plates.

VIBRODAMPER compound is handled like paint, dries to a smooth, attractive finish, is non-toxic and nonflammable. It is resistant to alkali, grease, gasoline, and aliphatic oils, and is unaffected by ozone or sunlight. It has an extremely long effective life, and does not become brittle or change in any way with age.

Circle No. 227 on Subscriber Service Card.

Rejection Circuit

Kearfott Division of General Precision Inc., has announced the availability of the D4816-01 quadrature rejection circuit designed to operate from a preamplifier or gain controlled amplifier into a transistor servo amplifier.

Small and lightweight, this device rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to the load and the magnitude of the in-phase signal.

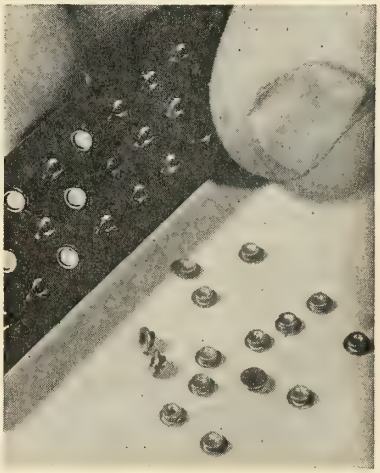
The unit is designed to operate in an ambient temperature range of –55°C to +115°C at altitudes from 0 to 100,000 feet.

Circle No. 228 on Subscriber Service Card.

Four Gigacycle Diodes

A miniaturized tunnel diode capable of oscillating at frequencies in excess of 4 gigacycles, four times the range of previously announced tunnel diodes, has been announced by Sylvania Electric Products, Inc.

The increased frequency range is



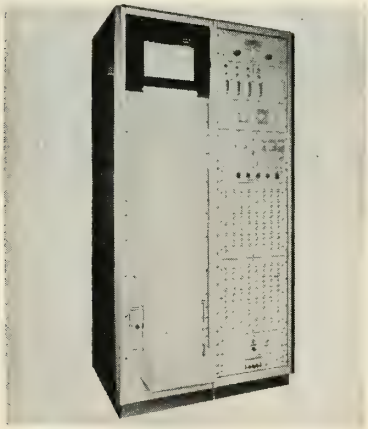
the result of a unique etching process and a low-inductance packaging technique. In addition to a frequency range of 3 kmc, the new tunnel diodes have a peak to valley ratio of 5 to 1, a peak current up to 4 ma, at approximately 50 millivolts, and a minimum current at approximately 350 millivolts.

Circle No. 229 on Subscriber Service Card.

Strain Gage Plotter

Designed for plotting strain or stress tests where loading is fast and data must be acquired rapidly, a new high speed strain gage plotter by Gilmore Industries, Inc. can be used to plot strain gage outputs on pressure vessels, rocket engine casings, and other structures.

The Model 221 scans and records 20 channels per second and plots in multiples of 96 channels. It automatically plots individual graphs for each



channel while the test is in actual progress. There are three zero positions per channel, separate range selectors, and separate gage factor selectors.

Switching is accomplished by heavy-duty large contact, low noise rotary type multi-deck switches. Positive gearing to chart drive insures synchronization between the chart graphs and their particular input channels.

Circle No. 230 on Subscriber Service Card.

Freeze-Free Transducer

An electro-pneumatic transducer that permits a pneumatic valve actuator to be used with an electronic control system has been designed by the Swartwout Division of the Crane Co. to eliminate freeze-ups caused by cold weather or low-temperature fluids.

The Type P2R Power Relay contains a 30 watt heater in the pneumatic section that prevents moisture in the air from freezing the mechanism.

It is a null-balance unit that contains no vacuum tubes, journal bearings, or other friction surfaces. A magnetic force is opposed by an air-loading pressure to produce a pneumatic force linearly proportional to the electrical output of the controller. The unit is temperature compensated to maintain its calibration accuracy over a wide range of ambient temperatures.

Circle No. 231 on Subscriber Service Card.

Multiple Throw Switches

A line of single-pole multiple-throw solid-state (crystal) microwave switches has been developed at American Electronic Laboratories, Inc. In addition to the single-pole ten-throw unit, A.E.L. has built double-throw and four-throw switches. These switches are generally characterized by their rapid switching time—less than 10 millimicroseconds—low insertion loss when "on" coupled with high "off" attenuation, broad RF bandwidth and the small amount of switching power required.

Units are available in various frequency ranges from 10 mc to 10,000 mc.

Circle No. 232 on Subscriber Service Card.

new literature

CONFORMAL CASTING. Methods of forming molds for casting resins by vacuum-drawing heated thermoplastic sheets over electrical components are described in an 8-page booklet available from Minnesota Mining and Manufacturing Co. The booklet is complete with photographs which demonstrate the vacuum forming process. A section is devoted to a discussion of materials and equipment required for developmental study.

Circle No. 200 on Subscribers Service Card.

SMALL TUBING GUIDE. A revised edition has been published by Superior Tube Company. The 12-page bulletin—designed for fast, easy selection of tubing for any given application—briefly summarizes the significant properties of 84 tubing analyses in seven groups: carbon steels, stainless steels, alloy steels, nickel and nickel alloys, copper-base alloys, glass sealing alloys and reactive metals. Each alloy is described in an easy-to-read tabular style which provides the AISI type number, available form (seamless or weldrawn), characteristics, and applications. Also included are concise descriptions of 13 specialty tubing products: hypodermic needle, capillary, super-pressure, aircraft hydraulic, miniature heat exchanger, large OD thin wall, superalloy, diesel fuel injection, carbon mechanical, SAE carbon hydraulic, tool steel, Bourdon, and thermocouple tubing.

Circle No. 201 on Subscriber Service Card.

SLIP RING ASSEMBLIES. A 28-page catalog available from Breeze Corporations, Inc., describes its line of seven standard slip ring assemblies for general purpose control and power, high voltage, radio frequency and video, switching and high-speed instrumentation. The catalog includes specifications and drawings of all the standard assemblies and photos and operating data on the custom units. In addition, there is illustrative and descriptive material on flat, cylindrical and concentric assemblies and a section on the manufacture of fabricated, plated and molded slip ring assemblies, ring materials and brushes.

Circle No. 202 on Subscriber Service Card.

HERMETIC SEALS. Catalog 1259, listing basic types of precision hermetic seals which are regularly available for evacuated or pressurized enclosures, has been published by Dage Electric. Each type of seal is clearly illustrated and listings give complete dimensional specifications. A special section gives latest accepted glass seal nomenclature. To assist the designer who requires custom-made seals, the 28-page catalog also covers general manufacturing techniques and usage recommendations. Dage precision hermetic seals are tested to insure unit integrity with respect to moisture, corrosion, extreme pressures, vibration and rare atmospheres.

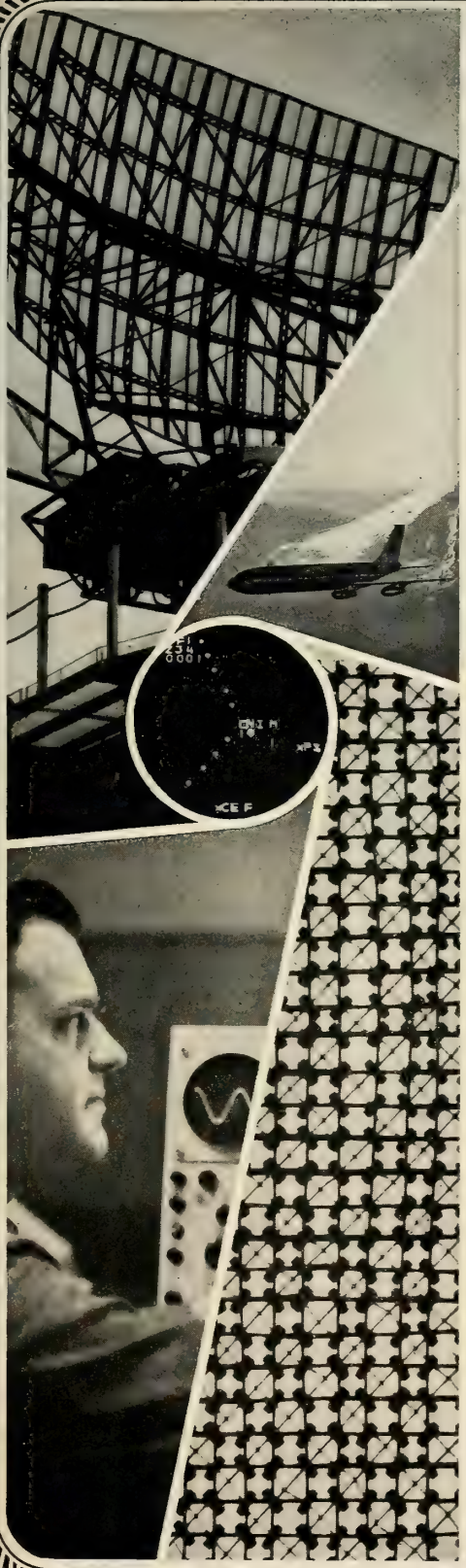
Circle No. 203 on Subscriber Service Card.

CLEVELAND AERO-SPACE ASSOCIATION, INC.—A brochure describing the capabilities of a group of industrial firms in the Cleveland area with many years of successful subcontracting experience in the missile, aircraft and general ordnance fields. Members are heavy investors in research and development facilities. Some of the areas include flight propulsion, missile fuels, chemicals, atomic energy and metallurgy.

Circle No. 204 on Subscriber Service Card.

WHICH WELDING PROCESS FOR THE NEW METALS? Authored by I. D. Holster, applications engineer, Air Reduction Sales Company, the brochure offers a comprehensive review of the problems involved in joining the new metals and alloys used in aircraft and missile design such as: PH stainless steels, ultra-strength steels, rene 41, beryllium, zirconium, molybdenum, tantalum and columbium. The article also contains tabular presentation of process data on four of these new metals.

Circle No. 205 on Subscriber Service Card.



ENGINEERS • SCIENTISTS

AIR TRAFFIC CONTROL SYSTEM DEVELOPMENT

• • • A growing area of activity at The MITRE Corporation where original thinking can find broad application

The MITRE Corporation is directing its experience in System Engineering toward the development of an integrated air defense/air traffic control system. To test the techniques and designs for full-scale system implementation, an advanced active experimental program, SATIN (SAGE Air Traffic Integration), is being developed by MITRE under contract from the Federal Aviation Agency. Employing a SAGE AN/FSQ-7 computer and associated radar and communications networks maintained by MITRE, SATIN will be capable of controlling aircraft in a test area that includes New England, New York and New Jersey.

MITRE's Air Traffic Control Department faces exacting problems in the areas of system design, development and evaluation. Precise methods must be developed for providing improved en route air traffic control services without compromising the air defense mission.

Engineers and scientists with an interest or previous experience in air traffic control problems are invited to investigate immediate Technical Staff openings.

Inquiries may be directed in confidence to:
VICE PRESIDENT — TECHNICAL OPERATIONS

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MITRE *is an independent system engineering organization, formed under the sponsorship of the Massachusetts Institute of Technology. Its convenient location in suburban Boston affords excellent opportunities for advanced study under* MITRE's *liberal educational assistance program.*

Bastian (Buzz) Hello: Former P5M and miscellaneous programs manager for The Martin Co.'s Baltimore Division, named program manager for the rocket booster portion of the Air Force *Dyna-Soar* project. **William A. Bortner,** operations planning manager since 1957, replaces Hello in his former position.


HELLO

C. B. Wilson: Elected vice president-program development for Applied Science, Inc. Was formerly corporate systems engineer for Fairchild Engine and Aircraft Corp.

Jean R. Nelson: Former project engineer with Minneapolis-Honeywell Co.'s Aeronautical Division, named director of engineering for Winzen Research, Inc., responsible for efforts in the design and construction of manned balloon/sealed cabin systems for scientific research in the stratosphere.

Gerald Lewis: Director of product engineering for Cooper Alloy Corp., appointed director of product development responsible for the development and introductory marketing.

Arthur P. Notthoff, Jr.: Former manager of Serva Engineering in Dalmo Victor's Engineering Division, named manager of engineering of the Electronic Systems Division.

Kenneth H. Hobbie: Promoted to director of marketing for the Driver-Harris Co. **W. P. Smith** succeeds Hobbie as sales manager.

Harold W. Gear: Elected manager of Operations Analysis within Atlantic Research, Inc.'s Solid Propellant Division. **Roger N. Saleeby, Jr.,** succeeds Gear as plant manager of the Pine Ridge facility.

Robert Beltz: Developer of the transistorized voltage tolerance supply for the *Falcon* missile and of components for the telemetry of the *Atlas* and *Thor*, joins the Jordan Electronics Division of The Victoreen Instrument Co. Was formerly staff engineer at Hughes Aircraft Co.


BELTZ

William C. Adams: Joins Lockheed Electronics Co. as manager of the Computer Systems Division of Information Technology. Previously served in various technical and scientific positions including six years at Edwards AFB.

Marvin E. Groll: Named product sales manager-microwave diodes, for the Semiconductor Division of Sylvania Electric Products, Inc., replacing **R. A. Swanson,** named product sales manager-transistors.

Robert O. Vaughan: Named vice president-marketing at Southwestern Industrial Electronics Co., with **Thomas M. Lynch** as marketing manager, Heavy Military Electronics. **S. Field Emerson** promoted to marketing manager, Light Military Electronics.

David Fox: Elected director of the Computer Division of the Systems Research Group, Inc.

John J. Giba: With American Bosch Arma Corp., since 1932, appointed manager of the firm's Tele-Dynamics Division.

Othmar W. Sailer: Former manager of product planning for Wiancko Engineering Co., named director of marketing for the Unitek Corp.

Jack L. Bowers: Named to the newly created position of vice president, Electronics Systems and Equipment Operation, Crosley Division, Avco Corp., responsible for engineering, marketing, production and administration. Was formerly assistant chief engineer-design for Convair Astronautics.


BOWERS

Kearfott Division of General Precision, appoints: **Walter J. Krupick,** general manager, Gyrodynamics; **William Supina,** manager and chief engineer of the Precision Gyro Dept., Gyrodynamics, and **John J. Daly,** manager and chief engineer of the Gyro Reference Dept., Gyrodynamics.

John F. Hegarty: Elected vice president-marketing of National Semiconductor Corp. Was formerly marketing manager.

Bruce McKay: Formerly general products manager, Vertol Division of Boeing Aircraft, appointed assistant vice president-marketing for Bell Aircraft Corp.'s Niagara Frontier Division.

Dr. James N. Waggoner: Medical director for The Garrett Corp.'s AiResearch Manufacturing Co., elected a Fellow of the Aerospace Medical Association. He has been assisting in the development of the environmental control system for NASA's Project *Mercury* and is one of nine chosen for his outstanding contribution to the aerospace medical field.

Donald F. Davern: Former manager of planning at Hughes Aircraft Co.'s Tucson missile manufacturing plant, named project manager of industrial control systems,

James R. Wescott: Appointed to the newly-created position of vice president-marketing for the Gabriel Electronics Division of The Gabriel Co. For the past five years was marketing manager of the Heavy Military Division of General Electric Co.


WESCOTT

William W. Crossman and **Robert J. Martin:** Named, respectively, manager and sales manager of Hitemp, Inc., a newly formed subsidiary of Hitemp Wires, Inc.

Stanley A. Lawrence: Appointed assistant division manager-Special Project for Collins Radio Co.'s Western Division.

Ted J. Gordon: Named project engineer of Douglas Aircraft Co.'s *Saturn* second-stage program at Cape Canaveral. **Hal M. Thomas** appointed manager of the project. Gordon was previously project engineer for the *Thor-Able* space vehicle program and the *Delta* space probe and satellite launchings. Thomas was program manager of the *Thor* IRBM.

George D. Clark: Appointed manager of RCA's missile test project at the Air Force Missile Test Center, succeeding **K. M. McLaren,** who recently resigned as vice president, MTP.

Dr. James M. Carter: Recently corporate research advisor for Aerojet General Corp., appointed director of the Physical Sciences Division of Space Systems Laboratories.

Dr. Alan G. Stanley: Advanced to assistant director of research at General Transistor Corp.

James R. Corcoran, Jr.: Former president and treasurer of Topic, Inc., appointed assistant to the vice president of the Ogden Division of The Marquardt Corp.

Alan R. Stearns: Former partner and general manager of the Stearns Co., elected manager, special projects, for Marshall Industries.

Harold A. Price: Named manager, industrial products division of Horkey-Moore Associates. Was formerly manager of the Permanent Filter Corp.'s Lafayette and Long Beach Divisions.

Donald A. Cook: Appointed director of the Transducer Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

—when and where—

MAY

National Telemetering Conference, Miramar Hotel, Santa Monica, Calif., May 23-25.

Tappi Coating Conference, Eleventh Annual, Edgewater Beach Hotel, Chicago, May 23-25.

German Society for Rocket Engineering and Space Flight, 12th Annual Meeting, Research, Heidelberg, West Germany, May 23-25.

ASME Design Engineering Conference & Show, Statler Hilton Hotel, New York City, May 23-26.

14th Annual Armed Forces Communications and Electronics Association Convention, Sheraton-Park Hotel, Washington, D.C., May 24-26.

American Society for Quality Control, Annual Convention, Sheraton-Palace Hotel, San Francisco, May 24-26.

Japanese Rocket Society, Second International Symposium on Rocketry and Astronautics, University Club in Tokyo, May 24-28.

IAS Specialists Meeting, Guidance of Aerospace Vehicles, Hotel Somerset, Boston, May 25-27.

The Psychophysiological Aspects of Space Flight, sponsored by the School of Aviation Medicine, ATC, Aerospace Medical Center, Southwest Research Institute, San Antonio, May 26-27.

Society of Naval Architects and Marine Engineers, Spring Meeting, Statler Hotel, Washington, D.C., May 26-28.

Fourth International Symposium on the Reactivity of Solids, Amsterdam, May 30-June 4.

JUNE

Instrument Society of America, Annual Instrumental Methods of Analysis Symposium, Montreal, June 1-3.

Sixth Annual Radar Symposium, University of Michigan, sponsored by Army, Navy, AF, Willow Run Laboratories, Ann Arbor, June 1-3.

Fourth Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, NYU's University Heights Campus, Bronx, N.Y., June 2-3.

ASME Summer Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, June 5-9.

Society of Automotive Engineers, Summer Meeting, Edgewater Beach Hotel, Chicago, June 5-10.

Machinability Seminar, Pennsylvania State University, University Park, June 6-10.

National Society of Professional Engineers, Annual Meeting, Statler Hotel, Boston, June 8-11.

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 12-15.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

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Space Act Revision—Well Done

Two years ago, in an atmosphere of startled concern over Russian achievements in space, Congress passed the National Space Act. It was hastily-drawn legislation and not the best.

The House Space Committee has now reported out a reorganizational bill (HR 12049). It is an excellent measure. It corrects the major faults of the original. It deserves to pass the House and to be sent to the Senate Space Committee without deviation so that final action can be accomplished at this session of Congress.

The new measure eliminates many of the undesirable features of the old bill, adds certain necessary clauses and clarifies roles and missions in the space field. Specifically, it:

Relieves the President of a rather ridiculous role as project officer for space projects.

Abolishes the President's National Space Council and substitutes a DOD-NASA board co-chairmanned by NASA's Deputy Administrator and DOD's Director of Research and Engineering.

Eliminates the Civilian-Military Liaison Committee.

Gives the military a positive role in space.

Strengthens NASA's peaceful role in space.

Pulls NASA's patent authority into line with that of the military.

Provides machinery to indemnify contractors against unusually hazardous risks.

The first three listed changes are purely administrative. Making the President personally responsible for planning and surveying the nation's space needs had placed upon him an impracticable burden, which will now be removed. Elimination of the Space Council follows logically; its chief function was to advise the President on the detailed work he is no longer responsible for —and really never did anyhow.

The Civilian-Military Liaison Committee never functioned, either, for a number of reasons. The new measure insures coordination and cooperation between NASA and DOD at all levels.

Giving the military a positive role in space was a much-needed step. We pursue peaceful exploration of space with the very best intentions, but it is easy to foresee that a time may come when we shall have to fight to be allowed to conduct this exploration. Certainly the military must be prepared to see that no other nation denies us the right to operate in space.

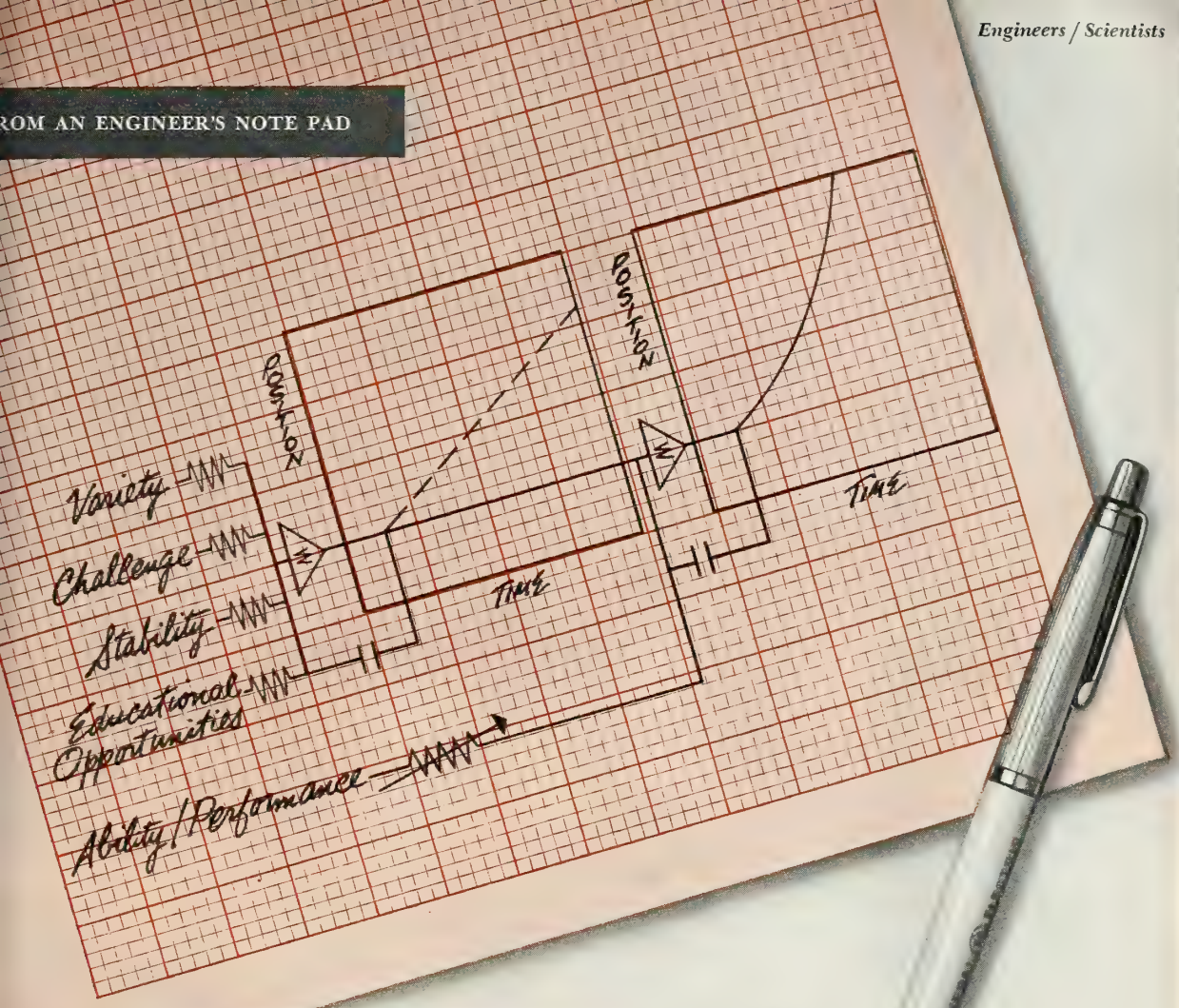
The role of NASA is strengthened by giving the agency a clear responsibility for planning and directing civilian space activities for peaceful purposes. Thus it gives the NASA administrator many of the executive duties heretofore incumbent upon the President. If there is a dispute between NASA and the Services, then the President must arbitrate.

As previous Congresses have done, the Subcommittee concluded that the interests of the government and national economy are best served by allowing a contractor to retain the rights to a scientific invention. The reason is, of course, primarily incentive—specifically because many space research programs generate commercial applications. Without patent protection the manufacturer has little incentive to develop for the commercial market. Under the revised law, the government has rights to the invention for its own use but permits the inventor to retain commercial rights.

The addition of indemnification is just common sense. In dealing with potentially hazardous space powerplants, no contractor can be or should be exposed to the enormous financial risks which might incur through an accident—risks so large that it is impossible to obtain insurance against them. The new bill provides protection.

Few would claim that HR 12049 is the perfect solution. But it certainly is a great improvement over its predecessor, and it appears to provide a workable law. We urge the fastest possible action in both houses of Congress on this imperative piece of legislation.

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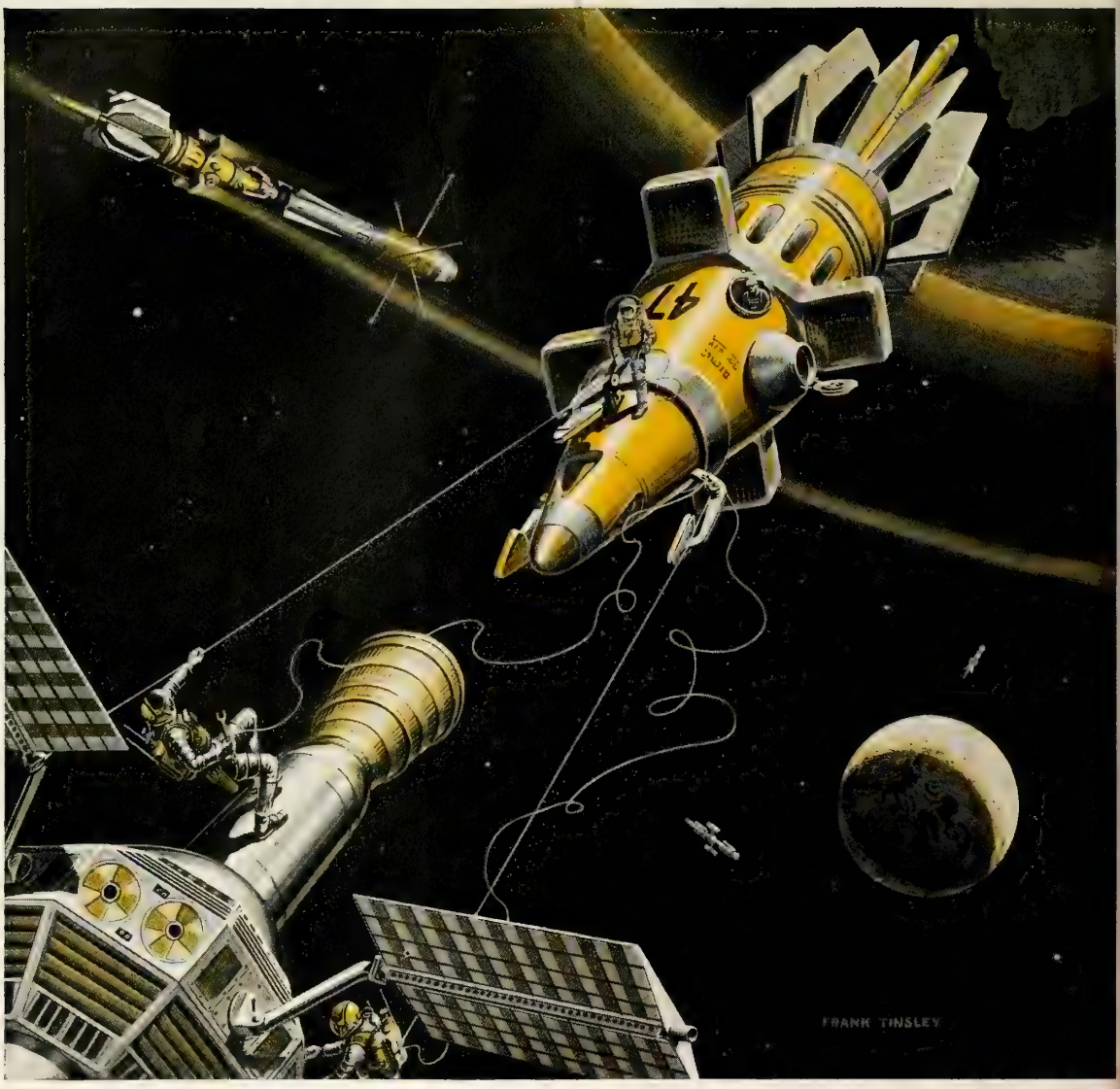
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STEPS IN THE RACE TO OUTER SPACE

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By 1970 our solar system will be filled with expended satellites—whirling aimlessly in space with dead batteries and electronic equipment, their missions long since completed.

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2. Crewmen attach lines to the satellite (as in illustration). Then they haul the towboat forward and its nose cone is clamped to the satellite's rocket nozzle.

3. The towboat's engines are then switched to full reverse and the linked machines gradually lose momentum, nosing into a spiral path toward the Earth below.

4. When a safe point is reached, the towboat automatically releases the satellite and it is consumed by friction as it plunges into the heavier atmosphere. The towboat, regaining its speed, moves on to its next assignment—breaking a traffic jam in some other congested point in space.

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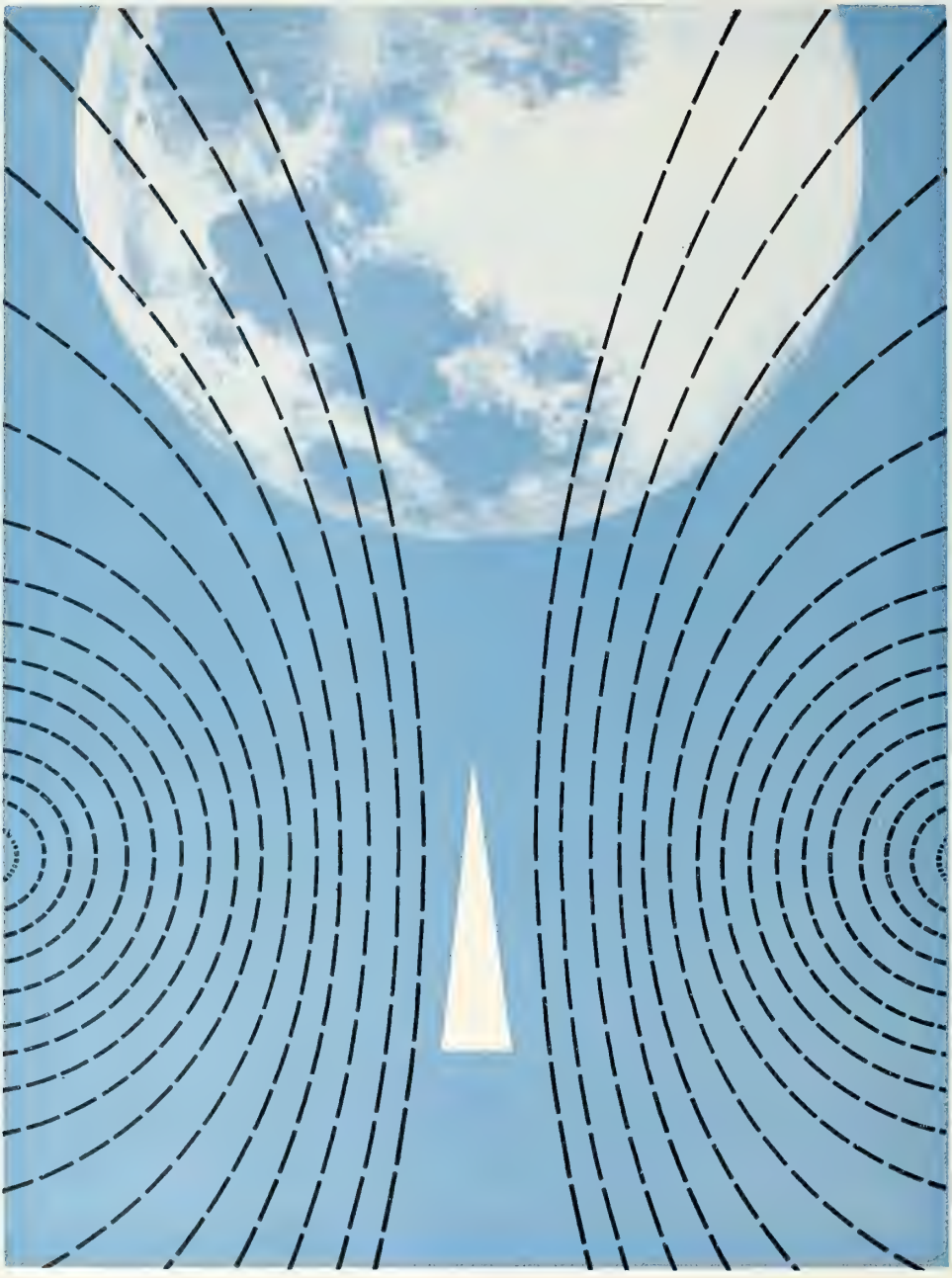
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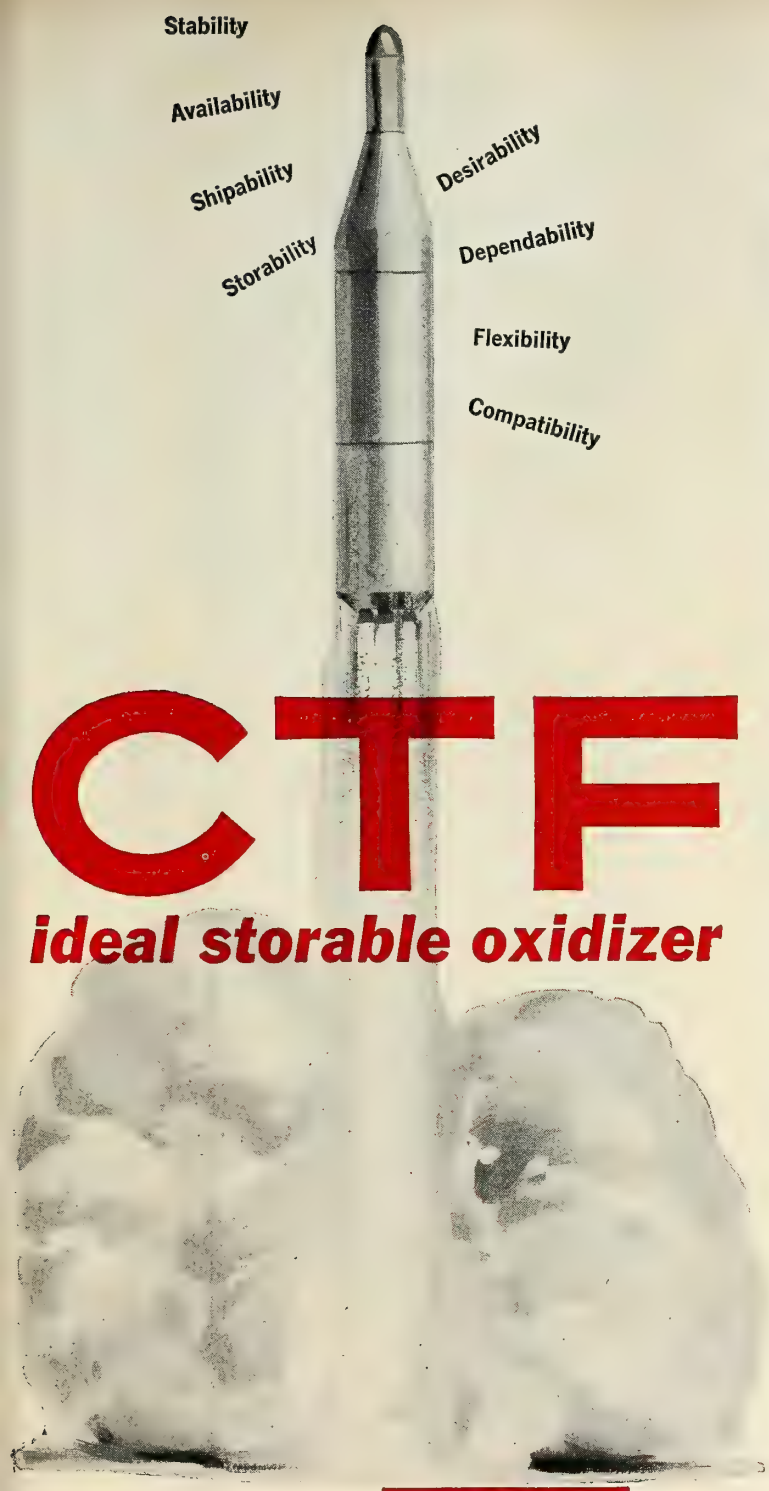
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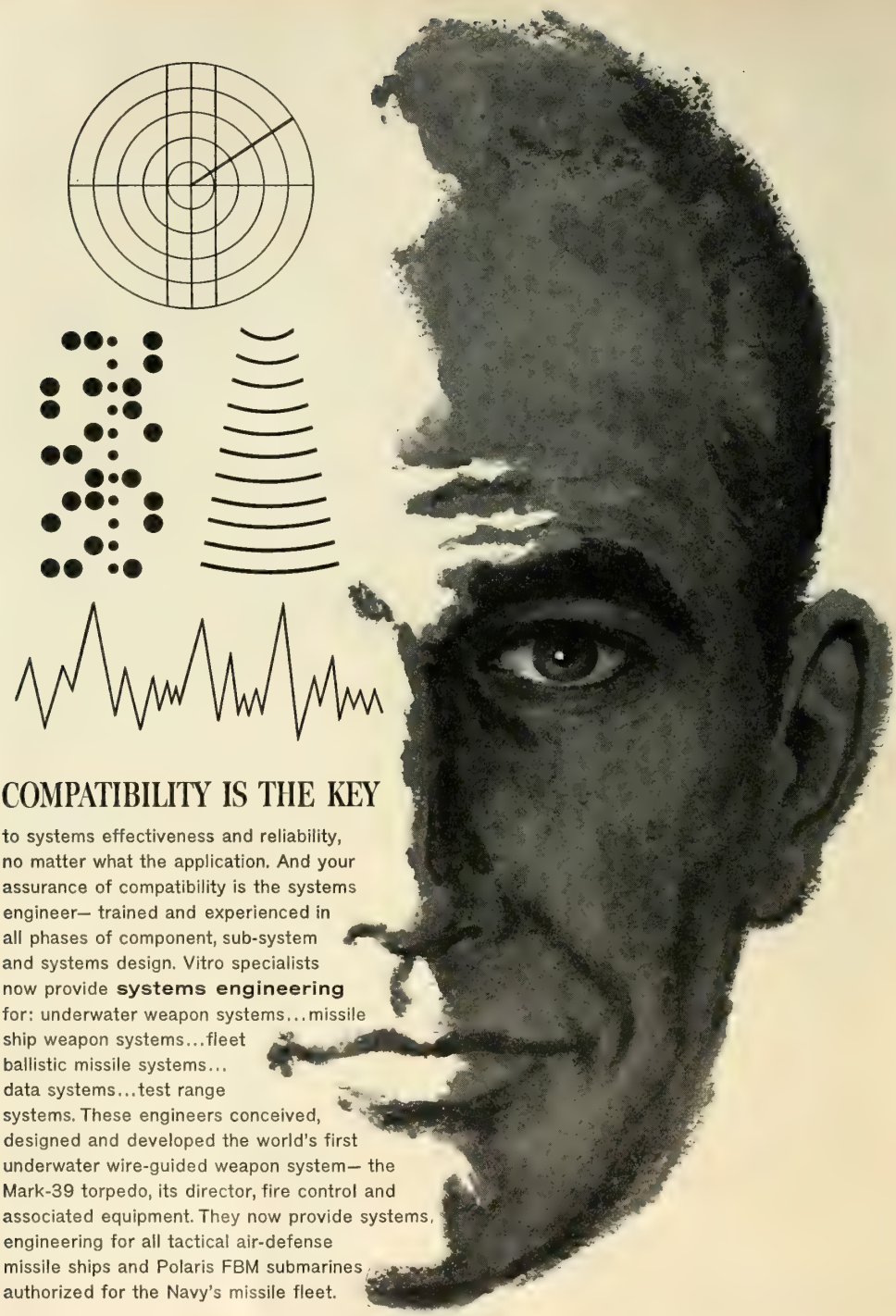
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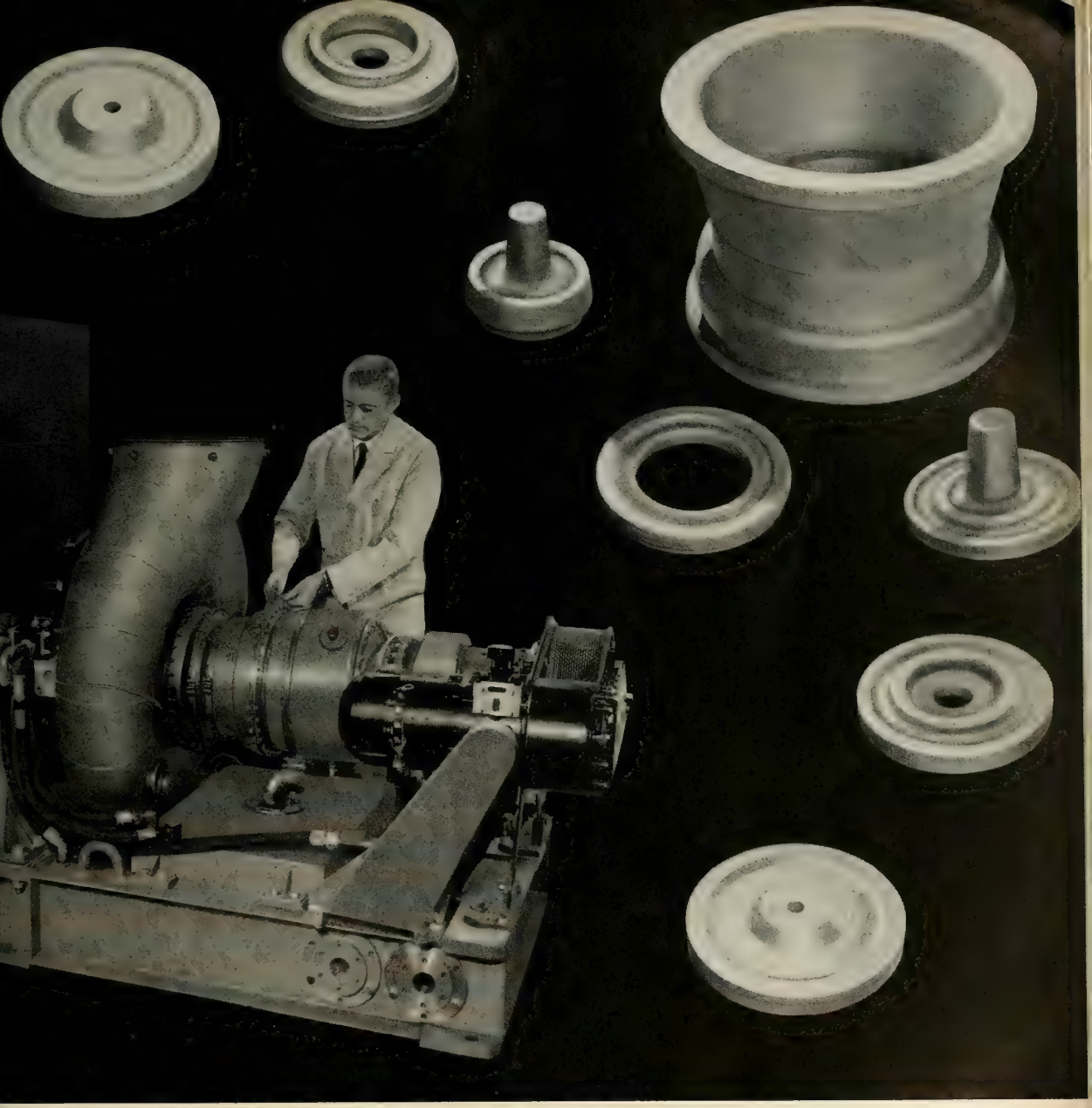


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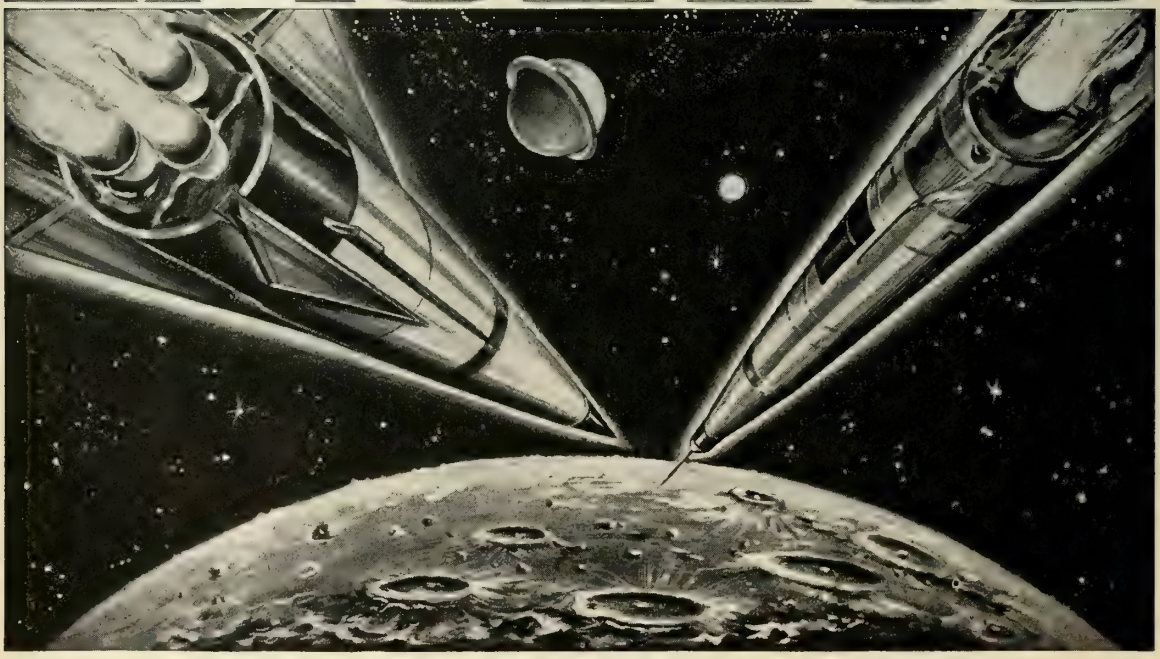
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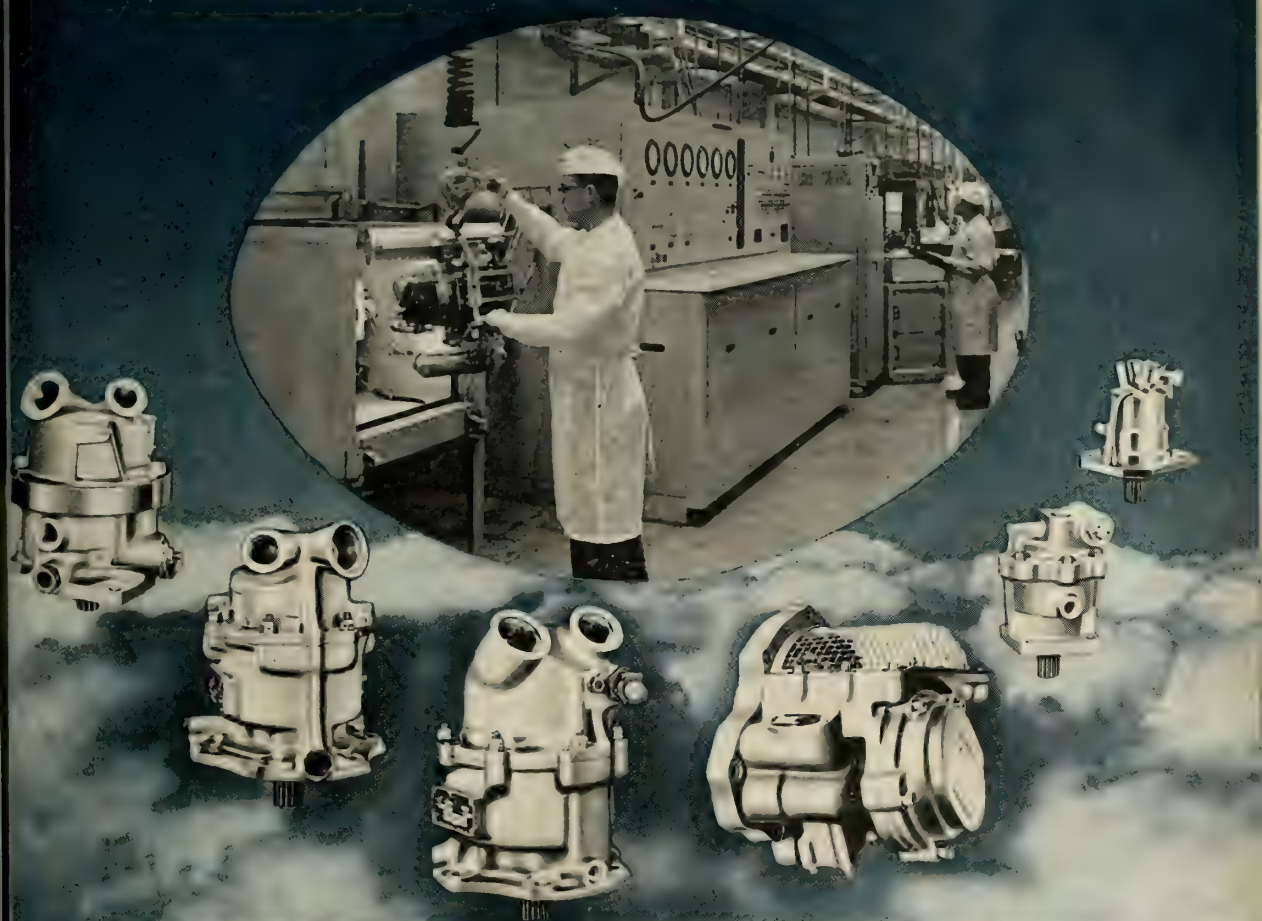
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P65	.65	8.1	6000	16.2	.286	9000	24.6	.188	4.66	6.00
P56	.568	8.1	7000	16.5	.281	10000	23.9	.194	4.66	6.00
P16	.163	3.5	12000	8.0	.250	16000	10.8	.185	3.50	4.75
P11	.115	2.6	12000	5.7	.261	16000	7.7	.193	3.25	4.47
*Stainless Steel Housings with No Increase in Weight										
*P064	.064	2.1	12000	3.1	.388	18000	4.8	.250	2.125	3.35
*P044	.044	1.8	12000	2.15	.479	18000	3.3	.312	2.000	3.06
'Pump Weight/Hydraulic Horsepower at 3000 PSI										

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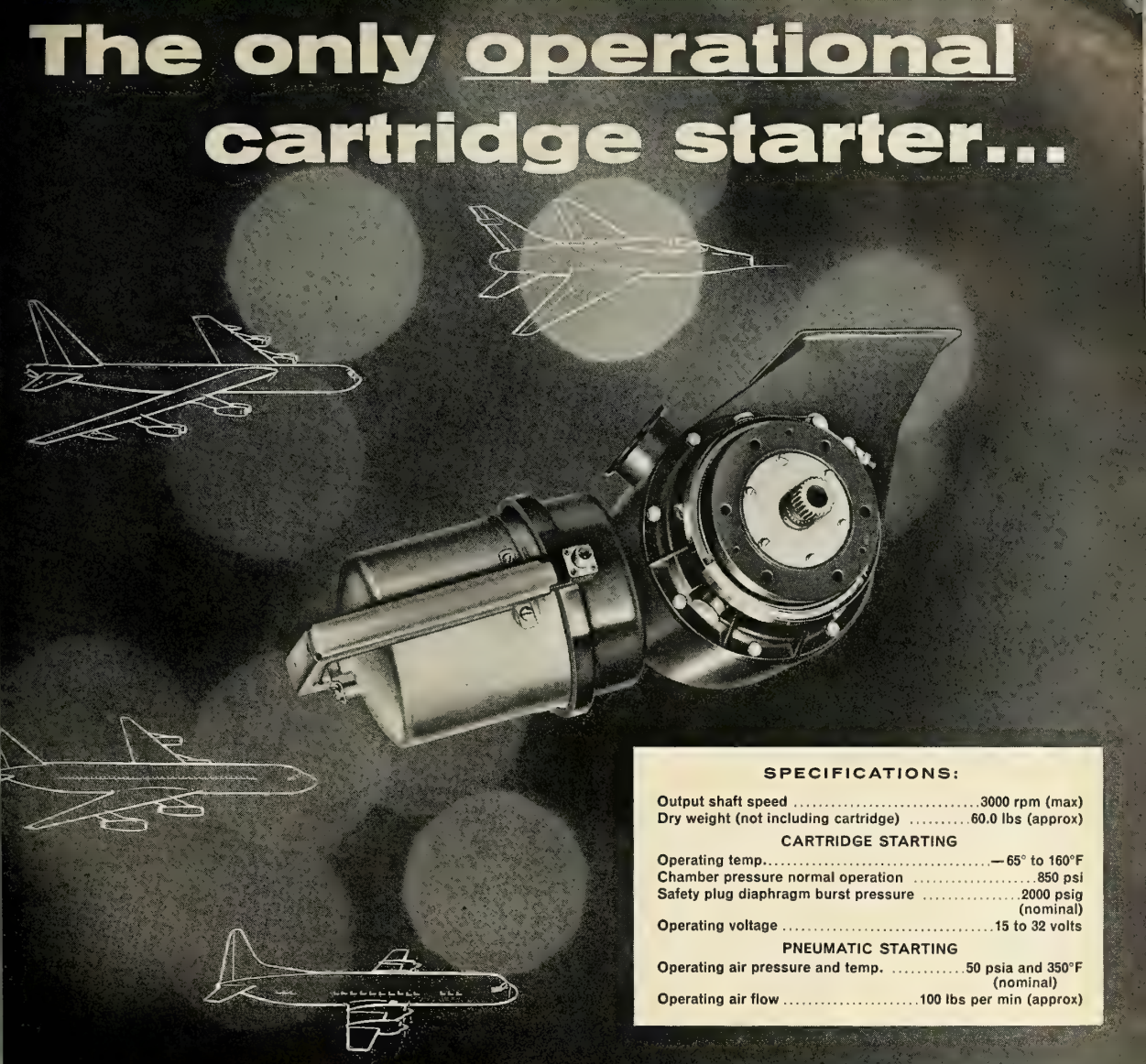


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Operating temp.	—65° to 160°F
Chamber pressure normal operation	850 psi
Safety plug diaphragm burst pressure	2000 psig (nominal)
Operating voltage	15 to 32 volts
PNEUMATIC STARTING	
Operating air pressure and temp.	50 psia and 350°F (nominal)
Operating air flow	100 lbs per min (approx)

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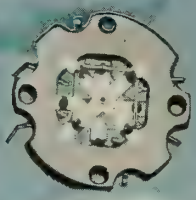
Your inquiries are invited.

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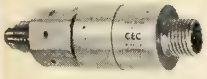
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—letters—

Impressed by Rickover

To the Editor:

I am certain that the Congressional testimony by Vice Adm. Hyman G. Rickover reprinted in M/R, May 9, is sure to raise many eyebrows and trigger mixed emotions at all levels of government, industry and the public at large.

My hat is off to the Admiral for presenting it and to you for publishing it. What he has to say is no earth-shattering news, as I am sure the problems which he speaks of with such authority and conviction are the basic administrative maladies confronting our technical climate. Although the excerpted testimony is short, those who read it can do an awful lot of reflecting and soul-searching. It may be that something as brief and sincere as this will stimulate those who can do something about the drastic state of the technical lag in this country.

Richard D. Ventres
North Babylon, L.I., N.Y.

Canadian Unification

To the Editor:

In regard to your announcement concerning astronautical unification in Canada (M/R, May 16, p. 38), we would be most grateful if you would correct a mistaken impression which has caused considerable confusion and not a little embarrassment over the last two years.

The Canadian Astronautical Society is in no way tied up with or part of The de Havilland Aircraft of Canada, Limited, either now or in the past. True, the Sosiety was founded by a handful of engineers from the company's Guided Missiles Division and, further, the company has always adopted a benevolent and helpful attitude, but the Society is and always has been an independent body, its de Havilland membership amounting to only a few percent of the total.

As regards the unification move we started in Canada over a year ago, negotiations are still in the early stages and we were surprised to see a unilateral press release on the subject at this early time with so little settled.

E. E. Maine, Acting Secretary
The Canadian Astronautical Society
Downsview, Ontario

Air Catch by 'Harpoon?'

To the Editor:

It seems to me that reports indicate that we are having great difficulty in perfecting the "air catch" system for recovering nose cones or capsules of any nature.

I would like to offer a suggestion, but I do not know exactly where to direct it. Perhaps if it has any merit you could forward it to the appropriate persons.

The idea:

As the whaler harpoons his prey by firing a spear with barbs, so then could we,

← Circle No. 7 on Subscriber Service Card.

by launching a small missile such as the *Sidewinder*, which we would home in on a radiation cell suspended under the parachute. By towing a line with grappling hooks, the missile could snag or thread the suspension lines of the chute. By giving some slack to the line until the missile had cleared the area of the chute, it could then be "braked," causing the line to leave the missile, as an umbilical cord, and set off a destructive charge to prevent any earthly damage by the missile. Hence your catch, by an already proven accurate harpoon.

D. G. Carberry,
Great Valley Laboratory
Burroughs Corporation,
Paoli, Pa.

ASW Praise and Caution

To the Editor:

You are making a much needed contribution to the very important subject of ASW, particularly since the House Appropriations Committee is urging a Manager for ASW. Congratulations! I shall read the subject matter in your new department with great interest.

H. L. Collins, RADM, USN (Ret.)
Assistant to Technical Manager,
Central Technical Dept.
Shipbuilding Div., Bethlehem
Steel Co., Inc.
Quincy, Mass.

To the Editor:

The lack of (editorial) coverage of ASW engineering and its problems has been apparent to me and others in the field—but not to enough others.

The advent of the new nuclear-powered, missile-firing submarines should dramatize the importance of this field.

I certainly look forward to reading additional coverage in this area. I think it will provide a real and necessary service.

Anthony J. Finocchi,
Quality Assurance Manager
ITT Laboratories
Nutley, N. J.

To the Editor:

To date your new ASW section has been most interesting. Several of the articles, such as the ASW Budget breakdown, have been most informative. You have made a bold start and I do hope you will be able to continue, although I realize you are going to be limited, owing to the highly classified status of most of the information on the subject.

May I inject a word of caution? Somewhat more care is needed in assuring the accuracy of your data. I have noted some rather glaring inaccuracies which tend to raise doubts in the reader's mind as to the exactness of statements on subjects with which he is less familiar.

Best of success for your new project.

Frank D. Peltier, Chairman
Weapons Sub Task Committee,
ASW Advisory Committee
National Security Industrial
Association

M/R strives for accuracy; we'd welcome any specific corrections.—Ed.

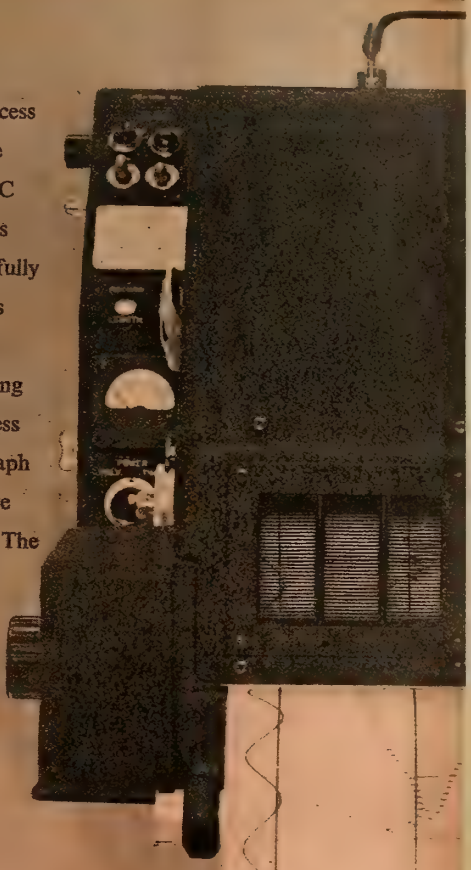
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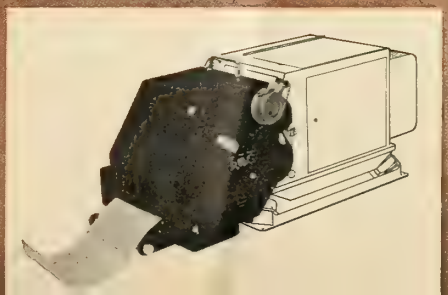


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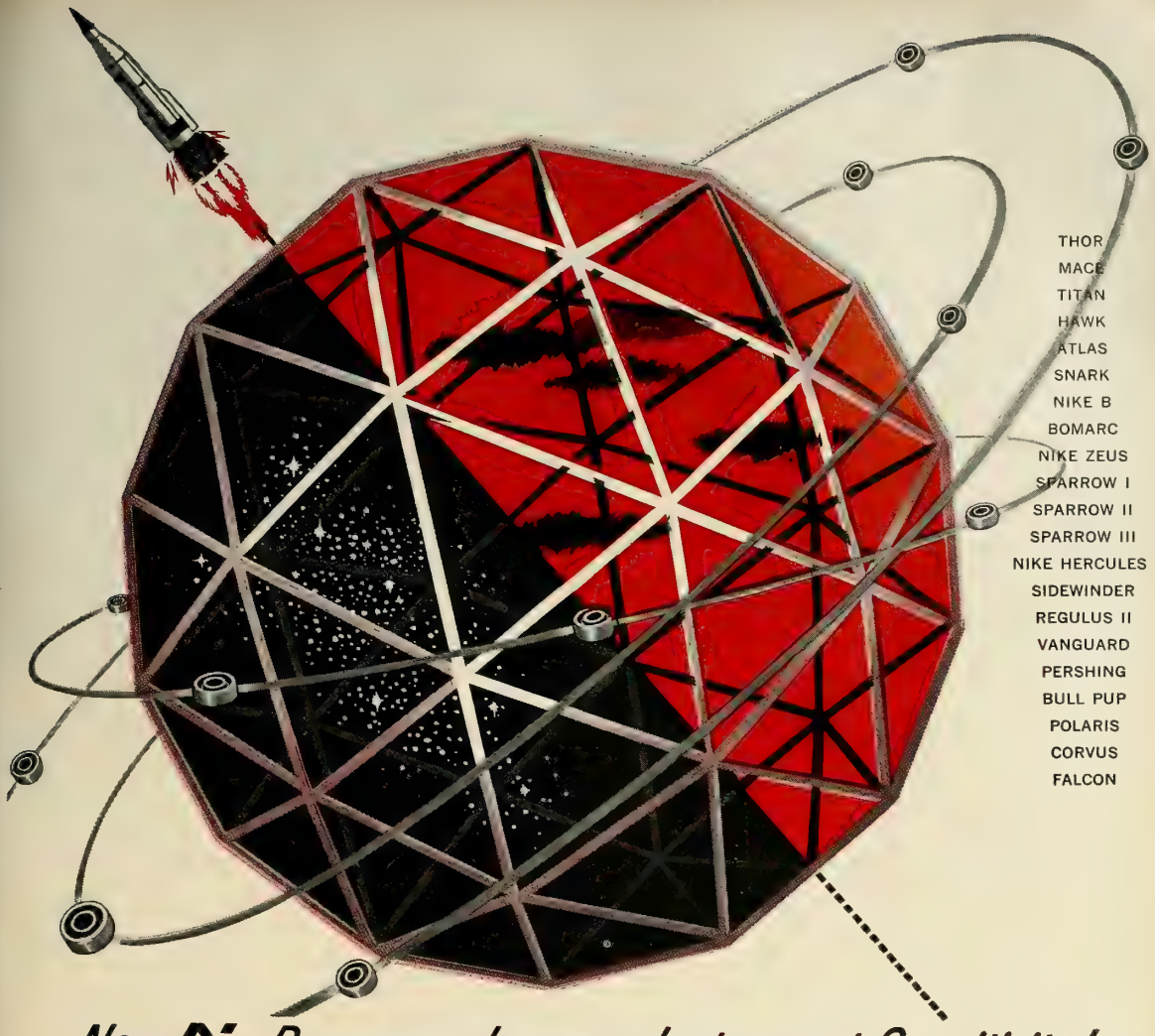
Official United States Navy Photograph

Sparrow III Navy air-to-air missile is now operational with both the Sixth and Seventh Fleets. Raytheon is prime contractor for this potent weapon.

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The Countdown

WASHINGTON

Missile Oversight

In the switch to missiles, the Navy now finds itself without a replacement for the battleship-mounted 16-inch gun of yore. The *Talos* antiaircraft missile is too expensive for shore bombardment, so the Navy is frantically trying to develop a cheap, 10-40-mile-range bird which would have a high-explosive warhead effective against shore installations or other ships in limited war.

Samos May Be Twins

The Air Force may wind up with two types of *Samos* reconnaissance satellites. One would radio pictures back to earth from orbit—the other would send them back via capsule, like *Discoverer*. The AF has a *Samos* camera about the size of a Speed Graphic that can photograph a plane on the ground from a distance of 300 miles.

Missile Question of the Week

Is the *Nike-Zeus* program in greater jeopardy? The House already has taken back $8 million intended for *Zeus* drone-launching installations on Johnston Island in the Pacific on grounds that DOD doesn't want them. But DOD says it hasn't decided yet. Elimination of the *Jupiter* drone program for the AICBM would mean that *Zeus* could only be tested by trying to score near-misses against ICBM's launched from Vandenberg AFB.

Transit II Marks Time

Launch of another Navy R&D *Transit* navigation satellite has been delayed while the Air Force installs range equipment improvements at Cape Canaveral. The shot, originally scheduled for May, now will be attempted sometime in the next month to six weeks.

INDUSTRY

The Return of Plato

The Army's call for July 5 bids on a mobile antimissile missile feasibility study (M/R, May 23, p. 11) actually is a revival of its old *Plato* program. The new system—like *Plato*—would give the Army a battlefield antimissile missile that could be used against anything from big tactical missiles to ICBM's. As envisioned originally by Sylvania, *Plato* would utilize the *Nike-Zeus* missile and other components of the *Zeus* system.

Hydrazine Plant Going Up

A $15-million hydrazine plant for the *Titan* storable liquid fuel program is being built by the Air Force at Saltville, Va. Olin Mathieson will operate it.

Out of the Missile Industry

Firestone Tire & Rubber Co., THE COUNTDOWN is told, will close down its guided missile division by November.

Lanphier Crusade Nears End

Ex-Convair v.p. Thomas J. Lanphier Jr. is winding up his "Missile Gap" crusade this week and heading back home to San Diego. His next move: a job—possibly with a foundation, newspaper or TV network.

More on Minuteman

The Air Force is now planning to test-fire *Minuteman* from railroad car launchers at Cape Canaveral. The Southern Pacific RR will take part in the initial operational launches from Vandenberg AFB, Calif., where ICBM crews are trained. Meantime, Boeing is building a *Minuteman* underground silo and launch complex at its Seattle plant to simulate operational firings and is also instrumenting a rail launch car there.

Where Radiation Hurts

Atomic Energy Commission engineers are more worried about the effect of radioactivity on the vehicle and payload of a nuclear rocket than on the atmosphere. A 6000-megawatt reactor for such a rocket would generate fission products equivalent to a half-kiloton A-bomb, if the reactor ran five minutes. However, not all of these products would get into the atmosphere and the resulting radiation would be difficult to detect.

If He Could Only Talk

Convair, one of the bidders on a Navy hydrofoil, is attempting to learn more about underwater propulsion from an instrumented porpoise. The sleek mammal's movements are recorded as he gambols in a 100-ft tank.

INTERNATIONAL

Germans By-pass Cobra for SS-11

A decision by the West Germans to turn down their own *Cobra* antitank missile for the French *SS-11* may spur production of the *SS-11* under license in the U.S. The Germans want 25,000 *SS-11's*—which will command virtually all of Nord Aviation's manufacturing capacity. Thus, another source will be needed to fill U.S. requirements.

French Test 4-stage Rocket

A solid-fueled four-stage rocket built by the Air Administration and ONERA attained a height of 93 miles over France's Ile du Levant Test Range May 19. The vehicle carrying an instrumented nose cone was designed for an altitude of 185 miles.

Italians Try Sodium Tests

Rocket shots launched off Sardinia by Italy this summer will be sodium cloud tests at a height of 250 miles.

Beryllium for Seaslug

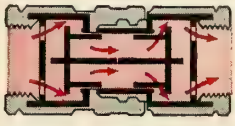
Britain's Armstrong Whitworth Aircraft Co. is now reported to be using beryllium extensively in the *Flutter Dart* test rocket and the *Seaslug* ship-to-air missile—the first missile manufacturers in Europe to do so.

Hey, Herman... Snap-Tite valved couplings come in big sizes too!

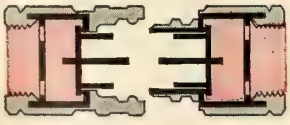


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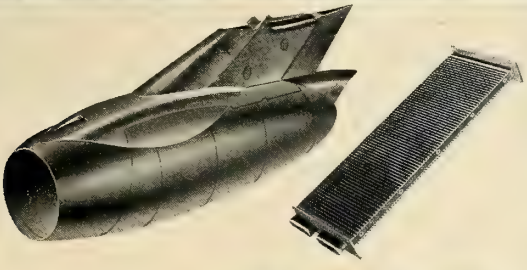


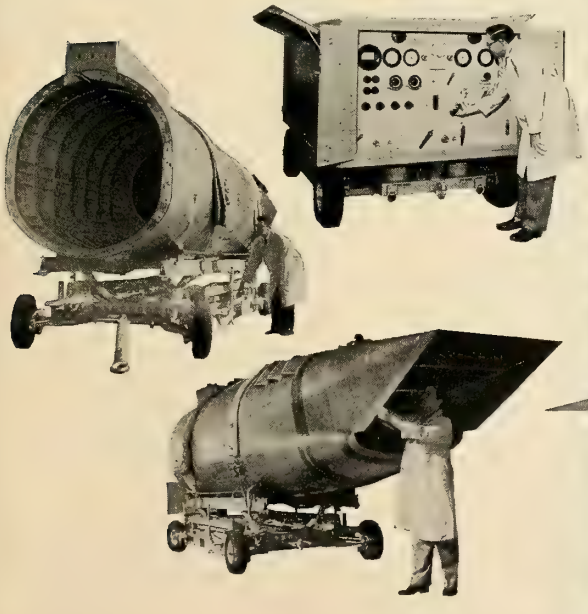
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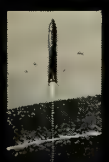
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The key to this phenomenal performance lies in the micro-thin aluminum film securely deposited on the surface of the light weight flame proof cloth backing. This finish, reflecting more than 90% of all radiant energy, unlike heavier aluminum foil won't crack or peel away from the backing. Furthermore, it doesn't detract from the original drape of the fabric or add noticeable weight. Those fabric backings available as standard products are the cotton, glass, and asbestos combination, the herringbone asbestos, and flame proofed rayon. If these don't suit your particular needs, special base fabrics are available on minimum yardage basis. If "Scotch-Shield" kindles your imagination, why not check with your REFLECTIVE PRODUCTS representative, or fill in the coupon below?

■ YOUR BIRD CARRYING A TORCH?

It might be doing just that, if you're still using conventional encapsulating resins on its hot little electronic innards. Of course, finding a truly flame proof resin system hasn't been an easy task. That is, not until "Scotchcast" XR-5019 entered the scene. This new two-part flexible epoxy resin system is so flame proof that it doesn't burn, even when given all sorts of encouragement. For example, in the Manson flammability tester—one that's really a scorcher—XR-5019 beat the standards of NEMA for non-flammable resins by a substantial margin. In this test, where the goal is to get the lowest possible number, values of 0.55 to 0.80 were achieved by XR-5019. These figures can be compared to a value of 6.2 for a conventional casting resin, which, incidentally, also passes the flammability requirements of Mil I-16923C. One manufacturer enthusiastically reports that XR-5019 insulated transformers have met the flammability requirements of even Mil T-27A without a waiver, which is something of a "first."

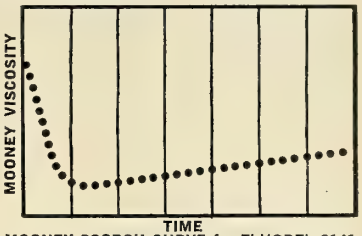
But this versatile resin system doesn't put all its eggs in one basket. In a thermal shock test developed by 3M, the resin cured around a ¼" metal insert is recycled between 130° and −55°. XR-5019 was cycled for ten times, with no failures. And its virtues don't end there. It features low impregnating viscosity and high adhesion to most metals. Its pot life of 3 to 4 days after mixing is nothing to overlook, either. Needless to say, these advantages are not offered at the sacrifice of electrical properties. Why not contact your local ELECTRICAL PRODUCTS representative, or check the box below for additional information?

■ SOME GUM!

A real aristocrat among synthetic elastomers is our CHEMICAL DIVISION'S new "Fluorel" 2141 Brand Elastomer. This fully saturated polymer is fluorinated to the hilt—containing greater than 60% fluorine by weight. Once you've been exposed to "Fluorel's" remarkable stability you'll realize that the fluorine is not along just for the ride.

Chemical stability is just one area in which it takes the blue ribbon. It resists almost all fuels, lubricants, and hydraulic fluids currently being used or developed for rocket and missile systems, even the high energy fuels of the boron type. It takes hot oils, many organic solvents, as well as strong inorganic acids and bases in its stride. Nor does it have to be pampered, as far as outdoor weathering is concerned.

High temperature is no enemy to "Fluorel," either. It performs under continuous long-time service at 400° F. without marked degradation. Under some conditions for reduced periods of exposure, temperatures above 600° F. can be tolerated. Then of course there's the fringe benefit of its excellent resistance to compression set, which is a handy property to have around, if you're concerned with seals or closures.



MOONEY SCORCH CURVE for FLUOREL 2141

Offering properties like these, you might expect that "Fluorel" would be a real prima donna when it comes to compounding—tain't so! It's easily processed on standard rubber compounding equipment with a Mooney Scorch rating ideal for the rubber processor—can be molded, extruded, and adhered to metals. It's natural for application to O-rings, gaskets, tubing, expellant bladders, fuel cells, and countless other demanding areas.

For a complete brochure on properties and handling of "Fluorel," contact your Chemical Division representative or check the coupon below.

And if you have questions on any of the items mentioned here, or would like to know what else 3M makes—or could make—for your needs, mail coupon.

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Please send more information on ☐ "Scotch-Shield" Heat-Reflective Fabric
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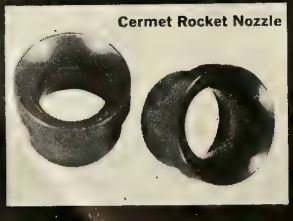
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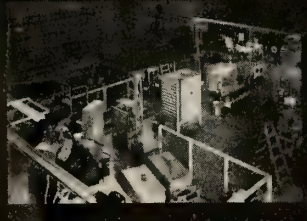
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when and where

MAY

Fourth International Symposium on the Reactivity of Solids, Amsterdam, May 30-June 4.

JUNE

Instrument Society of America, Annual Instrumental Methods of Analysis Symposium, Montreal, June 1-3.

Sixth Annual Radar Symposium, University of Michigan, sponsored by Army, Navy, AF, Willow Run Laboratories, Ann Arbor, June 1-3.

Fourth Annual Summer Conference on Vacuum Metallurgy, New York University's College of Engineering, NYU's University Heights Campus, Bronx, N.Y., June 2-3.

ASME Summer Annual Meeting and Aviation Conference, Statler Hilton Hotel, Dallas, June 5-9.

Society of Automotive Engineers, Summer Meeting, Edgewater Beach Hotel, Chicago, June 5-10.

Machinability Seminar, Pennsylvania State University, University Park, June 6-10.

National Society of Professional Engineers, Annual Meeting, Statler Hotel, Boston, June 8-11.

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

1960 Radio Frequency Interference Symposium, sponsored by the IRE, Shoreham Hotel, Washington, D.C., June 13-14.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 12-15.

Symposium on Molecular Structure and Spectroscopy, Dept. of Physics and Astronomy, Ohio University, Columbus, June 13-17.

1960 Cornell University Industrial Engineering Seminars, Ithaca, N.Y., June 14-17.

Special Summer Program on Fluid Power Control, Massachusetts Institute of Technology, Cambridge, June 14-24.

American Institute of Chemical Engineers, Del Prado Hotel, Mexico City, Mexico, June 19-22.

University of Connecticut, Institute for Practical Research on Operations, Storrs, June 19-25.

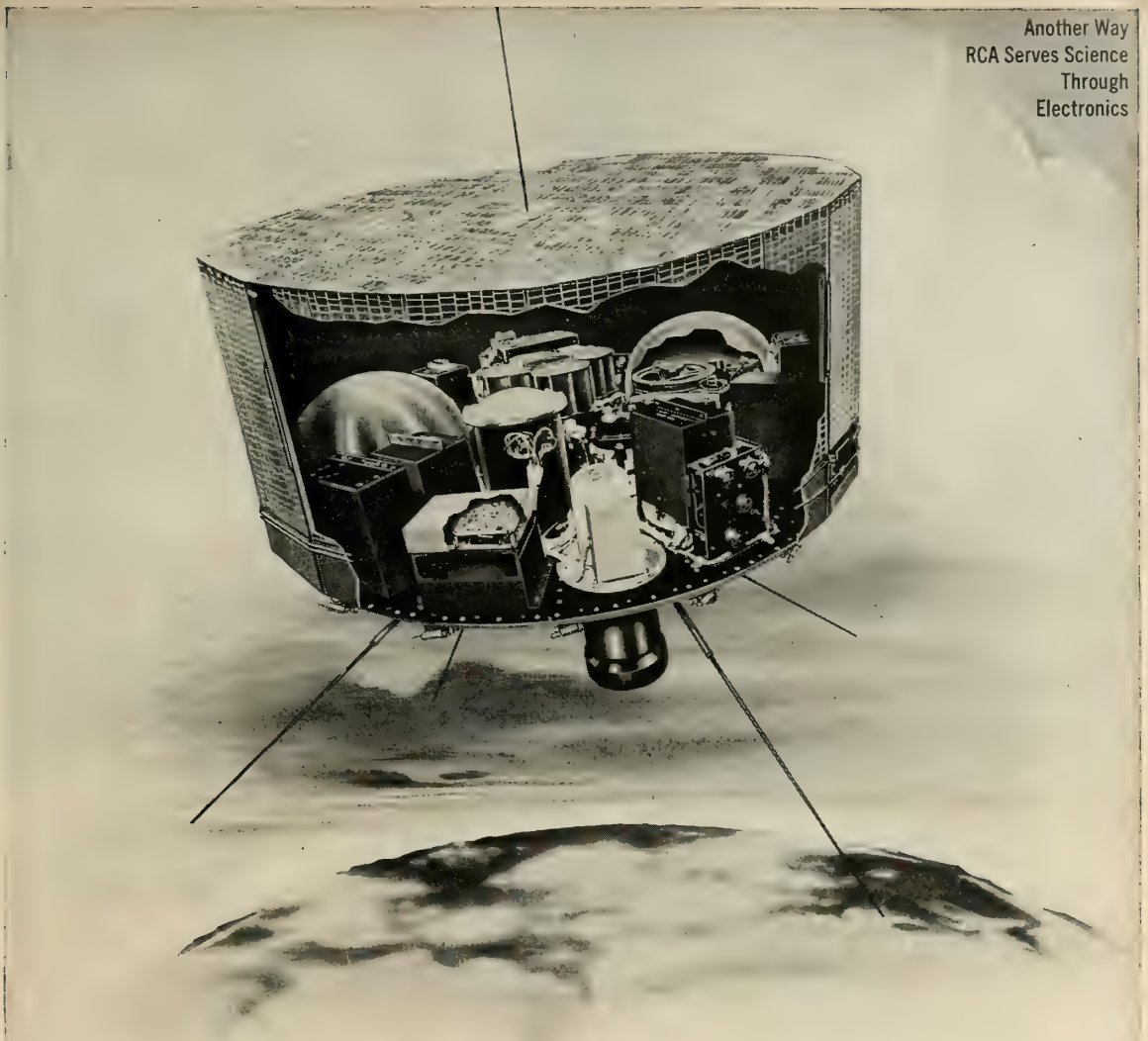
Atomic and Molecular Gas Beams Symposium, University of Denver, Denver, June 20-22.

ASME Applied Mechanics Conference, Pennsylvania State University, University Park, June 20-22.

Gordon Research Conference, Colby Junior College, New London, N.H., June 20-24.

Institute of Navigation, 16th Annual Meeting, Air Force Academy, Colorado Springs, June 23-25.

Another Way
RCA Serves Science
Through
Electronics



THIS IS TIROS...
Experimental Weather Observer

This is TIROS—the world's most advanced television-equipped earth satellite. In one giant step it has extended man's powers of continued observation 400 miles into space. The pictures of cloud cover and wind patterns it is now sending down are a major contribution to the science of meteorology—bringing ever closer the day of improved, long-range weather analysis and forecasting.

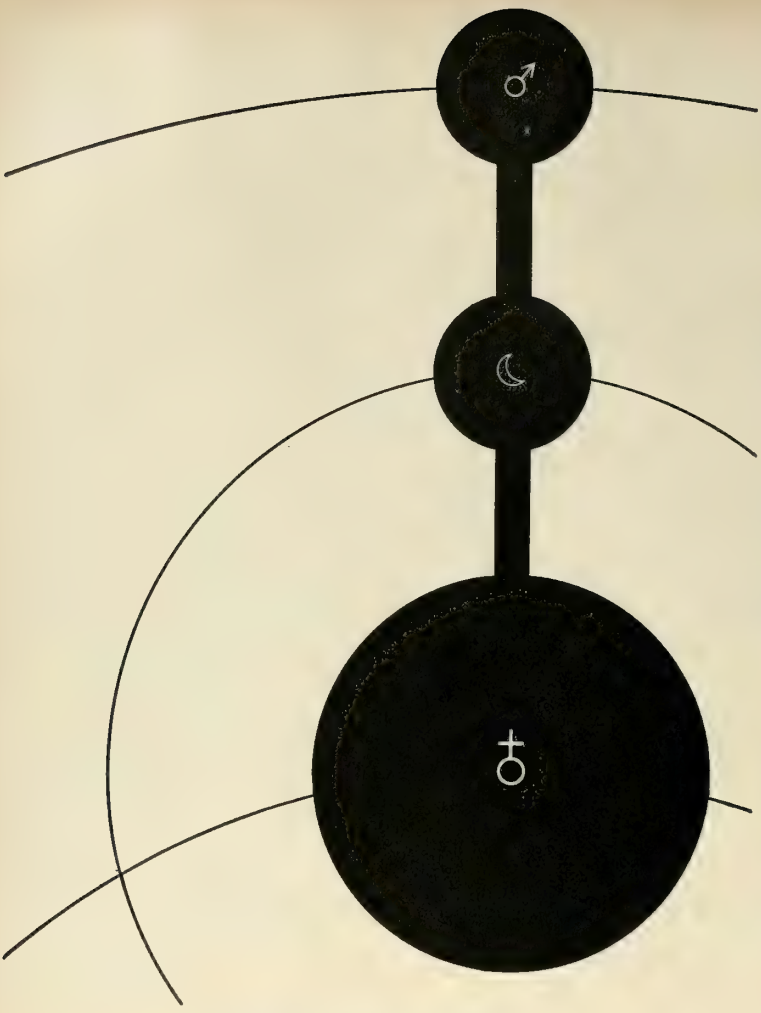
The entire TIROS satellite, its component systems and associated ground equipments were developed and built by RCA's Astro-Electronic Products Division for the National Aeronautic and Space Administration under the technical direction of the U. S. Army Signal Research and Development Laboratory. Included in the satellite are two TV cameras equipped with shutters so they can take still pictures, tape recorders to store the pictures when out of ground station range, TV transmitters, command receivers and timing clocks for function control, radio beacons and telemetry equipment, and numerous auxiliary devices to control satellite dynamics. Power is supplied by storage batteries recharged by an array of 9200 solar cells which convert the sun's energy into electricity.

Significant as it is, TIROS is a beginning, not an end. Future satellites and space probes will be far more complex. Yet they will grow out of the experience and capabilities in space electronics, satellite dynamics and structural loading techniques that made Project TIROS a reality. To find out how you can draw on this unique research and development capability, get in touch with the Marketing Manager, RCA Astro-Electronic Products Division, Princeton, N. J.

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names in the news

Dr. Wolfgang W. Gaertner: Joins the staff of CBS Laboratories as manager of Electronic Semiconductor Research and Development. Dr. Gaertner, author of more than 35 papers in the field of solid state physics was formerly associated with the Solid State Devices Division, U.S. Army Research and Development Laboratory, as chief scientist.



GAERTNER

L. D. Rexroat: Formerly chief of marketing for HRB-Singer, Inc., joins U.S. Science Corp., a division of United Industrial Corp., as vice president and director of marketing.

A. C. Werner, Jr.: Named general sales manager for the Semiconductor Division of Hoffman Electronics Corp. **Jan Black,** former product manager for Pacific Semiconductors, Inc., named transistor product marketing manager.

Dr. Cloyd A. Snavely: Former assistant manager of the Chemical Engineering Dept. at Battelle Memorial Institute, joins Sifco Metachemical, Inc., as general manager.

Edwin A. Sweo: Appointed manager of the Servo Engineering Dept. of Dalmo Victor Co.'s Engineering Division, replacing **Arthur Notthoff,** appointed manager of engineering for the firm's Electronic System's Division.

Albert W. Chapple: Former marketing research manager for Perkin-Elmer Corp., named marketing manager of the Optics and Metrology Division of Keuffel & Esser Co.

Walter A. Kirsch: Joins Telechrome Manufacturing Corp. as Defense Products Manager and assistant to the vice president and director of sales, **H. Charles Riker.**

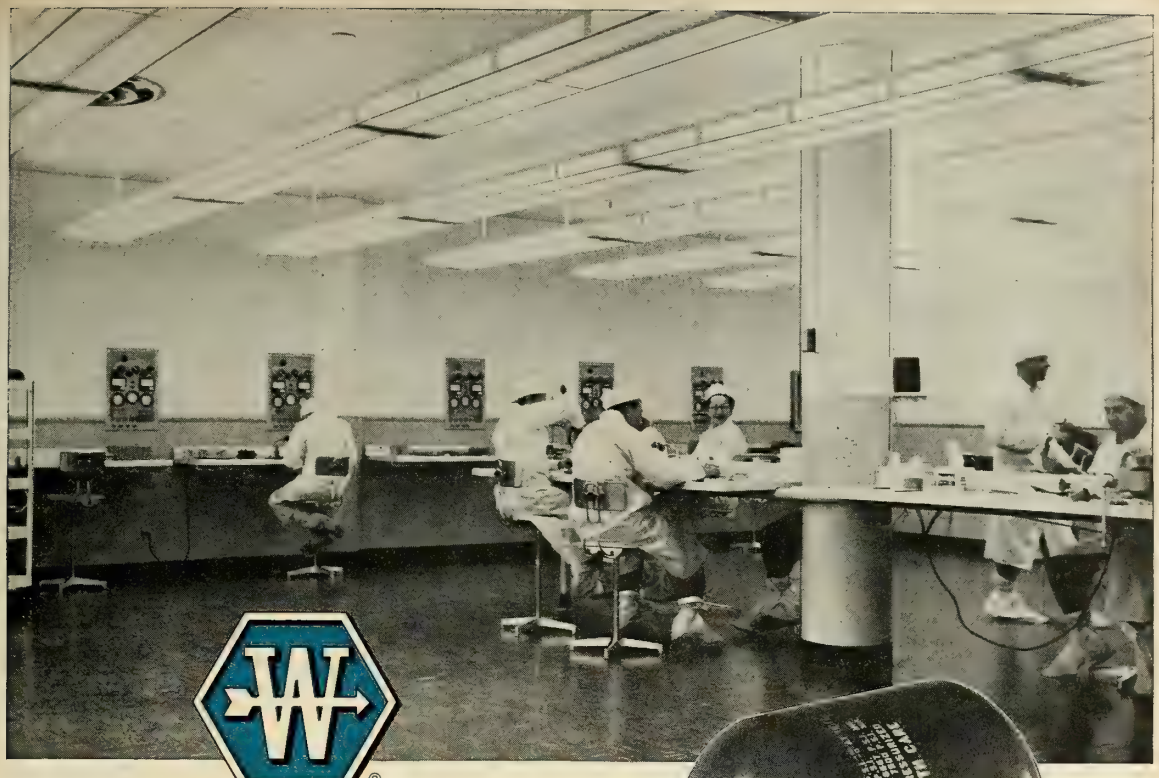
Dr. Steward S. Flaschen: Former staff scientist, promoted to the position of manager of Research and Development for the Semiconductor Products Division of Motorola, Inc. Prior to joining the firm in 1959, was associated with Bell Telephone Laboratories.

Clifford R. Brown: Named executive vice president and general manager of Standard Rectifier Corp. Most recently served as an officer and director of Narmco Industries, Inc., and earlier was affiliated with Aerojet-General Corp. and General Electric.



BROWN

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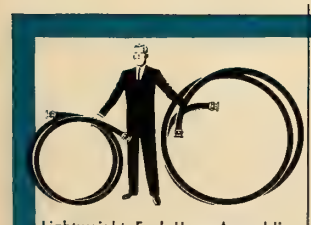
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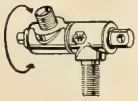
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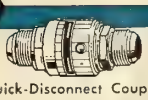
Lightweight Fuel Hose Assemblies



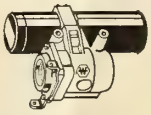
MS Fittings



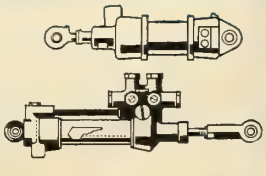
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More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. *Atlas* intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

Billions of operations. To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) *continuously* without failure—over 37-billion operations!

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. . . names

James R. Wescott: Appointed to the newly created position of vice president of marketing for The Gabriel Co's Electronics Division. Was formerly marketing manager of the Heavy Military Division of General Electric Co.

Ted Dunnegan, Jr.: Elected manager of the new Project Administration Dept. of Temco Electronics. **T. W. Swafford** will assume his former position as manager of the Electronics Division's Auxiliary Services Dept.

Saul D. Wills: Joins the staff of REF Manufacturing Corp., as project engineer. Was formerly assistant chief engineer at Greer Hydraulics, Inc.

Albert Belge: Former production engineer for the Firewel Division of Aro Equipment Corp., named manager of manufacturing engineering for International Resistance Co.'s Burlington, Iowa, Division. **Harry Johnson** also named senior sales engineer for the Control Components Division.

Edward G. Schwarm: Elected president of Applied Dynamics, Inc., a subsidiary of Bowmar Instrument Corp. Prior to joining the firm in January as vice president, he was manager of advanced systems engineering and project engineer at Link Aviation Co.

Lionel B. Buraks: Named field engineer-in-charge of Consolidated Vacuum Corp.'s newly opened Washington, D.C. office.

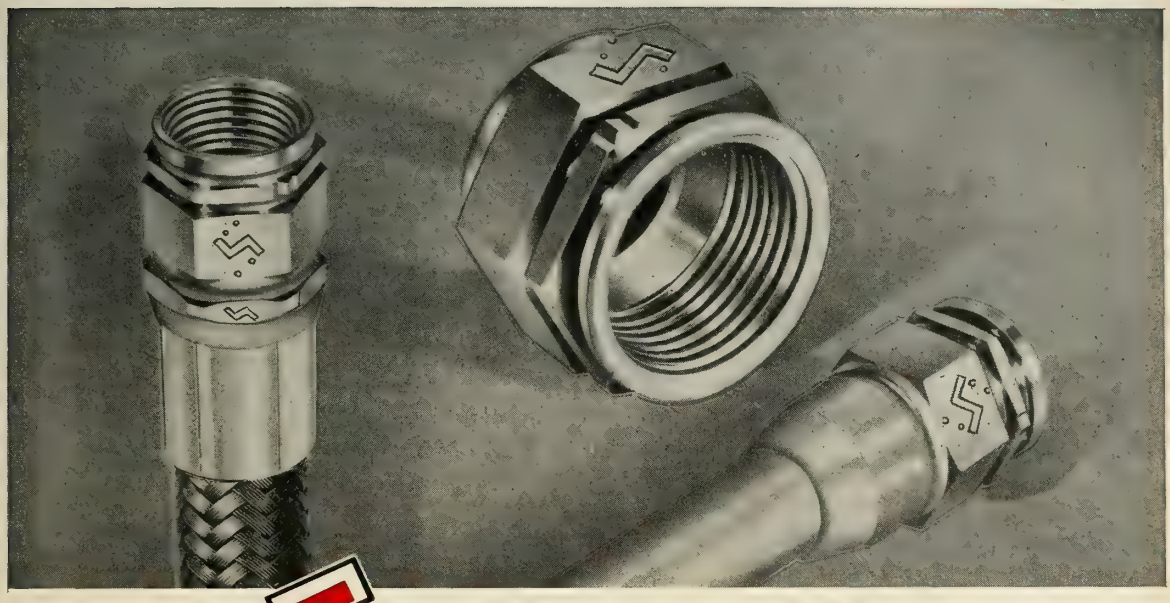
John H. Striebel: Former Hughes Aircraft Co. marketing executive joins Houston Fearless Corp., as assistant to the vice president-sales.

William B. Gurney and **Jack O. Nash:** Appointed engineering manager and chief engineer, respectively, of Chandler Evans Corp. Gurney was formerly manager of the firms west coast engineering and sales office and Nash appointed assistant chief engineer in 1956 has supervised the company's advanced engineering and component development program.

Dr. T. C. Helvey: Appointed chief scientist for Ortronix, Inc. Was previously in charge of all human factors activities at Radiation, Inc. and also headed the bio-physics and bio-astronautical efforts of the firm.

Robert Ferran and **Anthony Fessicini:** Join the research and development staff of Technology Instrument Corp., to specialize in design work of transducers. Ferran was formerly with Transonics, Inc., and Fessicini served as a cooperative student with Transonics, Inc.

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Stratolok nuts meet all locking performance requirements of Specification MIL-N-25027. They are available in a complete range of sizes and are reusable and completely interchangeable with existing AN and MS nuts. Stratolok "S" series nuts, for temperatures up to 550°F, are Cadmium-plated steel; "CR" Series, for temperatures up to 800°F, are silver-plated stainless steel.

SF4-0

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THE POSITION is within the Advanced System Engineering group, formed to direct the system support product line, which is concerned with the engineering and manufacture of equipment supporting current and advanced military vehicles. The design of advanced support equipment requires close consideration of advanced military, operational, and maintenance factors, as well as the application of advanced system technology.

Each staff member of this group is provided with every opportunity, facility and detail of environment to use his creative and analytical skills to the maximum advantage and at the highest level. He may call in any specialist needed and has full access to all available information—military, academic and industrial. Furthermore, specialized research projects and laboratory work may be carried out at his request by other departments of RCA.

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RCA ® ***RADIO CORPORATION of AMERICA***
DEFENSE ELECTRONIC PRODUCTS

. . . names

John J. Jarosh and **Dr. William L. Parker:** Named manager of inertial devices and manager of guidance systems, respectively, at Hughes Aircraft Co.'s research and development laboratories. Jarosh, holder of many patents on gyroscopic devices, was formerly director of engineering at Sterling Precision Corp. Parker is former chief of systems engineering for the Nortronics division of Northrop Aircraft, Inc., where he participated in the development of the *Snark* missile guidance system.

George A. Work: Named chief project engineer of the Leach Corp.'s Special Products Division. Previous posts: Chief engineer and head of product development, Instruments and Electronics Division of Land-Air; Lockheed Missile and Space Division on the *Polaris* project, and the U.S. Navy Radiological Defense Laboratories.

David A. Williams: Appointed director of Standard Steel Corp.'s newly established Research and Development Dept. **Leon F. Howard,** former assistant, succeeds Williams as Director of Engineering for the Cambridge Division.

C. J. Moore: Former general sales and marketing manager of Exide Industrial Division, The Electric Storage Battery Co., promoted to vice president-marketing of the division.

K. Russell Knoblauch: Named market sales manager of Minneapolis-Honeywell Regulator Co.'s Industrial Products Group. Was formerly chemical industry market manager.

A. Henry Schutte: Appointed to the senior staff of Arthur D. Little, Inc.'s chemical engineering section. He is the holder of many patents in the fields of fractionating, absorption, cracking, catalysis, dewaxing and centrifugal separation, and was formerly vice president of the Lummus Co.


SCHUTTE

Harry E. Lockery: Appointed manager of engineering, Electronics and Instrumentation Division, Baldwin-Lima-Hamilton Corp. Prior to joining the company in 1958 as chief engineer, was project engineer for Industrial Controls Division, Manning, Maxwell and Moore, Inc.

Joseph M. Saba: Named director of Laboratory for Electronics, Inc.'s newly established International Division. Was formerly with Raytheon Co. as Director of Planning, International Division.

W. D. Cowgill: Elected general sales manager for Cleveland Graphite Bronze Co.

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Jerome Perlstein: Joins Tenney Engineering, Inc., and will be associated with the development engineering group.

H. Kenneth Hudson: Named eastern division sales manager of The Hallicrafters Co.'s military electronics division. Was formerly electronic warfare products sales manager for Raytheon Co.

Jack Simon: Formerly assistant sales manager, test and ground support equipment for Greer Hydraulics, Inc., joins REF Manufacturing Corp., as an applications engineer.

Carl A. Hultberg: Formerly an engineering group leader at Bell Aircraft Corp., joins the staff of Hoover Electronics Co. as senior project engineer.

E. S. (Bud) Turner: Appointed northwest regional marketing manager for Southwestern Industrial Electronics Co., a division of Dresser Industries, Inc.

Geoffrey Robillard: Named chief of the newly formed Propulsion Division at the California Institute of Technology Jet Propulsion Laboratory. Was formerly chief of the Solid Propellant Division and played a prominent role in the development of the solid rockets used in the upper stages of the *Jupiter C* and *Juno II* launching vehicles.

James E. Heywood: Formerly with International Business Machines Corp., joins Ford Motor Co.'s Aeronutronic Division as assistant general operational manager of the Computer Operations.

Walter H. Hassler: Appointed manager of materiel for Summers Gyroscope Co. Previous posts: Convair, Kaiser Industries and Boeing Airplane Co.

A. S. (Al) Ginsburgh: Staff member of the *Polaris* project at Aerojet-General Corp., appointed manager of the firm's Materials and Fabrication Division for the solid rocket plant of the Sacramento plants.

Jose M. Teliez: Named manager of the Army computer systems department at Hughes Aircraft Co.'s ground systems group. Formerly served as assistant manager of the Army computer systems department; systems section head of the MSG-4 department; group head in charge of systems and circuits for the Missile Monitor system; and circuits design engineer.

Edward C. Leeson: Formerly director of customer relations for the Astrionics Division at Fairchild Engine and Airplane Corp., joins Kollsman Instrument Corp. as vice president-marketing.

Charles E. Heitman, Jr.: Former president of ACF Industries, Inc.'s Carter Carburetor division, joins the staff of **George E. Stoll,** executive vice president of the Bendix Aviation Corp., with responsibility for major manufacturing and organizational functions.



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—reviews—

BASIC RESEARCH RESUMES—A SURVEY OF BASIC RESEARCH ACTIVITIES IN THE AIR RESEARCH AND DEVELOPMENT COMMAND. Herner and Co. for ARDC. Order PB 161291 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 342 pp., $5.

Most of the 1400 scientific research projects described in this index are being conducted at leading U.S. colleges and universities. Other projects are the work of industrial laboratories, government facilities, and private, non-profit research institutions. About 14% of the research is assigned to ARDC's own labs, while 20% is done outside the U.S.

All work is listed under 24 subject categories which cover six technical areas: propulsion, materials, electronics, geophysics, biosciences and aeromechanics. There are two research sections and three indexes.

DIRECT CONVERSION OF HEAT TO ELECTRICITY. Edited by Joseph Kaye and John A. Welsh. John Wiley & Sons, New York. $8.75.

A timely and valuable edited collection of papers in this new and exciting field. The book includes fundamental discussions, considerations of practical application, and problems associated with the four predominant new methods of direct energy conversion: thermoelectric, thermionic, MHD (magnetohydrodynamic), and fuel cells.

MECHANICS OF MATERIALS, A. Higdon, E. H. Ohlsen, and W. B. Stiles, John Wiley & Sons, New York, 502 pp. $7.75.

Featuring an approach compatible with the engineering science viewpoint, the work is designed to develop a working knowledge of the relations between the loads applied to a non-rigid body and the resulting deformations, between loads and stresses in non-rigid bodies and a clear insight into the relations between stress and strain.

HYDROMAGNETIC CHANNEL FLOWS, Lawson P. Harris, Technology Press of the Massachusetts Institute of Technology and John Wiley & Sons, Inc., New York, 90 pp., $2.75.

This monograph, a doctoral thesis written under a WADC contract, is most timely in view of the heightened interest in magnetohydrodynamics, the study of flows of electrically conducting fluids in the presence of electromagnetic fields.

This book presents analyses for three flows of viscous, electrically conducting fluids in high aspect-ratio rectangular magnetic fields. The situations considered are turbulent flow in the presence of a d.c. magnetic field and both laminar and turbulent flows in induction-driven flows.

The methods used are analogous to the "semi-emperical" techniques of fluid mechanics in depending for their success on the combined use of the basic hydromagnetic equations, a dimensional analysis, and the results of experiment.



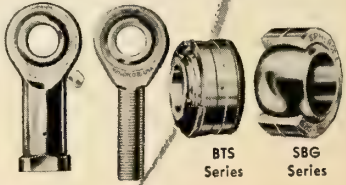
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FLUID POWER CONTROL, Blackburn, Reethof and Shearer. Technology Press of M.I.T. and John Wiley & Sons, Inc., New York. 710 pp. $17.50.

In certain respects the first in its field, this book evolved from notes for MIT refresher courses for working engineers. It is based on the work of the Dynamic Analysis and Control Laboratory at MIT.

The book is divided into three parts: a review of fluid properties and fluid mechanics; the design of hydraulic and pneumatic drives; and the application of such devices.

Due to the nature of its parentage, the book is somewhat loosely organized and does not cover the subject completely. However, it is up to the minute and fills a definite place in a poorly covered field. It discusses thoroughly the principles of operation, design, and application, and the quantitative factors necessary in putting fluid-power devices and techniques to work.

PROPULSION SYSTEMS FOR SPACE FLIGHT, William R. Corliss, McGraw-Hill, 300 pp., $10.

The major propulsion concepts for flight beyond the atmosphere are described in this book. It is a well-written text that attempts a technical survey of advanced propulsion systems such as nuclear rockets, ion drive, photon drive and a comment on anti-gravity devices. These are all compared in performance capabilities, technical feasibility and present state of the art. The requirements of various space missions are compared with the abilities of the different propulsion systems; and power-generating and energy-conversion theories are analyzed over a wide power range.

PROPERTIES OF HIGH-TEMPERATURE CERAMICS AND CERMETS ELASTICITY AND DENSITY AT ROOM TEMPERATURE, S. M. Lang, National Bureau of Standards Monograph No. 6. Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. $.20.

In order to supply reliable engineering data on high-temperature ceramics, NBS has assembled a stock of ceramic and cermet materials. The properties investigated include mechanical strength, elastic and anelastic characteristics, temperature dependence of these properties, and thermal properties in general.

The first report presents the results of an investigation to: (1) determine room-temperature elastic properties by a sonic method; (2) determine both the bulk and theoretical densities; (3) evaluate from a statistical treatment of the data the variability of fabrication of the materials using the elastic and bulk density data; and (4) compare measurements of the elastic properties and densities for their usefulness as indicators of significant variations in fabrication.

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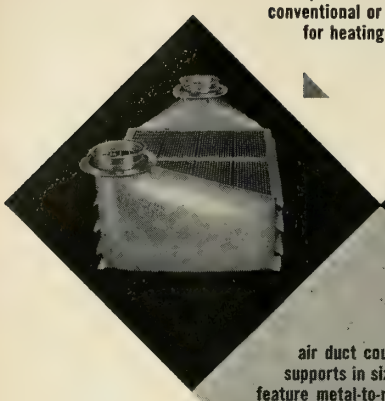
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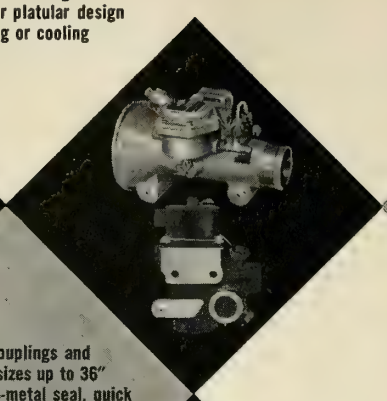
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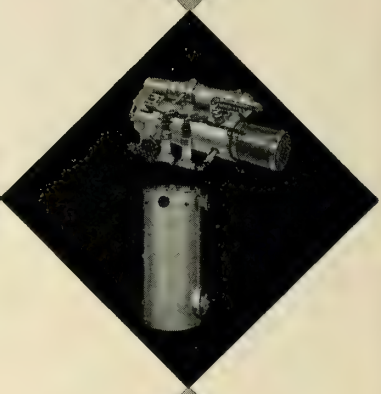




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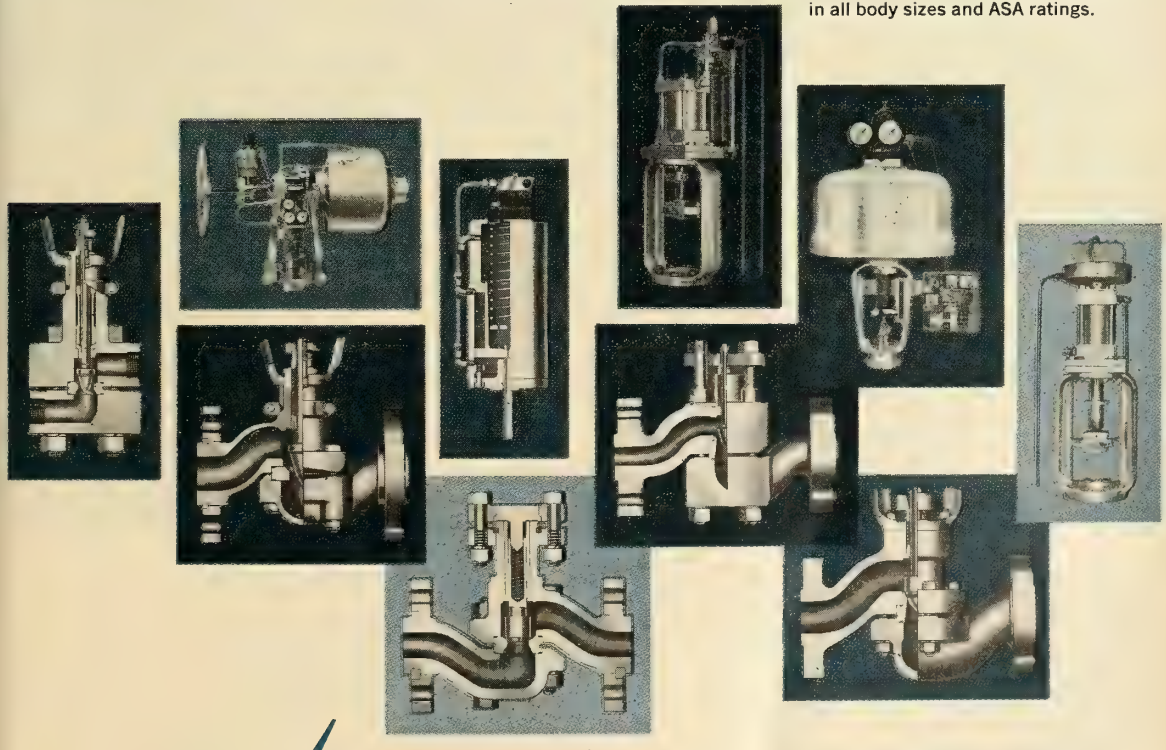
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Role Seen for Mobile Bomarc

Truck and rail launching system may stave off death of troubled program

by William J. Coughlin

SEATTLE—An attempt is under way to enhance the attractiveness of *Bomarc* air defense missile by making it mobile.

Despite cutbacks in the program by the Air Force and Congress, Boeing Airplane Co. officials feel—apparently along with some Defense Department officials—that a requirement still exists for an area defense missile if it can be made invulnerable.

The argument is based largely upon the assumption that Russia will pose a manned bomber threat for some time to come, in spite of its heavy reliance upon missiles. A mobile *Bomarc* transported either by truck or train would be designed to combat aircraft using stand-off missiles to pave the way for an attack. The moving version similarly would be capable of riding out a strike by submarine-launched missiles and catch a follow-up wave of bombers.

Bolstering hopes somewhat for a mobile *Bomarc* system was the demand two weeks ago by Deputy Defense Secretary James Douglas for a restoration of $294 million in the defense appropriation bill to complete 10 squadrons of *Bomarc B*. The bird has had some successful tests recently, but Congressional leaders are cool to this proposal.

Although Boeing disclosed the existence of the mobile *Bomarc* only this week, with the declassification of pictures of the system, the program has been under way for some time.

"We are going to work intensively to show the Air Force and other customers that this weapon has the inherent flexibility to be used in many military situations," says a Boeing spokesman. "And it's here now. It's not a concept, it's hardware."

The company is continuing development testing and the entire program is going ahead in what is described as "high gear."

Advocates insist that troubles plaguing *Bomarc B* were ironed out during the propulsion test program at Cape Canaveral and that the missile is proving its worth in the successful firings on the Eglin Air Force Base Range.



MOBILE BOMARC on transporter-erector is shown in this exclusive photo. Company feels this system will make the antiaircraft bird more flexible, less vulnerable.

Richard A. Montgomery, *Bomarc* Development Program Manager, and William M. Shultz, *Bomarc* Customer Liaison Manager, spelled out in an interview with M/R the company's defense against major criticisms of the program. Here are the charges and Boeing's answers:

• Bomarc is too late; it is no longer needed.

"USAF says there is still a substantial bomber threat. *Bomarc A* is operational now and *Bomarc B* will be operational next year. These weapons will be operational in the time period when this threat exists. We believe *Bomarc* is the most capable answer. If there are bombers to be shot down or air-breathing missiles carried by bombers, this is a weapon that can shoot them down."

• Bomarc costs too much.

"When you compare *Bomarc* development costs with other weapons on the basis of the large procurement initially planned and not on the present reduced program, these costs were not excessive."

"Excluding development costs, the investment cost and annual operating costs are one-fifth those of Century Series fighters."

• Bomarc is vulnerable because it can operate only from fixed sites.

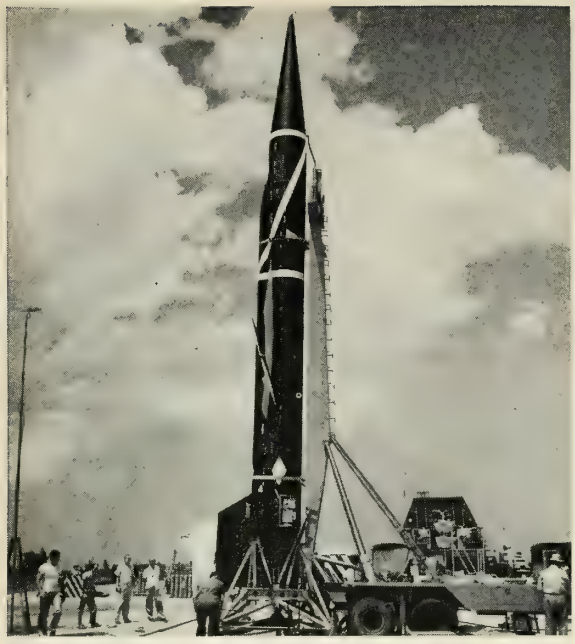
"This is not true. The present *Bomarc B* configuration with a solid booster system makes it readily adaptable to mobile launchers of any type."

• Bomarc is useless without the SAGE (Semi-Automatic Ground Environment) control system.

"This likewise is not true. Obviously the better the data, the better the missile will do. But *Bomarc* carries its own search and homing radar. The same procedure by which manned interceptors are launched to the general area of an intercept is effective with *Bomarc*."

"In fact, *Bomarc* has more effectiveness in the non-SAGE area than any other weapon. The changes in manned radar system coordination required to handle *Bomarc* can be made for less than $500,000, according to the Air Force."

• Manned fighters can do the same



LIGHTWEIGHT launch pad is attached to missile and rests on ground. Transporter moves away from missile for firing.



IN LATER versions mobile *Bomarc* would be fired directly from truck bed or from railroad car, as will mobile *Minuteman*.

job and also can be used in a limited war.

"*Bomarc* can deliver a nuclear warhead against incoming bombers at a considerable range faster than anything else. On May 12, a *Bomarc A* fired from Eglin scored a direct hit on a *Regulus* supersonic drone. That was not a direct hit in the usual sense. The *Bomarc* actually smashed into the *Regulus*. This clearly shows its potential capability even with high explosive warheads, indicating its usefulness in advanced theaters in limited war."

• **Bomarc is unreliable.**

"It's a proven weapon and it is in operation. The things we found wrong, we fixed—and they never recurred. The seven so-called "unsuccessful" *B* tests at Patrick were testing three different kinds of government-furnished engines and were not tests of a true *B* missile. Only the last two had actual *B* engines and on these the ramjets worked all right. The first two flights at Eglin have been true *B* designs with *B* test equipment and have both been successful."

"The *Bomarc B* program has been on the most accelerated schedule of any U.S. weapon system. It got under way in January, 1958. Things that would have normally taken four or five years, we've accomplished already. The modification to a solid booster engine required large steps. But we now are only three months behind the schedule set two and a half years ago."

First test of the *Bomarc B* from Eglin AFB was on April 13 when it flew 170 miles down the Gulf test range. The second test on May 17 went 270 miles downrange to intercept a simulated target. Boeing termed the two flights "completely successful."

The *Bomarc B* possesses a low-altitude capability and greater range than the *A*. Officially termed the *IM-99B Super Bomarc*, the missile is powered by a Thiokol solid-propellant booster rocket and two Marquardt ramjet engines. Its design range is over 400 miles.

First *IM-99A* base became operational at McGuire AFB last September. At one point, advanced planning for the program called for as many as 40 bases equipped with up to 112 missiles per base, the reduced Air Force program would have established 14 bases.

An indication of the ability of the *Bomarc* to operate independently of the SAGE system is given by Boeing's development of the tracking system it calls Mantrac, for manual angle tracking capability. This was developed by the Boeing Aero-space Division Preliminary Design Defense Analysis Group, primarily for use in conjunction with *Bomarc* in countries where it would be economically unfeasible to install the SAGE electronic system.

Using Mantrac, a few men with only basic plotting tools can track attacking aircraft or missiles from radar sightings.

In its announcement of the system last year, Boeing said: "Mantrac has shown that it possesses capabilities that could lead to its operation as a back-up to present defensive systems in this country. Electronic countermeasures, or jamming of the radar by the attacking force, pose no problem for Mantrac. Its method of operation in this electronic environment is classified, but tests have shown that Mantrac, properly set up to cope with this factor, can take it in stride."

Since it possesses the ability to operate with a manual radar system, combined with the mobility made possible by a solid booster, Boeing hopes successful tests of the *Bomarc B* at Eglin will change congressional opposition to the program.

Pioneer V Switched Back To Smaller Transmitter

Battery deterioration has forced NASA to switch the *Pioneer V* sun-orbiting satellite back to its smaller 5-watt transmitter.

The transfer was made on May 21, just 13 days after the larger transmitter was first activated.

According to NASA sources, the big power drain by the 150-watt transmitter could not be supplied by the deteriorating batteries. The radio telescope at Manchester, England, is recording 30 to 40 minutes of transmissions daily from the 5-watt transmitter.

Without undue further deterioration, NASA believes that Manchester will be able to stay in touch with the probe out to about 20 million miles.

USSR skirted for now . . .

Midas Opens Way to World Policing

The successful launching of *Midas II*—the Air Force's early warning R&D satellite—opened the way this last week for the launching of the first *Midas* operational prototypes late this year.

The 5000-lb. satellite soared from Cape Canaveral into a low-angled, nearly circular orbit that whipped it around the earth every 94.3 minutes but carefully skirted the Soviet Union.

However, the 3000-lb. *Midas* operational prototypes will be launched from Point Arguello into an operational polar orbit that will enable its infrared eye to police the entire earth.

As the Air Force prepared to put *Midas II* through its first early warning tests, the significance of the launching and its connection with the international furor over American U-2 spy flights was underlined by a series of related events:

- The State Department issued a statement calling *Midas* a possible key to world disarmament.
- Senate Democratic Leader Lyndon B. Johnson called for a crash program to develop reconnaissance satellites like *Midas* and its R&D sister, camera-packing *Samos*. He said such satellites would make "open skies" a reality.

The operational *Midas* system is expected to call for keeping six to eight satellites in orbit at all times. These will be designed to detect with their IR eyes the heart from the exhaust of ballistic missiles seconds after they are launched and signal warning back to the United States.

The warning would add another 15 minutes to the 15-minute warning that the BMEWS net is designed to provide.

The *Midas* system is designed to discriminate between the exhaust of a ballistic missile and other heat sources such as large fires and blast furnaces.

The Air Force will use two methods to test the effectiveness of *Midas* test satellites:

- Normal ICBM and IRBM launchings from Cape Canaveral and later from the West Coast.
- Lighting of great magnesium ground flares at Edwards AFB and Vandenberg AFB, Calif.

The flares will burn with a blinding rosy light for about 45 seconds and be visible from 50 miles away. The Air Force scheduled the first three flare tests to begin this week.

Midas II Vital Statistics

Total weight	about 5000 lbs.
Height	about 22 ft.
Diameter	about 5 ft.
Weight of empty orbital Agena	about 1700 lbs.
Weight of Midas R&D payload	about 3300 lbs.
Orbital time	94.3 min.
Apogee	292.1 statute mi.
Perigee	322 statute mi.
Est. useful life	1 month

The *Atlas-Agena* that put *Midas II* in orbit roared from Cape Canaveral at 1:37 P.M. EDT on April 24.

The 88-foot vehicle weighed about 272,000 pounds. The 22-foot Lockheed *Agena* weighed close to 12,000 pounds at the time of launching.

The Convair *Atlas* sustainer engine burned out as it approached the desired orbital altitude. The *Agena* ripped from the sustainer by means of explosive bolts, separation squibs and retro-rockets. Then the *Agena*'s 15,000-lb.-thrust liquid-propelled engine cut in and the satellite soared into orbit at about 18,000 miles an hour.

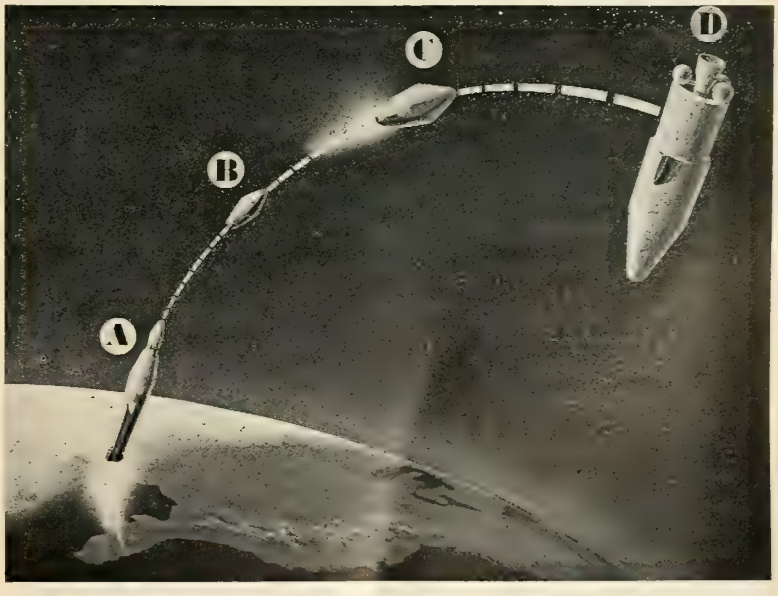
Air Force Satellite Tracking Stations at Vandenberg AFB, Calif., and Kaena Point, Hawaii, assumed their role as primary tracking points. All data obtained by them is fed directly to the Air Force Satellite Test Center at Sunnyvale, Calif.

Vandenberg and Kaena receive any data transmitted by the *Midas* satellite's IR scanner as well as telemetry on the operation of the satellite and its systems. Similar data also is received at Cape Canaveral and downrange tracking stations.

However, the key role is played by the stations at Vandenberg and Kaena which will become part of the final operational *Midas* system.

The first successful launching of *Midas* came after a series of postponements that followed the failure of the first launching on Feb. 26.

Midas I never went into orbit. Failing to separate from the *Atlas* sustainer, it burned up when it re-entered the atmosphere about 2500 miles downrange from Cape Canaveral.



MIDAS II GOING UP from Cape Canaveral. (A) An *Atlas* carried it to nearly the desired orbital altitude. (B) The *Agena* coasted to orbital altitude and positioned itself horizontal to the earth. (C) The *Agena* engine ignited and injected the satellite into orbit. (D) The *Agena* with its *Midas* payload adjusted its attitude into a nose-down position and stabilized itself.

Navy Rejects Extra Polaris Funds

The Navy stuck by its "wait and see" policy last week and turned down extra funds voted by the House for more *Polaris* submarines.

Adm. Arleigh Burke, Chief of Naval Operations, recommended that the Senate Appropriations Subcommittee restore a conventionally-powered aircraft carrier to the Navy's FY '61 budget and eliminate extra *Polaris* funds as well as most of the House-added money for antisubmarine warfare. Burke said the House changes would "tend to upset the balance which the Navy Department has striven to achieve in the fiscal 1961 budget."

About $241 million was provided by the House over and above the Navy request for *Polaris* to fully fund five Fleet Ballistic Missile submarines and to pay for long leadtime items for seven more.

The Navy told the Senate Subcommittee it could obtain a better balance with its original request—full funding of three and long leadtime items on nine.

Burke suggested that the House add-on was academic since the Navy, upon final tests this summer of the first *Polaris* sub, the George Washington, expects to seek a supplemental appropriation which would permit a start on construction of some or all of the nine in the new budget. Altogether 21 *Polaris* subs have been authorized, but only nine—including two that have already been commissioned—are fully funded now.

Burke recommended deletion of all but $41.9 million of the $320 million added by the House for ASW. The lesser figure would be used for R&D in the detection field.

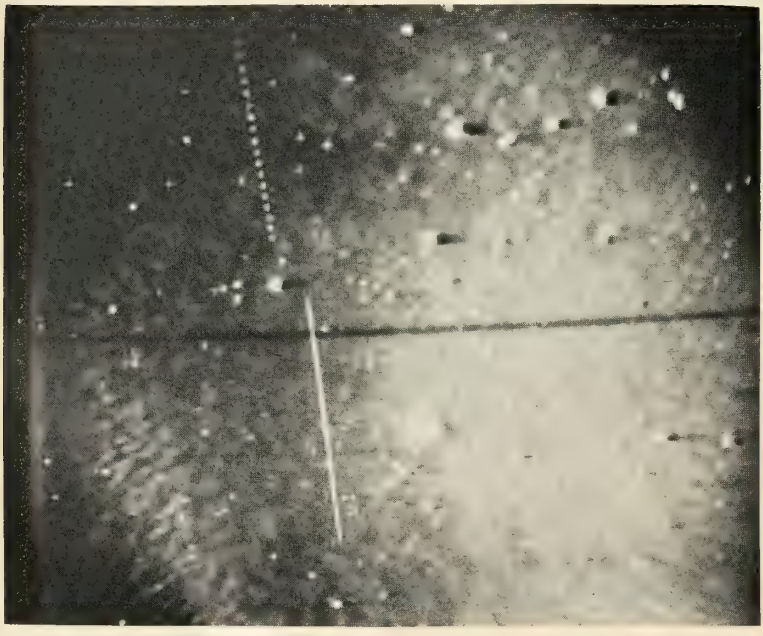
Soviets Admit Sputnick IV Ejection Failure

In a rare admission of failure, the Soviet Union announced last week that the cabin within the *Sputnik IV* space ship failed to return to earth because of a "mechanical fault."

The firing of the rocket ejecting the space cabin from the main vehicle did not function properly, and both the cabin and the vehicle were shoved into a larger, more eccentric orbit which, according to Tass, has an apogee of nearly 429 miles and a perigee of 191 miles.

U.S. experts speculated that the normal firing observance would have been the ejection of the cabin from the vehicle rearward by a rocket firing into a closed chamber. This push was to have given the space vehicle an extra kick of about 120 ft./sec., sending it into a higher velocity. The velocity of the capsule would have been correspondingly lowered so that its apogee shrunk to about 60 miles, at which time it would have circled into the earth's atmosphere.

Tass also stated that "data of the telemetrical measurements obtained show that the system of conditioning and heat regulation systems of the ship functioned normally throughout the entire flight and ensured conditions necessary for future manned flights."



TRACING OF SPUTNIK IV in the sky over U.S. was photographed May 18 by Bendix TV Satellite Tracker. Dotted line was made by tumbling last stage, while solid white line is 5-ton satellite, which later broke up into several fragments after failure of a re-entry capsule reportedly containing a dummy spaceman. Black line in center is a TV screen element. Pearl-like objects are stars.

Japanese Outline 10-Year Missile Output Schedule

TOKYO—Peak missile production in Japan should be reached by FY 1964, says the influential Federation of Economics Organization.

In its report to the Japanese Defense Agency, May 12, FEO's Defense Production Committee also predicted that nearly a third of the $1.574 billion to be spent over the next 10 years for missile/aircraft production will be for missiles and rockets. Domestic production will begin in FY 1961.

A variety of missiles are scheduled for production at an estimated 10-year total cost of $468 million. These include the following types and quantities per year: *Nike-Hercules* (110-150), *Hawk* (100-200), *Bomarc* (20), *Sidewinder* (400), *Falcon* (200), *Lacrosse* (30-40), and several types of anti-tank missiles (1500). Also, some 50,000-60,000 air-to-air rockets will be supplied annually.

Sidewinders will be produced first, says FEO, and R&D of ground control facilities and electronic devises also will be increased significantly.

Aimed at clarifying production prospects for the missile/aircraft industries, the report was prepared with the cooperation of the Society of Japanese Aircraft Constructors, Japan Ordnance Industries Association, and the Guided Missile Council.

Meeting Cites Space Telemetry Needs

by Frank G. McGuire

SANTA MONICA, CALIF.—Development of new telemetering techniques and new telemetering instrumentation will have to be stepped up considerably to keep pace with the needs of space exploration. It will be a good market for electronic firms who can meet the severe requirements.

This was made clear by a number of papers presented here at last week's National Telemetering Conference. The meeting was sponsored jointly by the American Rocket Society, American Institute of Electrical Engineers, Institute of Aeronautical Sciences, Instrument Society of America and Institute of Radio Engineers.

Much of the emphasis was on the need for useful data during the period of unmanned flight when the hazards of sending man into space will be evaluated. That need will grow as manned flight and deep space exploration get underway, it was pointed out.

"The exploration of space will place requirements upon instrumentation systems which cannot be met by present-day telemetry techniques," declared J. D. Yeagley and W. W. Godwin of The Martin Co.'s Denver Division. A maximum of information must be obtained from each space probe to justify the costs of such experiments.

As one step forward, they proposed a PCM/PS telemetry system employing pre-transmission data processing, describing it as "A significant advance in the art of space telemetry."

• **Weight advantage**—Processing to eliminate unneeded data before transmission from a space vehicle, they suggested, would cut power requirements considerably and reduce power supply weight to as little as 10% of that needed for full transmission.

Their emphasis on weight reduction was echoed by R. A. Porter and M. I. Lesnik of Avco Corp. who noted that the limited payload capacities of missile and space vehicles are creating a demand for smaller and lighter telemetry systems. They recommended more efficient data transmission by stepping up sampling rates to as much as 150% of present maximum recommended rates for PAM/FM/FM systems.

Requirement for more advanced instrumentation in the field of bioinstrumentation was stressed by George W. Gleason of Martin-Denver.

"There has been much transducer progress in the last year, but that much more progress is needed to support the immediate needs," he reported. Gleason said environmental transducer development is the most advanced, physiological instrumentation takes second place in terms of available hardware, and environmental instrumentation is the least exploited.

He said that for life support measurement in the important fields of oxygen concentration, carbon dioxide concentration, miscellaneous gases and gaseous flow, there are no transducers of electronic equipment available which satisfy all the requirements for space flight.

• **PCM interest**—Increasing interest in pulse code modulation telemetry (PCM) was noted by several speakers. William H. Seaver of EPSCO, Inc., told a session on PCM progress that the technique is drawing "widespread interest" as new techniques and new equipment are developed to permit the high-speed transmission of digital data.

R. L. Sink of Consolidated Electrodynamics Corp. said: "It is probably not exaggerated to state that if those now engaged in and who will remain in the telemetry field have not been involved in PCM programs to date, they will certainly be engaged in PCM programs within the next several years."

He said certain of the basic characteristics of PCM will not only justify but require its use in many forthcoming missile and space experiments, including *Minuteman* and *Titan*. He presented a detail survey of present and pending PCM use.

AF Reorganizes R&D Direction

Lt. Gen. R. C. Wilson, Air Force Deputy Chief of Staff for Development, has reorganized his office in order to handle all new weapons generally on a weapon systems basis.

A new Directorate of Systems Development has been established under Maj. Gen. Marvin C. Demler, former director of R&D. The new directorate will be in charge of all weapon systems programs. At the same time, Maj. Gen. V. R. Haughen, director of development planning, will become Wilson's assistant succeeding Maj. Gen. Leighton Davis. Davis has been named commander of the Atlantic Missile Range.

One of the major changes is that the Air Force Director of Advanced Technology also will report to Demler rather than directly to Wilson. He will serve as Demler's deputy.

The switch takes effect as Brig. Gen. Richard D. Curtain of the Ballistic Missile Division assumes the job as director. He succeeds Brig. Gen. Homer Boushey, a pioneer in rocketry, who has been named commander of the Air Force's Arnold Engineering Development Center at Tullahoma, Tenn.

Correction

Due to a typographical error, last week's M/R inadvertently referred to the Pluto *reactor as Tory I instead of Tory II. Tory I was a design which never left the drawing board. In the same story, transposition of a paragraph made it seem that a reference to difficulties with the use of liquid hydrogen in a nuclear reactor applied to Tory II. This, of course, concerned the* Rover *Program, not the* Pluto *Program.*

Lunar Systems Activity Formed by Ford Division

Ford's Aeronutronic Division has formed a Lunar Systems Activity to manage its lunar capsule development program for NASA.

Ford was picked to construct a 300 pound instrumented package to be landed on the moon within the next two years. The package will be launched from a larger spacecraft being built by Jet Propulsion Laboratory, Pasadena.

Frank G. Denison has been named Lunar Systems manager, and will assume responsibility for technical administration and direction of the program.

The Lunar Systems Activity is comprised of four components: System Integration, Applied Mechanics, Electronics, and Product Qualification.

Retros To Brake Mercury

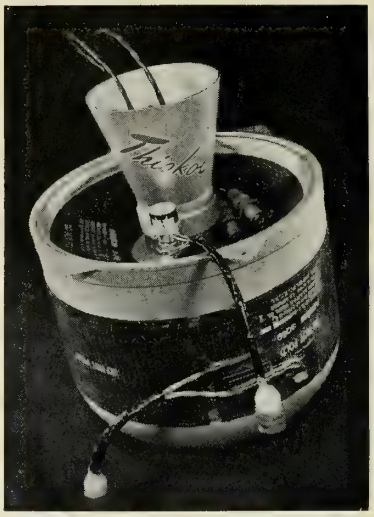
The *Mercury* space capsule will be braked from orbital speed by the firing of three solid-propelled retrorockets developed and manufactured by Thiokol Chemical Corp.

The rockets that Thiokol is developing under subcontract to McDonnell Aircraft Corp. will brake the capsule velocity by about 500 ft./sec.—enough to initiate descent from orbit.

NASA said the three rockets, each 15 in. long, 12 in. in diameter and generating 1000 lbs. thrust for a classified period of time, will reduce the capsule from orbital velocity of 17,400 mph to subsonic speed and 70,000 ft. altitude in less than 10 minutes. At this point, the capsule's drogue chutes will come into play.

The rockets will be fired one at a time, on signal from the astronaut, an electronic programer inside the capsule or a command signal from the earth.

Thiokol said that in a recent static test under simulated altitude conditions, plastic nozzle materials were used successfully. The test was conducted at the Air Force's Arnold Engineering Development Center in Tullahoma, Tenn. Use of plastic will allow a valuable savings in weight.



THIOKOL TE 316 Retrograde Rocket Engine for *Mercury* manned capsule, showing igniter leads, pressure-sensing switch and heater blankets.

Thiokol manufactures the rocket, designated TE-316, at its Elkton, Md., plant.

Tiros I Camera Reported In Working Order Again

In the wake of the U-2 "spy" plane incident, NASA announced recently that *Tiros I's* high resolution camera was again in working order and is taking pictures over the Soviet Union as well as most of the Northern Hemisphere.

Earlier pictures from the camera indicated that its resolution was not high enough to detect significant objects on the ground. NASA, according to Administrator T. Keith Glennan, originally held up the high resolution camera's pictures until it determined whether or not the civilian space agency could be accused of having a spying eye in the sky. Principal purpose of both cameras is to give weather experts information about cloud cover.

The timing mechanism which controlled remote operation of the narrow-angle camera failed April 2. It began to respond again May 10.

NASA officials forwarded a possible explanation that a small joint in the wiring in the timer's wiring opened at low temperature, breaking a contact. "Soaking" in sunlight may have closed the joint, re-establishing the contact.

If such were the case, the officials warn that continued exposure to low temperatures may result in a recurrence of loss of contact until heat from the sun again closes the opening.

New Procurement Bill Introduced in House

A bill limiting negotiations and extra incentive payments has been introduced by Chairman Carl Vinson (D-Ga.) of the House Armed Services Committee.

HR 12299 would eliminate the President's Korean War emergency powers and substitute a new authority for negotiated procurement—for use in a national emergency declared by Congress or by the President.

Incentive payments would go to contractors who could ". . . clearly and completely demonstrate" the savings were due to skill, efficiency or ingenuity in the performance of a contract.

Any of the other exceptions to advertised bidding would require the Pentagon to submit written findings that formal advertising would not have been feasible and practicable. A copy of this would be sent to GAO.

Negotiated procurement over $2500 would have to be solicited from a maximum number of qualified sources and procurement officers would have to hold written or oral discussions with all responsible contractors submitting proposals within the competitive range.

Military R&D to be Topic At IRE-Sponsored Meeting

Military research and development will be the subject of the opening panel discussion at the Fourth National Convention on Military Electronics in Washington, D.C., June 27-29.

Dr. J. R. Zacharias, Professor of Physics at Massachusetts Institute of Technology, will moderate the discussion by officers from the three military services. Panel members include Vice Adm. John T. Hayward, Deputy Chief of Naval Operations (Development); Maj. Gen. Leighton I. Davis, Air Force Assistant Deputy Chief of Staff, Development, and an Army representative not yet announced.

The technical program of the convention—sponsored by the IRE Professional Group on Military Electronics—will include 20 unclassified and 5 classified sessions. The classified portion will be sponsored by the Air Research and Development Command, and attendance limited to those with appropriate security clearance.

Unclassified session topics are: satellite electronics; microwave devices and techniques; instrumentation; noise effects on precision and data; communications; reliability; antennas; data handling; special electronic components; radar; simulation; missile ancillary systems; space technology; camera display devices; and vulnerability, guidance and control.

There will be classified sessions on instrumentation, electronic generation, switching and radiation, guidance and space technology, and reconnaissance and ranging.

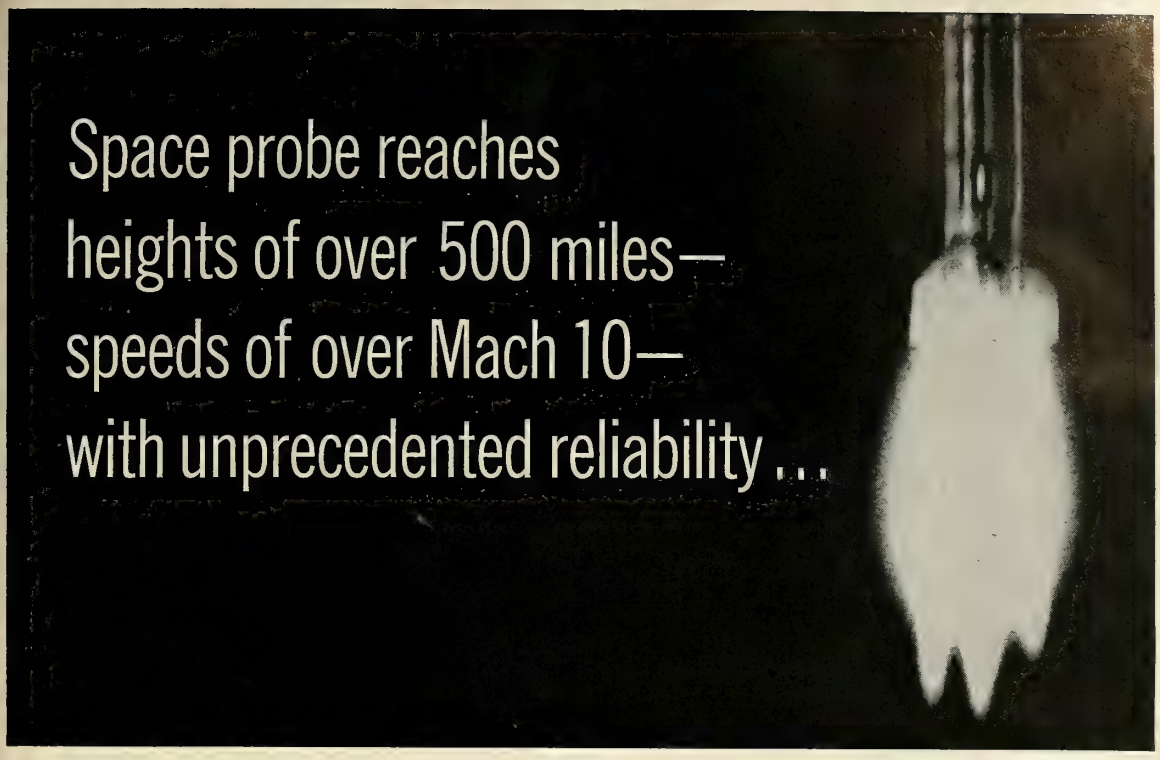
Callery Plans to Begin Producing Pentaborane

Callery Chemical Co. expects to begin production of pentaborane at its Muskogee, Okla., plant by late summer.

E. G. Sanner, Callery president, said last week that employment at the plant will rise from 190 to 300 when the current modification is completed.

Pentaborane has been causing considerable stir in the rocket industry because of its storability and very high specific impulse with most oxidizers. The Air Force last February awarded Callery a $9-million production contract.

"We are optimistic about the future of pentaborane because it has con-



...AND BRISTOL SIDDELEY SUPPLY THE POWER

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant, the Gamma produces a total sea-level thrust of 16,400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of only 700 lb.

The Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with a reliability that is unprecedented. For, to date, the Gamma has never failed to fire successfully.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. *By combining these components in single or multi-chamber lay-outs, thrust requirements from 500 lb up to 100,000 lb can be met.*

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The Bristol Siddeley Orpheus powers the Fiat G 91, NATO'S light fighter.



The Bristol Siddeley Proteus powers the Britannia airliner.

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NASA Life Sciences Group To Farm Out Most of Studies

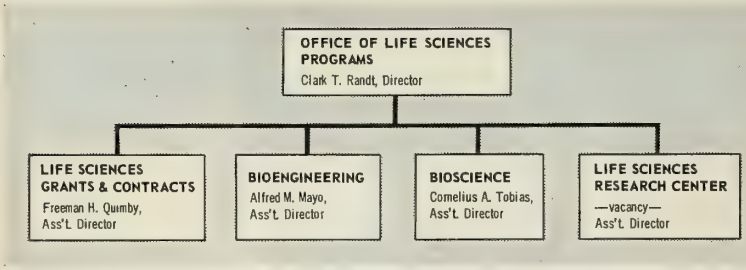


TABLE OF organization of NASA's new Office of Life Sciences.

NASA's recently organized Office of Life Sciences expects to be spending at least three-quarters of its budgeted funds for outside work. Some of these funds will be used for studies at military aerospace laboratories.

NASA also plans a Life Science Research Center, which would be built to attract outstanding life sciences talent.

The work of the Office of Life Sciences is being divided into four categories, each with its own assistant director. Heading up Grants and Contracts is a former Office of Naval Research chief scientists, Freeman H. Quimby. He will be overseeing the money given to sponsored research, grants and contracts research.

Taking the Bioengineering post is Alfred M. May, with Douglas Aircraft for the past 20 years; and the Bioscience post, Cornelius A. Tobias, on leave from the University of California, where he is professor of medical physics. Still unfilled is the job of assistant director of the Research Center.

• **Man-machine integration**—One of the major pieces of work for the Office is to help get man into space. Phases of the problem are in biotechnology and in basic medical and behavorial sciences.

"Biotechnology," as defined by OLS Director Clark Randt, "refers to men-machine integration; environmental stress tolerance—that is, the definition of limits of tolerance and protection therefrom; a special category of protective equipment, escape devices, and radiation shielding; life support systems; public health problems, and ground crew safety."

Pointing out how important biotechnology is to the effort of his office, Randt emphasized that the military services have great capability in this field as regards personnel, facilities, equipment and programs, and that consequently "we will turn for major support (in biotechnology) to the military service laboratories."

In basic medical and behavioral sciences, the Office sees the best help coming from the medical schools. The speaker hastened to add that these remarks should not be taken "as an attempt on my part to assign roles or missions" but merely as a recounting of accomplishments.

The program for the Life Science Research Center is now being planned so that it can be shown to Congress for approval next spring. Major reason for the Center "is that this would enable us to attract and productively utilize the talents of a few high-quality individuals to provide leadership for a national program in the space-related life sciences."

• **Select staff**—It was estimated that the facility would be small, maybe reaching 90,000 square feet and a staff of about 60 professionals. "We have no intention of building this Research Center across the waterfront in order to do any major portion of our research and development work there . . . " Represented would be flight medicine and biology, space medicine and behavioral sciences, and space biology.

Randt said that his Office is particularly concerned with planning and participating in the follow-ons to Project *Mercury* in the manned space flight area. He observed that Project *Mercury* itself is already well down the road, with the planning phase being over, and hence there is little work here for his office except minor consulting.

Of more immediate interest is starting a program for biological experiments in the upper atmosphere and space environment. Randt said that within the next two months there will be a meeting of scientists interested in this work who will be advising on productive areas of research and the priorities they should have.

Speaking of work that outside contractors could do, Randt called for instruments able to make automatic analyses of remote planetary surface and subsurface organic compounds. "We would like to be (in) on the development of instruments for that purpose . . . "

NASA would also like to get a device which after emplacement would collect samples of possible life forms on other planets. "Such collections of samples and the automatic instruments that by telemetry would record data then will bear on the major problem of the origin of life and the genetic mechanisms of evolution," Randt said.

NASA Spending

House Votes More Power Than Appropriations

The House last week left NASA with a $94 million discrepancy between its Fiscal Year 1961 authorization and appropriation.

After having passed an appropriations bill cutting NASA's FY '61 spending by $38,950,000 (M/R, April 25, p. 61), the House turned around and passed the Senate-House conferees' authorization bill giving the space administration authority to spend $55 million more than it had asked for. (The Senate subsequently passed the authorization bill and sent it to the President.)

According to the House appropriation bill, NASA can spend $866 million; according to the House-Senate authorization bill, NASA is authorized to spend $970 million. NASA had asked for an authorization and appropriation of $915 million.

The Senate Appropriations Committee is currently considering NASA's budget. It is expected to recommend that the Senate appropriate $50 million more than NASA asked for in FY '61, thereby making the Senate appropriations bill identical to the Senate authorization bill.

Then the opposing bills will be submitted to a conference committee where some compromise will be attempted to eliminate the $93 million contradiction in the House bills.

In the final version of the authorization bill passed by the House is a provision for 30 additional "excepted" positions not subject to normal Civil Service regulations. This would give NASA authority for a total of 290 of these high-grade jobs.

Discoverer Problems Still Unsolved

by Hal Gettings

No final answers have yet been found as to why the *Discoverer* program has failed to yield a successful re-entry and recovery. The puzzle is being intensively investigated by Lockheed, the prime contractor, and General Electric, developer of the re-entry vehicle.

Eleven of the Air Force satellites have been fired without success. Six have been put into orbit but none has re-entered in the planned recovery area. At least two, and possibly three, probably re-entered in other areas, but no recoveries have been made.

The *Discoverer* program calls for the launching into polar orbits of a number of *Agenas* for development of the satellite and its systems, and for bio-medical and other scientific experiments. *Agena* is boosted to near-orbit altitude by the AF *Thor* which separates after burnout. The satellite coasts upward as it positions itself in a horizontal attitude; then its own engine is fired to bring it to orbital speed.

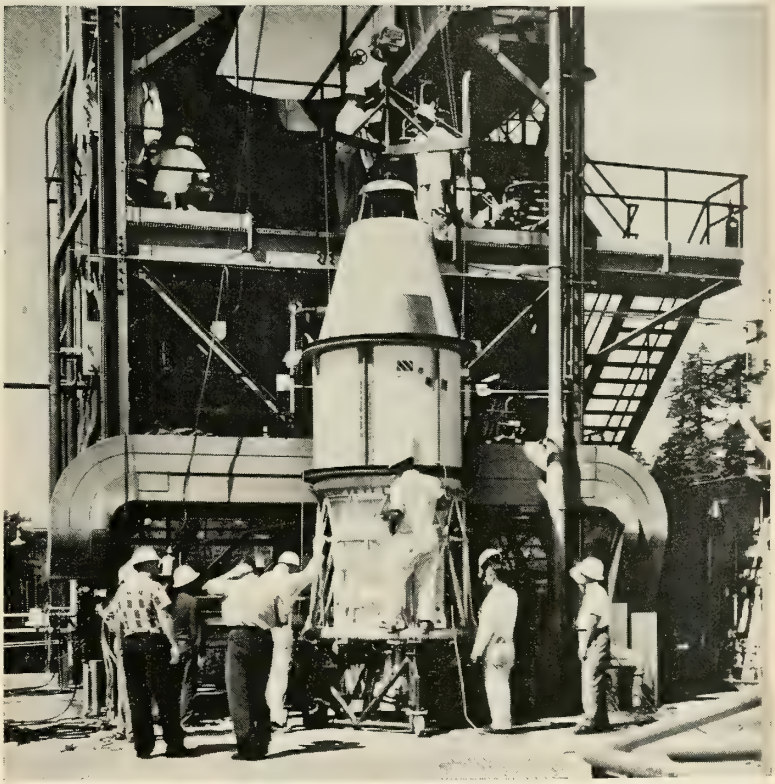
Soon after attaining orbit, the satellite is programed to turn 180° to face the nose section rearward and destabilized in this attitude.

On the 16th pass, the satellite is tilted 60° downward and stabilized to permit ejection of the hose section.

As the satellite swings over the pole and past Alaska, a timer activates the ejection sequence and the re-entry vehicle-recovery capsule is separated from the rest of the *Agena*. A retrorocket on the nose section fires to slow it down to permit a gradually curved entry into the earth's atmosphere. A parachute is opened at the proper time in order that an aerial recovery attempt can be made near the Hawaiian Islands.

• **Monkeys delayed**—The phase involving the carrying of live monkeys into space for bioastronautic research has been delayed until after two successful recoveries of "unmonkeyed" capsules have been made. (Monkeys used in the experiments must be American-bred, due presumably to their being held sacred in some countries of origin.)

One capsule carried mice, but failed to orbit. An instrumented but unoccupied "mouse house" was carried



SECOND-STAGE *Agena* **carried re-entry vehicle into polar orbit. After stabilization and proper attitude orientation, nose cone is separated and returns to earth.**

Discoverer Box Score

DISCOVERER	LAUNCH	ORBIT	SEPARATION	REASON FOR FAILURE
I	OK	OK	OK	Not Known.
II	OK	OK	OK	Incorrect timing. Re-entry over Spitsbergen.
III	OK	NO		Not known.
IV	OK	NO		Not known.
V	OK	OK	OK	Possible wrong attitude at separation. Vehicle probably became satellite "Unknown 1-60."
VI	OK	OK	OK	Navy planes supposedly tracked re-entry body, but no recovery.
VII	OK	NO		
VIII	OK	OK	OK	Attitude control problem. Re-entry outside recovery area.
IX	OK	NO		
X	NO			
XI	OK	OK	OK	Not known. Could be rocket failure, improper attitude, physical hangup on separation.

in *Discoverer II*, which re-entered over Spitsbergen in the Arctic Ocean. Instrumentation of the life-capsule on other shots has telemetered back data indicative of its successful operation.

Troubles plaguing *Discoverer* can come from any number of possible sources. Precise stabilization of the *Agena* in orbit is one vital consideration. Due to critical re-entry angle and speed, the re-entry vehicle must be exactly positioned in attitude when ejected from orbit. Otherwise, it will go into another orbit or burn up in the atmosphere. Stabilization has been achieved but, apparently, attitude was not correct or other malfunctions occurred.

In the most nearly successful operation to date—*Discoverer II*—everything went well but timing. The re-entry vehicle was spotted by "qualified observers" in the Spitsbergen area but could not be located after it hit the ground. The capsule of *Discoverer VIII* also re-entered outside the planned area and was not recovered.

• **Tough requirements**—Other items in the re-entry complex can also become significant due to the sophisticated nature of the operation. Separation must be clean and exact. Retrorocket firing must be exactly timed and of precise thrust. Attitude of the re-entry vehicle after separation must be properly stabilized when the retrorocket fires. The radio beacon must operate at the proper time for ground tracking. Any one of a number of minor malfunctions can abort the mission.

The program in its early stages did not provide for telemetry. As problems developed, however, telemetering equipment was added to the vehicle. But telemetry didn't provide all the answers. In most cases it could tell what went right but not what went wrong. There was no way to verify, for instance, that there might have been a physical hangup on the re-entry vehicle separation . . . or that final attitude was not disturbed on separation . . . or some other malfunction did not occur. It is practically impossible to instrument for all contingencies—and still carry a useful payload.

In the meantime, investigation is still going on to find the answers. Other vehicles are scheduled to be launched in continuing attempts to successfully accomplish the mission and put the experiments on a routine basis.

Lockheed was recently granted a $50-million contract for 16 more *Agena* vehicles, some of which will be used in the *Discoverer* program. The exact number of future firings has not been released, but present plans are to continue the open-end project for some time.

Constant Satellite Watch Feasible With TV Equipment

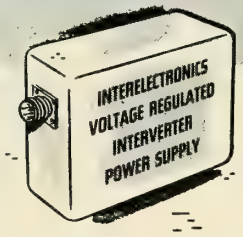
Supersensitive astronomical daylight photographs are now practical using television techniques. Equipment has been developed by International Telephone and Telegraph Corp.'s ITT Laboratories, Ft. Wayne, Ind.

The importance in this development, says ITT, is that 24-hr. observations are now possible. Perhaps more important, 25 or more telescopes equipped with this closed-circuit equipment could maintain constant satellite observation.

Six years have gone into the development, sponsored by the Air Force Aeronautical Research Laboratories, Dayton.

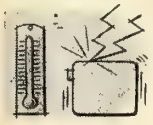
Heart of the equipment is an electronic transducer which receives the light and transforms it into electrical impulses. These are amplified and converted to a visual image on a storage cathode ray tube. The object being scanned then may be observed visually or photographed.

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over 260,000 logged hours— voltage-regulated, frequency-controlled, for missile, telemeter, ground-support, 135°C all-silicon units available now—

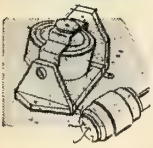












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Saturn Pad and Its Escape System

On this page are pictures of the *Saturn* launch facility and its service tower's safety escape mechanism presently being constructed at Cape Canaveral.

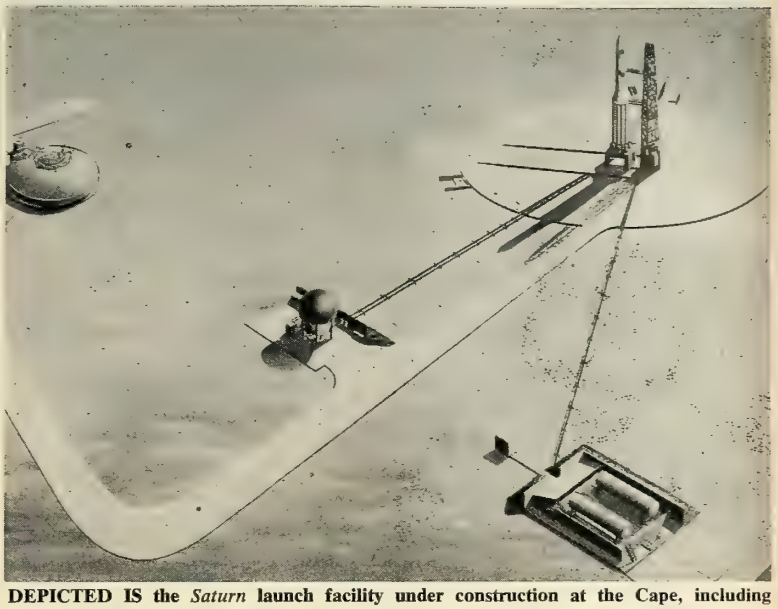
The hazards of fueling the upper stages of *Saturn* necessitated construction of the novel escape system. The huge vehicle may eventually carry a nuclear top stage.

At right is a schematic of the three-stage version of the vehicle sitting on the launch pad, with a service structure and propellant-loading facilities of liquid hydrogen and liquid oxygen in the upper stages.

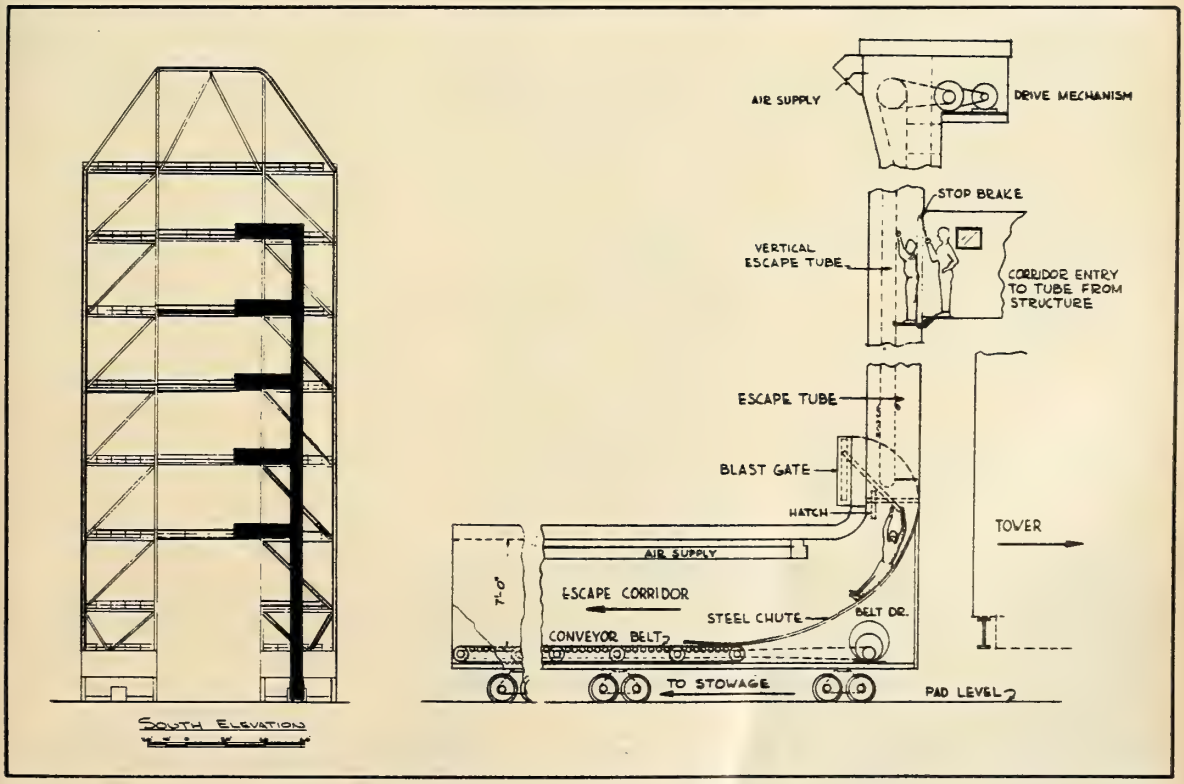
At right in the schematic is the blockhouse from which the firing will be carried out.

The facility will be used for the first launching sometime in the summer of 1961.

Funds for the facility were included in NASA's FY 1961 budget.



DEPICTED IS the *Saturn* launch facility under construction at the Cape, including the propellant-loading facilities for LOX and liquid hydrogen.

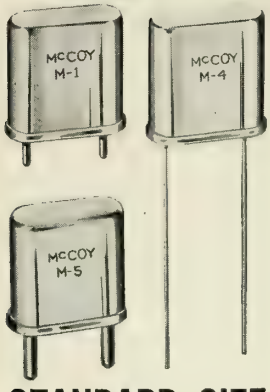


TO BE BUILT at *Saturn* launch site is a safety escape mechanism. Vertical descending manlift transfers to horizontal belt for transporting personnel to edge of pad. System is needed because of service tower's 30-story height.

McCoy

a synonym for quality, stability, and dependability in

CRYSTALS and CRYSTAL FILTERS



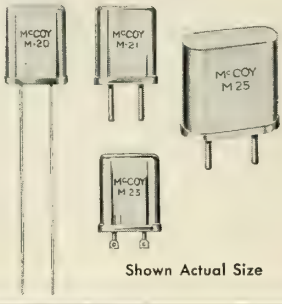
STANDARD SIZE CRYSTAL UNITS

The crystals that made the name of McCoy a synonym for quality. Metal encased, the M-1, M-4, and M-5 are available in frequencies from 500.0 kc to 200.000 mc.

Shown Actual Size

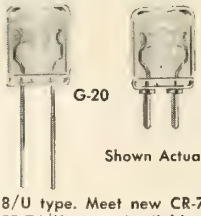
SUB-MINIATURE CRYSTAL UNITS

Fill the need for miniature crystals from 1.0 mc to 200.0 mc. Meet specs MIL-C-3098B and ARINC No. 401



Shown Actual Size

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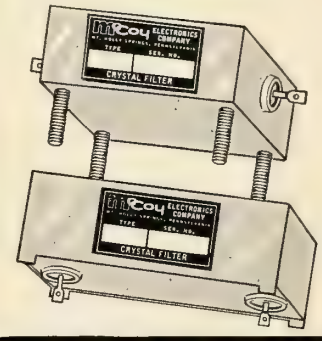


Shown Actual Size

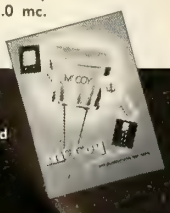
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AFCEA Meeting

Record Session Opens With Moon Relay Test

The Armed Forces Communications and Electronics Association officially opened its 14th Annual Convention in Washington with a ceremonial moon relay to and from Pearl Harbor.

The Naval Communications Station here served as the initiating site for this first public showing of the moon relay system, developed by the Navy and Developmental Engineering Corp. UHF high-powered transmitters and highly directional narrow-beam antennas were used during the communication.

Relay time for the 1,000,000-mile round trip distance was roughly five seconds. The first message was sent by AFCEA President B. H. Oliver, Jr.

Certainly the Missile/Space Era dominated all aspects of this year's May 24-26 meeting. A majority of the 160 exhibits at the Sheraton Park Hotel involved missile or space products and R&D services, as did all of the panels and speeches.

Theme of the convention was "Communications and Electronics—The Arm of Control, the Voice of Command." By M/R's press time, more than 4500 persons had registered —topping all previous records—and all social events were sold out, an unusual occurrence at a technical conference.

• **Principal speakers**—The keynote speaker, Admiral Arleigh Burke, Chief of Naval Operations, summarized recent advances in military electronics and stressed the need for cheaper, more reliable and less complex equipment and systems.

Maj. Gen. George L. Black (USA, Ret.), an executive of International Resistance Co., was principal speaker at the Industrial Luncheon.

He reviewed the milestones leading up to the 100th anniversary of the U.S. Signal Corps—from smoke signals in the early 1800's, through a weather service assignment in 1870, to flag and torch, heliograph, telegraph, telephone, radio, and finally communication satellites.

Leo Cherne, Executive Director of the Research Institute of America, was main speaker at the Conference banquet.

• **Panel**—A six-man panel from the National Aeronautics and Space Administration presented a well-rounded discussion of the use of satellite communications, positioning, and tracking, plus a glimpse at some advanced research in this field.

Lockheed's MSD Faces Crippling Strike Threat

Four vital defense programs will halt at Lockheed's Missile and Space Division if the 10,548 members of the International Association of Machinists resort to strike action in the current contract negotiations.

The strike authorization was voted in last week by 95.4% of the IAM membership. The union is proposing a 7% cost increase for each year of a two-year contract. The figure includes both pay and fringe benefits.

Thomas E. McNett, IAM spokeman, charged earlier that the negotiations have been subject to government interference in the form of rumors that no provisions will be made in contracts for employe relocation and other expenses related to the assignment of personnel to off-base test sites. One IAM request concerns relocation pay for some 2000 employes at LMSD's Van Nuys, Calif., plant.

McNett accused the firm of "dragging their feet" in the negotiations which began at Santa Barbara, Calif., April 5.

Six Lockheed plants will be affected by the strike, halting production on *Polaris* missiles, and *Discoverer, Samos* and *Midas* satellites.

mergers and expansions

AIRTRON DIVISION of Litton Industries has established an Advanced Devices Laboratory for R&D in microwave subsystems, components and materials. Dr. Ernest Wantuch will be director of the Morris Plains, N.J., facility.

ELECTRO NETWORKS, INC. of Syracuse, N.Y., has disclosed acquisition of all outstanding stock of Camden Electronics in New Jersey. Maintaining its same line of products, Camden will operate as a division of Electro Networks.

GIANNINI CONTROLS CORP.— has moved its general offices and gyro division to Duarte, Calif. An 80,000-sq.-ft. facility is planned which eventually also will hold the company's Transducer Division.

ELECTRONIC ASSEMBLY CO. has changed its name to Elasco, Inc.

WEATHERHEAD COMPANY, Cleveland, put into operation a new $100,000 facility for assembly and testing of critical missile fluid power system components under surgically clean conditions.

ELGIN MICRONICS broke ground for a new 15,000-sq.-ft. Research and Engineering Lab at Rolling Meadows, Ill., 28 miles Northwest of the Chicago Loop.

NORTH ELECTRIC COMPANY, Galion, Ohio, has acquired control of Power Equipment Company. The latter produces power supplies for computers and other electronic systems.

AERO INSTRUMENT CO., Burbank, Calif., has been purchased by Radioplane Division of Northrop. Aero will continue to operate under its own name and management.

PUROLATER PRODUCTS, INC. has opened new research laboratories in a newly constructed half-million dollar building with more than 13,000 square feet of space . . . Western Scientific Instrument Co., Inc., firm of instrumentation engineers has established a technical coordinator district in the San Diego area . . .

INTEGRATED DATA PROCESSING, INC. has been acquired by Monroe Calculating Machine, Inc., a division of Litton Industries. IDP, who furnishes financial reports to all types of companies, will operate as part of Litton's Monroe Division.

financial news

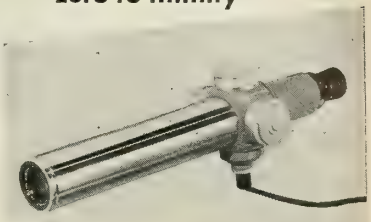
Textron Electronics—First quarter sales were $6.5 million; net income was $226,000. Textron's backlog of business as of March 31 was $5 million.

Garrett Corp.—A net profit of $3.9 million from consolidated sales of $166.6 million was realized for the nine months period ending March 31. Net income was 59% higher than that of the corresponding period in the previous year.

Air Reduction Co., Inc.—Sales for the first quarter of 1960 were $53.3 million, 11.1% higher than that of 1959's first quarter. Net income in the first quarter of 1960 was $4.2 million, or 10.9% over the previous year's first quarter.

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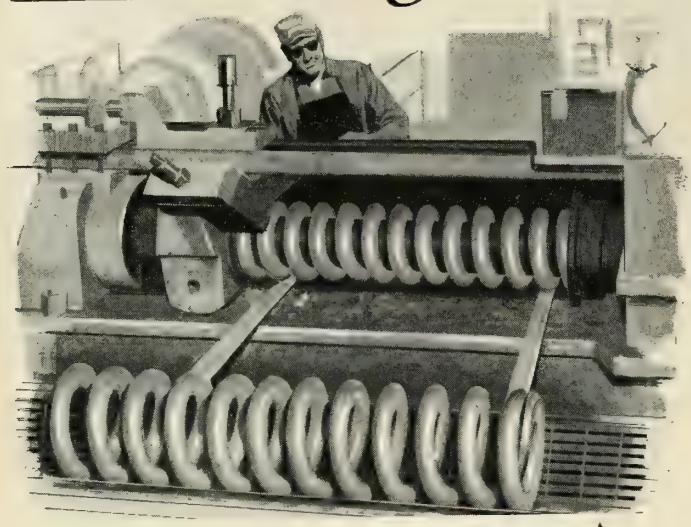
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——contracts——

NASA

$450,000—Space Electronics Corp., $118,000 for fabrication and test of flight decoder units, ground equipment and system test consoles related to a spacecraft radio command system and **$325,000** for design, packaging and fabrication of a digital data handling system for transmission of information from deep in space.

AIR FORCE

AiResearch Manufacturing Div., The Garrett Corp., for design, development and manufacture of a liquid oxygen converter system capable of operating at zero gravity. Amount not disclosed.

Electro-Optical Systems, Inc., Pasadena, for a mathematical study of performance characteristics affecting solar energy concentrators. Amount not disclosed.

$118,000,000—Convair, General Dynamics, San Diego, for continued production of the *Atlas* including both weapon system and space booster uses.

$46,000,000—Hoffman Electronics Corp., Los Angeles, for production of Tacan sets.

$4,000,000—Continental-Emsco Co., Dallas, for constructing 12 structural steel cribs for *Atlas* missile underground launching pads.

$3,800,000—American Machine & Foundry Co., for development of an underground launching system for *Atlas*. Subcontract from **Convair.**

$3,500,000—GPL Division, General Precision, Inc., for overall design, integration and testing of the navigation subsystem package for the ALRI program, an extension of SAGE.

$1,500,000—Bendix Aviation Corp., for initial production of the AN/GJQ-9 automatic ground check-out system for the *Sky Bolt* and *Hound Dog* missiles.

$600,000—Hydraulic Research and Mfg. Co., Burbank, Calif., for electro-hydraulic steering actuators to be used on the *Atlas*. Subcontract from **Convair-Astronautics.**

$120,000—Cornell University, Ithaca, N.Y., for continued research on linear beam tubes.

ARMY

Telecomputing Corp., Whitaker Gyro Division, Los Angeles, received a contract for the design and development of a two-axis free gyro for use in the *Shillelagh* missile. Subcontract from **Aeronutronic Div., Ford Motor Co.**

$13,560,853—Raytheon Co., Waltham, Mass., for components for the *Hawk* missile system. (Three contracts covering ground equipment, field maintenance equipment, telemetering and ground stations subassembly.)

$5,303,912—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant* missile system.

$4,077,000—Western Electric Co., Inc., New York, for research and development of the *Nike-Zeus*.

$2,477,247—Five Boro Construction Corp., New York, for construction of missile master support facilities in the Pittsburgh defense area.

$1,094,319—Raytheon Co., Waltham, Mass., for repair parts, *Hawk* missile system.

$683,785—Forrester Construction Co., Flint, Mich., for construction of SAC *GAM* facilities, Wurtsmith AFB.

$214,000—Freuhauf Trailer Co., for manufacture of missile pallets for the *Hawk* missile. Subcontract from **Raytheon Co.**

$193,204—Aeronca Mfg. Corp., Middletown, Ohio, for design, fabrication, test firing and evaluation of a rocket-deployed parachute support target system.

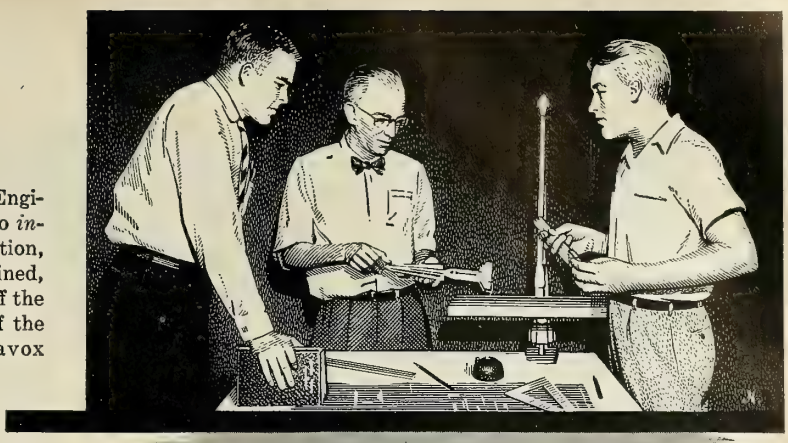
$175,000—Columbia University, New York City, for analysis of radar noise in the *Nike* and related systems.

$98,872—Martin Construction Co., Cocoa Beach, Fla., for construction of Azusa Service Center, Cape Canaveral Missile Test Annex.

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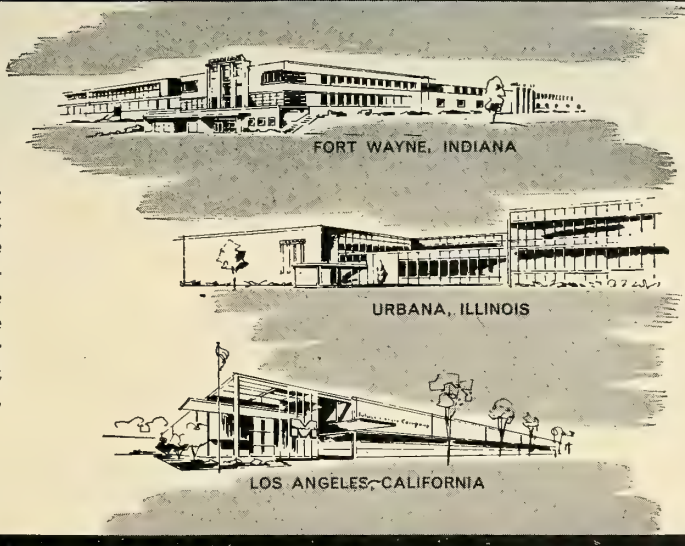
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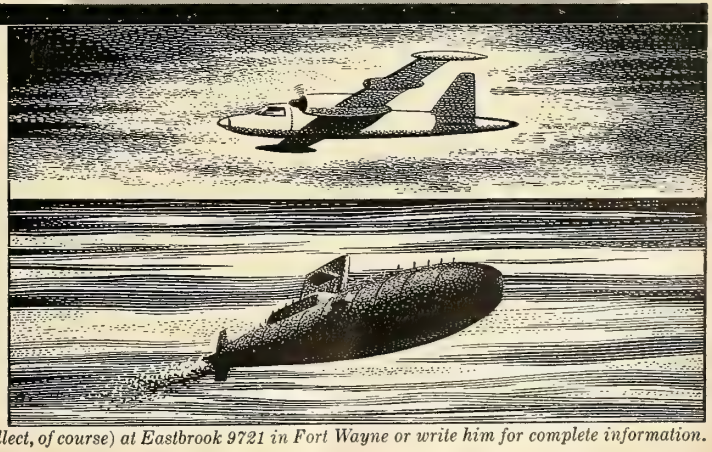
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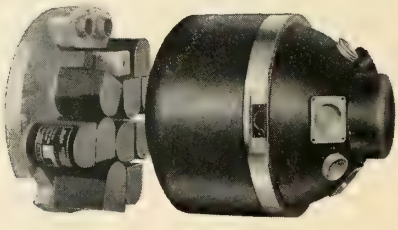
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Technical Countdown

ELECTRONICS

Two-Mile Impact by Atlas

Air Force is keeping it quiet, but the payload of the recent 9000-mile *Atlas* shot impacted within a two-mile target area in the Indian Ocean. The bird used General Electric's radio-command guidance system and was not a stripped-down version. Weight savings in Rocketdyne propulsion system was the key factor. The Mark 3 nose cone was reportedly same weight as operational RVX-4.

Solar Radiation Communications

Electro-Optical Systems, Inc. is developing a new communications system (SOCOM) using solar radiation as the transmitting mode. Providing optical communications over interplanetary distances, the system will be used for all types of data transmission in space, and possibly from space to earth. Sponsored by AF's WADD, it has very narrow beam width which appears to be invulnerable to ECM. EOS says the system can be satellite-tested in two years.

High Capacity at Aerojet

Total cost of instrumentation and the electronic control centers at Aerojet-General's 22,000-acre test facility outside of Sacramento, Calif., was roughly $15 million. Sounds high, but about 40% of the total test center is used for each major contract. At present, company is running from 400-700 liquid-fuel engine tests/month; 400-2000 solid rocket tests/month.

Douglas Heavy With Computers

If there is any doubt in anyone's mind that the missile/space industry isn't extremely computer-oriented, take a look at just one typical prime: Douglas Aircraft Co. has 14 autonomous computer sections using 17 major data processing machines and 29 smaller free access computers. Its Missile Computer Engineering section, however, employs half the total talent available and takes one third the total operating expenditure.

GE in Battelle Program

GE's Light Military Electronics Department will represent the company in the Battelle Memorial Institutes' Electronic Component Reliability Center program. Purpose is to develop reliability, performance and application data on component parts from pooled raw test data supplied to the center by some 12 participating companies. Results will be documented to the companies. Involved are transistors, diodes, tantalum capacitors and relays.

Sub for Shillelagh

Telecomputing Corp. has one-year subcontract for design and development of the gyro for Army's *Shillelagh*. Assuming the gyro design work is successful, follow-on production contract would be awarded by Aeronutronic, a division of Ford.

ASW ENGINEERING

Barium Titanate Cost Criticized

Transducer manufacturers are griping that the price of barium titanate is "way out of line." One manufacturer says he has to pay $40 for a flat plate 4 in. in diameter, 1 in. thick—and that its cylindrical shape couldn't possibly justify such a cost. But with not many standard types available and the trend in transducer sizes becoming larger to accommodate lower frequency, costs probably will remain high. There is talk of putting in megawatt pulse.

RUM Vehicle Worries

ONR's remote control ocean bottom crawler, dubbed RUM, has a good many missile/space companies goggle-eyed at its production possibilities. But Navy sources say the original "insiders"—Hughes, Orbitran, General Mills—probably will reap the production benefits.

MATERIALS/STRUCTURES

Oops, We're Sorry!

Standard Steel Corp.—not Standard Pressed Steel (as reported in M/R, May 2) has been licensed to make a super-insulation developed by National Research Corp. for long-term storage vessels for liquid helium, hydrogen and fluorine.

Switching Advance at Goodrich

Bellows activated switches took a big step forward last week with the development of "Omega design" seamless bellows operational up to 1200°F and 12,000 psi. at B. F. Goodrich. This is about twice the capabilities of current bellows.

Arc Chamber Cracks

Operational date for Boeing Airplane Co.'s new Mach 27 electrical arc discharge tunnel, scheduled for extensive use in the *Dyna-Soar* program, has been postponed. The tunnel's arc chamber cracked at 30,000 psi during hydraulic testing.

PROPULSION

F-1 Test in Spring

The word is that the first full thrust (1.5 million pounds) test of Rocketdyne's *F-1* engine will be at Edwards AFB in the spring of 1961.

Strip Steel Motor Cases

Solid cases reaching 305,000 psi hoop stress are in experimental fabrication at Ryan. Layers of Allegheny Ludlum's AM-355 are wound and then spot-welded into cylindrical chambers.

JPL Expansion

With the propulsion industry having to put its own money in new facilities—in most cases just to bid on contracts—Jet Propulsion Lab of CalTech is on same wagon. JPL has a three-year, $7-million program to relocate and modernize its solid and liquid propellant test cells and to establish new research laboratories. Construction soon will start on a 60-acre site near present Pasadena facilities.

As crisis continues . . .

Defense Market Due To Double by Mid-'60's

Mobility will become the major criterion and tactical missiles will get biggest R&D emphasis; military space effort is seen certain to expand



TEST firing of tethered Boeing *Minuteman* at Edwards AFB, Calif., symbolizes the push to get operational mobile ICBM systems by middle of decade.

by James Baar

The decade of the 1960's will see the missile come of age as America's prime weapon and means of reaching out into the Solar System. By the middle of the decade the military missile/-space market is expected to at least double.

For the Missile/Space Industry, four major trends are evident to many top military and civilian defense leaders as the decade begins:

- Mobility is rapidly becoming the essential element of any new missile system.
- The relatively short-range tactical missile is expected to become the prima donna of the development field as the big long-range systems are completed—except for follow-on improvements.
- Military space programs are expected to absorb a growing share of the defense budget.
- Missile defense systems are expected to call for more and more effort by the mid-1960's.

The result will be continued expansion of the Missile/Space market. Only the rate of that expansion remains to be determined, depending on the approach of the next administration to the nation's critical defense problems.

The FY 1961 defense budget includes nearly $7 billion for all missile programs plus another $1.7 for military astronautics, foreign missiles for military aid nations and missile maintenance. Congress is expected to add several hundred million more—that the present Administration may or may not spend.

Conservative estimates put total annual defense spending on missiles and space by 1965 at about $18 billion. A number of responsible military leaders put the figure much higher.

- **Imponderables**—Two of the biggest unknowns in speculating on the size of the missile/space military budget are missile defense and space.

Any foreseeable missile defense system designed to provide protection for continental United States would cost between $10 and $15 billion depending on how much defense the country bought. The Western Electric *Nike-Zeus* antimissile missile could provide protection for about half the nation's population for some $15 billion. Some proposed systems would cost three times as much or more.

The question that military planners face is whether a system that costs so large a sum is worth it. No decision has been reached.

The expansion of military operations into space is considered inevitable by most military men regardless of the current Administration's policy that the military services have no interest beyond a few thousand miles out.

Some top military men feel that by the end of the 1960's the military occupation of the moon will be necessary for national survival. Many more attach similar importance to the development of space bombers and space stations.

The question is how quickly the



PRIME DETERRENT WEAPON of '60's will be submarines like the Patrick Henry, whose *Polaris* tubes show clearly above.

United States will move toward these costly military goals.

• **Move to mobility**—The trend toward mobile missile systems is already very great.

By the mid-60's, much of the nation's major deterrent power will be vested in three systems: the *Minuteman*-launching railroad car, the *Polaris*-launching submarine and the *Sky Bolt*-launching bomber. However, present plans also call for a huge program for building dispersed, hardened *Minuteman* bases.

The same in trend is seen in the tactical missiles of the Army and Navy.

All of the Army's newest missiles are designed either to be easily transportable on trucks or tank treads or carried on a soldier's back.

The Navy's missiles have always been mobile because of their deployment aboard ships. However, the trend appears here, too, in the Navy's search for greater speed in the hydrofoil ship.

• **Hydrofoil destroyer?**—A contract for the first hydrofoil subchaser which will carry antisubmarine missiles is scheduled to be let by July 1. Many in the Navy advocate construction of a missile-packing hydrofoil destroyer as the next step. (M/R, May 23)

The hydrofoil destroyer would be deployed in fleets and be capable of downing sub-launched missiles with an antimissile missile such as the Westinghouse *Typhon* now under development. The new ships also would be capable of launching tactical range surface-to-surface missiles.

Some buildup of the Army's tactical missile arsenal will be underway this year if the Administration accepts the opinion of many congressional leaders. However, the big buildup is not expected to begin until 1962 at the earliest.

The Army not only needs to purchase its newest missiles in quantity to meet the threat of limited war but it is interested in the development of ever smaller, lighter missiles of various ranges up to 1000 miles. At present, it is prevented by official edict from extending the range of its tactical missiles beyond the 300-mile range Martin *Pershing*. There are some indications that this ceiling will be raised.

• **Gas carriers**—Another growing area of Army interest is in the field of poison gas missiles. Tactical missiles designed especially to carry chemical and biological agents in their warheads and similar strategic long-range missiles figure importantly in Army planning.

Some defense officials predict that development work in the mid-1960's will concentrate on tactical missiles because much of the effort and money that has been devoted to long-range missiles no longer will be needed.

All of the future ICBM and IRBM programs currently envisioned generally involve product improvements rather than radical innovations. Military men want to extend the range of the Lockheed *Polaris* to 2500 miles and increase the size of the warhead on both *Polaris* and *Minuteman*. The Air Force would like to develop a third generation ICBM which would for the most part be a small-scale *Minuteman*.

But none of these proposals involve the magnitude of difficulty that confronted the men who developed the first large liquid-propelled and solid-propelled missiles.

• **Ultimate mobility**—In the field of tactical missiles, the possibilities of the future can be seen in the nuclear-tipped *Davy Crockett* than can be carried by two men or on the back of a jeep and the Convair *Mauler* anti-missile missile, tactical battlefield weapon reported to weigh less than five tons in its entirety.

New materials, solid and pre-packaged liquid propellants with much higher specific impulse, nuclear and ion-powered rockets, still smaller electronic systems, all will be needed.

Many military officials feel that it is here that many firms must turn for contracts in a market where more dollars are continually being spent for fewer programs. But they argue that research as an end in itself and not as a means to production contracts is increasingly needed. If they are correct, the demand for radical changes in the contracting system can be expected.

• **Steady market**—Underlying all predictions as to what the 1960's hold for the military missile/space market is the assumption that the East-West struggle will continue in one form or another.

No top official in or out of military uniform is known to think anything but that it will. Moreover, many feel that America's great time of trial lies directly ahead and that the period between 1960 and 1970 may well decide the fate of the world for the next century.

With the money and policies to go with it, the weapons built by the American Missile/Space Industry will tell the tale.

NASA Outlay May Top $20 Billion

Spending estimates rise as space race intensifies; newly decentralized contracting set-up makes for fast award of contracts

by Paul Means

The National Aeronautics and Space Administration in less than two years of existence has undergone a major evolution. Changes which affect contractors include:

- A significant increase in the amount of money to be spent.
- A decentralization of the NASA procurement procedure.
- Major revisions about to be affected in NASA patent policies.
- The addition of two new field organizations.

The doubt about who-does-what-in-the-space-program was pretty well settled during 1959, with NASA becoming the nation's principal space organization. With few exceptions NASA is now charged with the development of future space boosters, upper stages, vehicles, instrumentation—the projects which will explore near space, and all of space more than 600 miles away.

Present estimates are that the Space Administration will spend from $15 to $20 billion during the next decade in carrying out this program, and this figure is being revised upwards as the space race progresses.

• **Decentralization**—One major change in NASA's procurement procedure during the past year was to decentralize. In the past, most of NASA's larger contracts, such as the development of *Nova, Vega,* and *Delta,* had been made at NASA headquarters in Washington. Now such contracts will be made by the field organization concerned.

Names of regional procurement officers are listed (see box) and the types of procurement done by these various field offices will be described below.

While supply and construction contracts are being made on a fixed price basis—largely by formal advertising—cost-plus-fixed-fee contracts are used for the bulk of NASA procurement, which is research and development. It is NASA's contention that cost contingencies, because of technical uncertainties, would make it necessary for contractors to include a substantial amount over their price to cover unknown costs or take a chance of losing money if such procurements were based on a fixed price basis.

NASA's basic procurement authority is the Armed Services Procurement Act, the same authority as the military departments. Its contract clauses, therefore, largely follow the clauses and procedures used by the military.

One advantage of NASA contracting procedure is that its procurement organization is small, allowing it to negotiate and conclude contracts with a minimum of time and formality.

• **How it works**—The average NASA contract to be let on a cost-plus fixed-fee basis begins with a bidders' conference, where early draft specifications are viewed by prospective bidders. This conference is held at the NASA center where the contract will be supervised.

Then a request for proposals goes out to possible bid sources. The number of companies bidding is usually fewer than the number attending the bidders conference.

After the bids are received, the NASA center supervising the contract hands the bids over to a source evaluation board which has been appointed from business and technical experts at the center. They evaluate the bids, considering the past economic history of the company, past bids made by the company, and technical evaluations of the company's facilities and personnel and the company's bids.

Once the local center's source evaluation board has made up its mind, and if the contract's potential cost is over $1 million, the board comes to Washington and briefs NASA Administrator T. Keith Glennan. Glennan then selects the bidder. He may follow the board's advise (as is usually the case) or he can select another company as the bidder. The final determination, and the responsibility, is his.

After selection of the bidder by the Administrator, the legal staff of the local center then negotiates a contract with the bidder. The contract contains a clause which states that either party in case of breach will submit to arbitration before NASA's Board of Contract Appeals. If the contracting company is still not satisfied, it can then appeal to the U.S. Court of Claims.

Since the Administrator makes the bidder selection on contracts whose potential cost is more than $1 million, the evaluations on which the board's selection are made are not made public. This has been criticized by Congress recently, but there is little chance that the procedure will be changed since NASA Constitutionally can withhold the information because of executive privilege.

After NASA has made a research and development contract, the military department having a contract administration staff at the contractor's plant is requested to administer the contract for NASA. NASA concluded an agreement with the Navy to assist in its procurement work some time ago, and recently effected a similar agreement with the Air Force. Payment of invoices, however, is made through NASA.

NASA also requests one of the military departments to contract for certain items, such as facilities to be used by NASA at a military base, or to procure boosters for its space shots. In these instances, the military department chooses the contractor, negotiates, writes and administers the contract. Though considered a DOD contract, such contracts carry the NASA patent clauses.

• **Small business aided**—Also created by NASA during the past year was the office of Small Business Adviser, headed by Jacob M. Roey. Each center has recently appointed a small business adviser. Since his appointment last July, Roey has been screening a list of small businesses (those with under 500 employes) supplied by the Small Business Administration for potential NASA contractors.

To this list Roey has added many small research organizations that are relatively new and have never been on the SBA list.

NASA's record of letting contracts to small business has been very good. The latest statistical evidence of this shows that between April 1 and Sept. 30, 1959, small business received 66.6% by number of contracts and 25.5% by dollar amount.

Where contracts are placed with larger companies, steps are taken to be sure the contractor allows small business to participate as subcontractors.

The Rocketdyne Division of North American Aviation, which has the NASA contract to produce the *Nova* million-and-a-half-pound-thrust single-chamber engine, for example, has placed 79.4% of its total subcontract work by volume with small business firms over a representative period. Total dollars showed $40 million going to small business subcontractors and less than $28 million to large business subcontractors.

General aims of NASA's small business program are: (1) to compile a well-indexed file of small businesses; (2) to screen proposed NASA contracts to determine what portions could be performed by small businesses; (3) to invite small businesses to participate as members of the audience when details of NASA-proposed contracts are explained to potential bidders; (4) to urge big business contractors to set up their own files of potential small business subcontractors; and (5) to urge small businesses to pool their resources so that they can jointly bid on larger NASA contracts.

• **Patents**—Though it is premature to interpret what NASA's new patent provisions will say, it is safe to predict that the space agency's patent law will read like the Department of Defense's, and will be executed accordingly.

Congress is presently in the process of revising NASA's patent laws.

Generally, the new law will give NASA a non-exclusive royalty-free license to use the patentable invention and the company will retain title. But this contract is revocable and waiver of title will be effected if NASA finds the company's use of their patent is to the exclusion of the national interest.

The only two areas where NASA may take more than a non-exclusive royalty-free license are where (1) the importance of the invention or process to the welfare of the country is such that title should be retained; and (2) the invention or process has to do with atomic energy and AEC patent policies are involved.

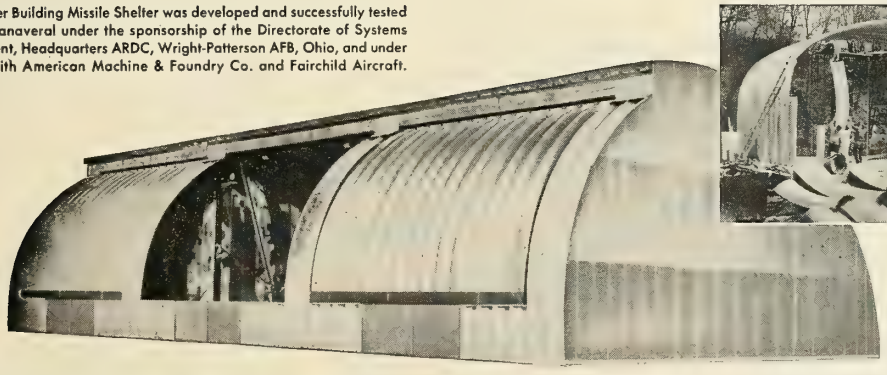
• **NASA centers**—In existence about a year and a half, NASA's table of organization has now been firmed. The space agency's centers, their projects, and procurement demands are:

• **The Langley Research Center** at Langley Field, Va. The oldest NACA facility, its areas of research are aerodynamic heating, hydrodynamics, and structure loads. More than $96 million has been spent in a recent year on research and development, construction and supplies. This represented 770 transactions with big and small business, other government agencies, and educational institutions. Though basically a research center, it has some development programs under way. One development project is the four-stage solid-propellant *Scout* satellite launcher.

• **The Lewis Research Center** at Cleveland, O. Lewis's staff is developing the chemical, nuclear and electric rocket propulsion systems of the future. Over $23 million has been appropriated in the last three years to expand its facilities.

• **High-Speed Flight Station** at Ed-

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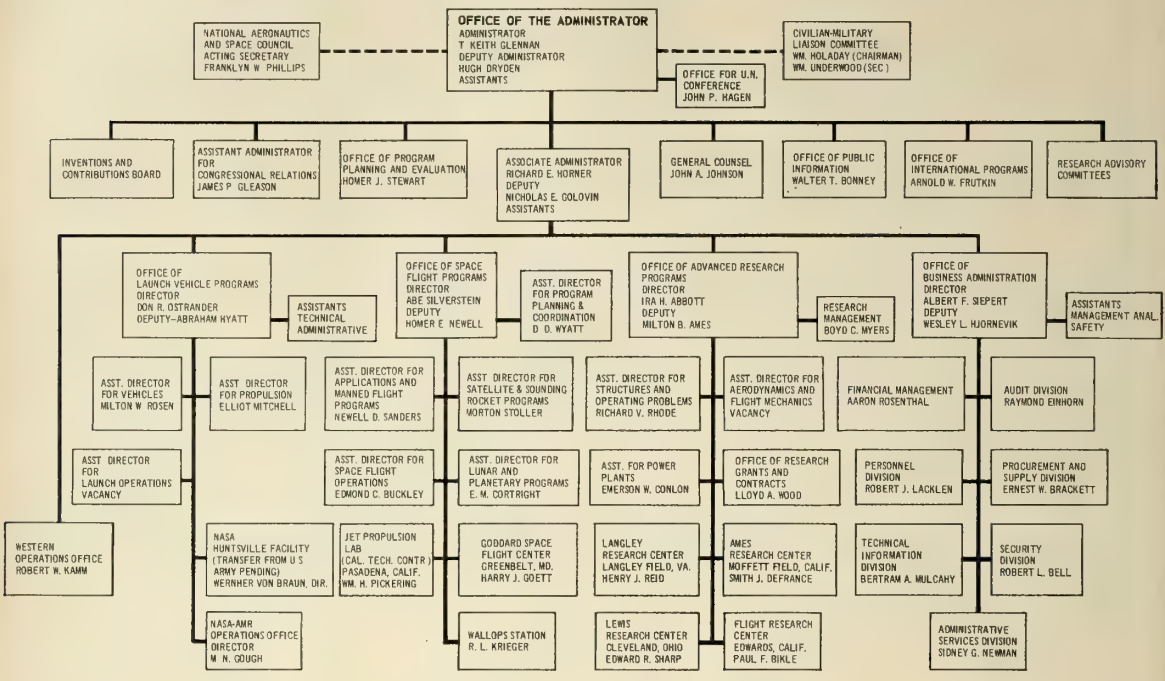
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wards AFB, Calif. Now engaged in propulsion and energy conversion, material sciences, structures and operating problems, and mechanics of flight. The station also is conducting the *X-15* research. The 1960 operating budget calls for $900,000 for research and development and $1,775,000 for construction and equipment.

• **Ames Research Center** at Moffett Field, Calif. Micrometeoritic impact and aerodynamic heating of space materials are among the principal research efforts. Over $10 million has been appropriated in the last three budgets to expand its facilities.

• **Jet Propulsion Laboratories** at Pasadena, Calif. This division of the California Institute of Technology operates on contract from NASA. All JPL contracts are written on a no-fee basis as cost-reimbursable, while JPL contracts with suppliers and vendors are negotiated with standard fee or profit provisions. Principal areas of research are propulsion, guidance and instrumentation. Recent contracts have included *Vega*, the payloads of many NASA scientific vehicles, and NASA's lunar impact vehicle program. $4 million has been appropriated for construction and equipment in FY '61.

• **The George C. Marshall Space Flight Center** at Huntsville, Ala. The latest and most glittering jewel in NASA's crown, Marshall is the only installation in the U.S. that can handle a launch vehicle program from conception through design, development and flight testing. Total spending during FY '61 is expected to exceed $300 million. Present basic area of activity is Project *Saturn* and the *Juno II* satellite launch program. To be transferred to NASA supervision in the near future are NASA's role in *Agena* B, *Centaur*, and the F-1 single chamber million-and-a-half pound *Nova*.

• **Goddard Space Flight Research Center** at Beltsville, Md. Another new NASA installation, Goddard has primary responsibility for space flight and manned flight. One of the significant NASA procurement changes is the pending transfer from NASA Headquarters to Goddard of personnel and active contracts. Procurement for the $350-million-plus Project *Mercury* will also be handled from Goddard, which is managed by the Space Task Group division of the Center. In the past three budgets $27 million has been spent to build this center.

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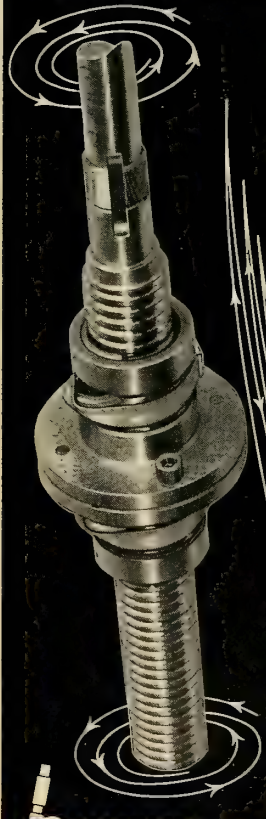
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EIA To Help Small Firms Get More Military Work

Electronic Industries Association's Small Business Committee has assumed responsibility for helping small electronic manufacturers obtain military business.

The decision was made—according to a report filed by the committee chairman, J. B. Elliott, president of Tele-Dynamics—after a survey which showed "that small business did not obtain enough government business and did not know how to obtain contracts."

Other problems of small business disclosed by a committee-sponsored regional conference:

• The small businessman suffers from the lack of progress payments during development and prototype stages of a contract. He also is hampered by payments for tools and advance production costs prior to the delivery of production merchandise.

• He is handicapped by lack of knowledge of planned expansion by DOD.

• Legislation is needed to guarantee small business a larger percentage of the defense dollar, regardless of whether the contracts are with prime contractors or the government.

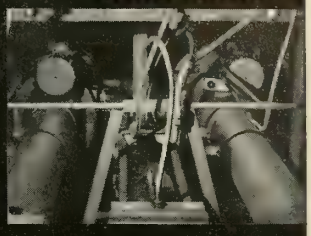
• Small businesses complain that primes and government agencies are obtaining know-how from individual smaller companies and, in some cases, using it for competitive bidding or even to manufacture equipment.

Proposed solutions center primarily around EIA providing ways and means of acquainting them with governmental procedures and available aids.

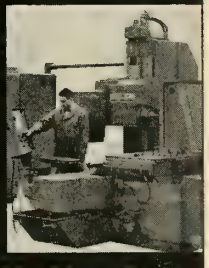
The committee recommended that regional small business representatives of the electronics industry be appointed on a non-pay basis. EIA could then correlate the major problems handicapping small electronic manufacturers and present them with recommendations to the Small Business Administration and the services.

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Industry Gets Nearly ½ of Missile $ $

EIA's new Fact Book predicts electronics' share of DOD budget will continue to climb; space projects grow in importance

Electronics accounted for almost half of total missile expenditures in fiscal 1959. In its just-published Electronics Industry 1960 Fact Book, Electronic Industries Association says that approximately $1.6 billion of the $3.5 billion spent for missile production went for electronics.

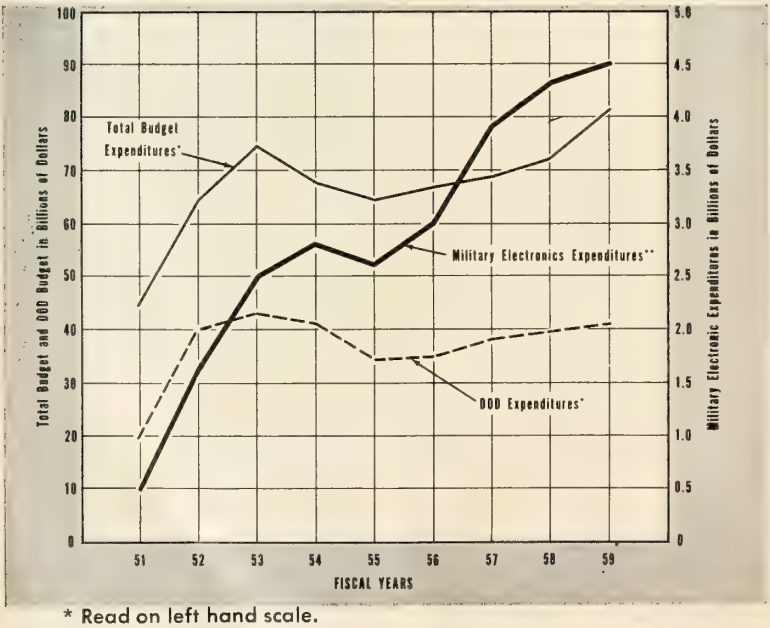
EIA credits the soaring increase in electronic missile dollars as a prime factor behind the remarkable growth of the electronic industry in recent years.

Total military purchases of electronic products during calendar year 1959 are "conservatively estimated" by EIA at $4.7 billion—more than nine times the $500 million outlay in 1950. And, despite a more-or-less static defense budget for the next few years, EIA anticipates a growing share of dollars for electronics. The Fact Book points out that research, development, test, and evaluation is a growing portion of the DOD budget—$2.86 billion in 1959 as against an estimated $3.9 billion in 1961—and one in which electronics has a major and increasing part.

These and many other important facts relating to the growth and major role of electronics in defense are contained in the Fact Book. As a service to our readers, M/R has obtained permission to excerpt pertinent data from the book as an aid in establishing marketing guidelines and policies in this vital aspect of the missile/space industry.

ESTIMATED MILITARY ELECTRONIC EXPENDITURES VS. TOTAL BUDGET EXPENDITURES AND DOD EXPENDITURES

(Fiscal Years 1951 - 1959)



* Read on left hand scale.
** Read on right hand scale.

• Growth started with WW II— The electronics industry's research and development effort first began to take on a new dimension under the stimulation of World War II. Under this impetus, electronics has become today "the common denominator of weapons for defense."

During the War, the LORAN navigation system, the proximity fuze, new bombsight equipment and improvements in sonar detection and radar systems were evolved. Scientists learned to use electronics in trajectory studies for counting and calculating. Speedy, automatic control devices were developed for aircraft and guns. From 1941 to 1945, military purchases of electronics and communications totaled $7.5 billion. At the peak of the war, more than 500,000 were employed in electronics production.

The 1950-53 period saw the manufacturing industry nearly doubled in size due to the electronic needs of the Korean War. Production for the military increased fivefold during these years to account for one-half of the $5.2 billion industry volume, and approximately 40% of an estimated 575,000 employed in electronics during 1953.

The intervening years have seen a continuous growth of military electronics to last year's total of $4.7 billion, an increase of seven percent over 1958.

• Space implications—Especially important in the long-range future are Government space programs which are requiring increasing electronics content in the design and fabrication of space vehicle payloads; data acquisition, reduction and transmission; and guidance and control of booster rockets.

Of the $385 million available to the National Aeronautics and Space Administration during fiscal 1959, an estimated $70 million plus is being absorbed by the electronics industry. During the next decade, over $14 billion will be authorized for space programs, of which approximately one-third will be available for electronics.

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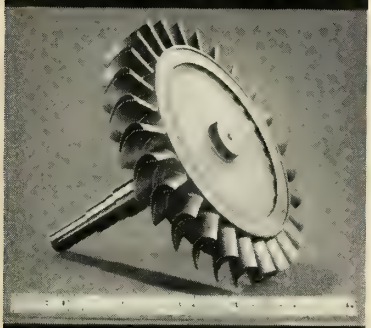
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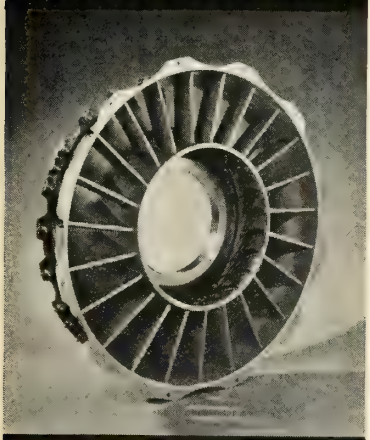
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Age technology to electronics production for commerce, industry, and the consumer. The impact will be felt more distinctly in commercial and public-service activities. For example, electronic devices placed in orbit will forecast the weather, aid ships in navigation, improve world-wide communications by serving as relay stations for signals, and permit long-range point-to-point communications at low levels, thus conserving the crowded radio frequency spectrum. Satellites containing electronics will patrol for icebergs, warn of forest fires, map the earth's surface and conduct geological surveys.

• **'Think-small' new concept**—The missile/space world technology race has been a strong force in advancing the trend to "think small." The urgent need has been, and certainly will continue to be, for smaller electronic systems requiring less power, performing more functions faster, and achieving higher and higher reliability.

The need—and the money supporting this need—provides much of the impetus for technical progress. But even more than this is the realization by industry in general that to stay ahead is to stay alive.

A secondary force in the think-small drive has been the computer industry which, in turn, has been attempting to satisfy the needs of the missile/space industry.

The same needs exist here, with the added problem of reducing vast cooling complexes—again an offshoot of component density and power usage.

Research programs in hundreds of firms are highly oriented by concepts of microminiaturization based upon functional circuits rather than by complex redesign of components and components assembly techniques.

Electronic equipments which have enjoyed significant size reductions through printed circuitry and transistorization are experiencing further diminution as a result of micro-module research and development.

Micro-modules are the result of an Army Signal Corps-sponsored fabrication technique in which tiny ceramic wafers containing semiconducting and insulating materials are combined to perform the electronic functions of basic components such as resistors, capacitors and transistors.

More than $7 million has been spent in the micro-module research program by the Signal Corps since its inception in April 1957. Already used to some degree by the military, micro-modules will save critical space and weight in portable ground communications, helmet radios, guided missiles, satellites, and in many other applications.

Solid-state tunnel diodes are the subject of intensive development work by many manufacturers. Related to transistors in form and function, tunnel diodes are potentially useful as oscillators, amplifiers, or switching devices, and promise to speed operations on small power requirements.

The influence of cryogenics, or superconductive phenomenon of certain metals at low temperatures, is already being felt in missilery, long-range communications, steel-making, and biochemistry.

Other significant technological progress which will shape the industry in future years, is being made in such areas as magnetics, thermoelectrics, solid-state physics, and microwave technology. Inroads in magnetics research and development, for example, are opening entirely new fields of engineering as advanced techniques are being successfully applied in new computer memory systems, in electronic control projects, and in magnetic amplifiers for high-speed aircraft and missiles.

Thermoelectrics, involving the direct interconversion of heat and electricity, is being extensively explored, and applications are envisaged in electronic refrigeration and in power generation for missiles, space vehicles, and at remote ground locations. Masers, microwave amplifiers of advanced design—offer wide potential in the communications field, particularly in radar, guided missiles, and space communications. Already in the prototype operating stage, these devices are able to detect and amplify extremely weak microwave signals.

Further in the future are the revolutionizing prospects of thin-film and molecular electronics. Presently in the applied research stage, this field involves the deposition of films of conductors, semiconductors, and insulators, or the molecular rearrangement of materials in such a way that single blocks of material perform functions of complete circuits. As a result of this work, entirely different concepts are in prospect for the construction of missiles, space vehicles, and a variety of conventional equipment.

Industry concentrated in few states—An estimated 3500 electronics companies operating nearly 5000 plants throughout the nation are currently selling well over 2000 classes of equipment and components. Nearly three-fourths of the total dollar volume of electronic production is concentrated in seven states: New York, Illinois, California, New Jersey, Pennsylvania, Massachusetts, and Indiana. New York last year led all other states in the shipment of military electronic equip-

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Total Budget, DOD Expenditures for Major Procurement and Production and Research and Development, and Estimated Military Electronic Product Procurement*

FISCAL YEARS 1951-1959 (Millions of Dollars)

	1951	1952	1953	1954	1955	1956	1957	1958	1959
Total Budget Expenditures	$44,000	$65,400	$74,300	$67,800	$64,600	$66,500	$69,400	$71,900	$80,700
Total DOD Expenditures	$19,772	$38,972	$43,711	$40,336	$35,532	$35,791	$38,439	$39,062	$41,250
Major Procurement and Production (MP&P)									
Missiles	$ 21	$ 169	$ 295	$ 504	$ 718	$ 1,168	$ 2,095	$ 2,737	$ 3,494
Aircraft	2,412	4,888	7,417	8,335	8,037	7,146	7,978	8,448	7,658
Ships and Harbor Craft	382	624	1,191	1,090	1,009	895	897	1,156	1,537
Combat Vehicles	189	1,014	1,926	677	740	48	266	66	149
Support Vehicles	57	900	408	240	296	190	124	150	134
Electronics and Communications	193	597	1,001	826	636	770	881	877	912
Other**	722	3,286	4,885	4,287	1,560	1,965	1,408	1,243	976
Total	$ 3,976	$11,478	$17,123	$15,959	$12,996	$12,182	$13,649	$14,677	$14,860
Research and Development (R&D)	$ 758	$ 1,164	$ 1,412	$ 1,385	$ 1,391	$ 1,491	$ 1,686	$ 1,742	$ 2,277
Total MP&P and R&D	$ 4,734	$12,642	$18,535	$17,344	$14,387	$13,673	$15,335	$16,419	$17,137
Military Electronic Product Procurement (EIA Estimates)	$ 510	$ 1,600	$ 2,500	$ 2,800	$2,600	$ 3,000	$ 3,900	$ 4,300	$ 4,500

*With the exception of estimated "Military Electronic Product Procurement," data contained in this table are derived from official U.S. Government sources, including the Department of Defense and the Bureau of the Budget. Data covering military purchases of electronic products represent EIA estimates only, and are based upon the best information available from both Government and industry sources.

**Includes artillery, weapons, ammunitions, production equipment and facilities, and other procurement and production.

ment—over 31% of the total. California was second with over 16%, and Pennsylvania third with almost 7%. By cities, New York (including Newark, N.J.) was tops with over 15% of total shipments, followed closely by Los Angeles with 14%. Philadelphia was third, Boston fourth, and Baltimore fifth.

Approximately 760,000 are employed in electronic manufacturing, about one-seventh of whom are engineers. Because the industry is so close to the frontiers of science, the demand for experienced engineers to fill specialized niches will remain strong. Computers, digital data processing, airborne instrumentation, guidance systems, semiconductors and microwave are among those fields requiring high degrees of engineering excellence. The demand for electronic technicians is particularly heavy in the area of computers and data processing.

• **Military over half of market**—Today, the military market for electronic products absorbs about 51% of total U.S. electronic sales. In 1950, military purchases were less than 20% of total sales.

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Total Budget and DOD Expenditures for Procurement and Research, Development, Test and Evaluation*

FISCAL YEARS 1959-1961 (Millions of Dollars)

	1959 Actual	1960 Estimate	1961 Estimate
Total Budget	$80,700	$78,400	$79,800
Total DOD (Excl. Mil. Assist.)	$41,233	$40,945	$40,995
Procurement			
Missiles	$ 3,339	$ 3,500	$ 3,479
Aircraft	7,658	6,670	6,027
Ships	1,493	1,651	1,644
Electronics & Communications	942	898	1,067
Other	979	1,223	1,384
Total	$14,410	$13,943	$13,602
Research, Development, Test and Evaluation (RDT&E)	$ 2,859	$ 3,680	$ 3,917
Total Procurement and RDT&E	$17,269	$17,623	$17,519

*Data are adjusted to reflect comparability with fiscal year 1961 appropriation structure.

phones and radio telegraph were used by the Navy while short-range communications and radio aids were used in airborne navigation. The military, at this time, was purchasing electronic equipment at an annual rate of about $100 million.

During the war, intensive research and development expanded the electronic art to encompass not only vast communications networks, but also special purpose walkie-talkies, fire-control equipment, improved radar, sonar detection devices and guidance systems. Production of electronics and communications products for the military grew rapidly to an annual rate of about $4.5 billion by mid-1945.

From the end of the war to 1950, military electronic production levels declined because of the national disarmament policy. When the Korean War began the electronics industry again quickly mobilized. Total expenditures by DOD expanded from nearly $12 billion during fiscal 1950 to $43.7 billion during fiscal 1953. Expenditures for electronics increased five-fold during this period to approach $2.5 billion.

The rapid growth of fiscal spending for military electronic equipment since 1953 is primarily attributable to expanding missile programs (including detection and defense), the increasing electronics content of sophisticated aircraft, and increasing command and general communications activities. While total defense expenditures for major procurement and production (MP&P) and R&D have remained below the fiscal 1953 level of $18.5 billion, missile expenditures have multiplied by more than 12 times during this period to total nearly $3.5 billion.

Since fiscal 1955, military electronics has increased its share of MP&P (including R&D) expenditures, rising from 18% to 26% in fiscal 1959. As a percentage of total DOD spending, military electronics has risen from 7% to 11% during this period.

The 1961 defense budget reflects a trend toward increased spending for research, development, test, and evaluation of new and improved weapons systems and equipment. Although the $13.6 billion budgeted for weapons systems procurement represents a decline of $808 million since 1959, this is more than offset by funds for RDT&E which increased from $2.6 to

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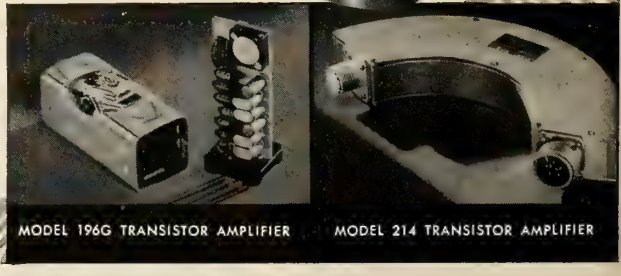
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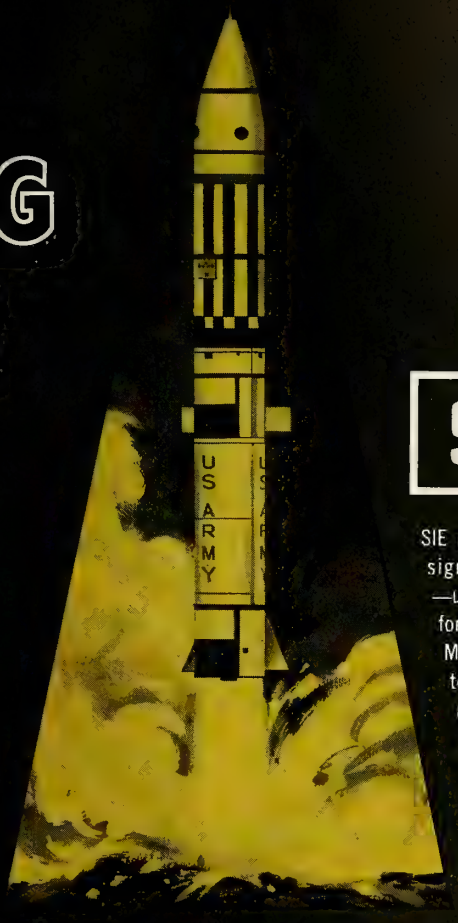
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$3.9 billion (see table).

• **Missile electronics prime factor**—Increasing electronics missile dollars is a prime factor behind the remarkable growth of the electronic industry during recent years. In fiscal 1955, somewhat more than $300 million of $718 million in missile expenditures was absorbed by electronics. Of the $3.5 billion spent for missile production in fiscal 1959, approximately $1.6 billion went for electronics.

Electronic equipment is used in missile systems for guidance, control, and information recording and transmission. Compact electronic gear within a missile, for example, translates and amplifies signals from ground control stations to operate missile control surfaces and guide it on a predetermined path. Ground-based guidance systems serve the remotely controlled *Minuteman, Atlas,* and *Titan.* Other supporting systems, including ground communications and testing equipment, fulfill vital functions in missile operations.

The 1961 budget reflects continued emphasis on missiles of all kinds in national defense. Funds for the procurement and production of the four main strategic deterrent missiles—the AF *Atlas, Titan,* and *Minuteman,* and the Navy *Polaris*—will be further increased. Procurement of the *Hound Dog* and *Quail* for use by the B-52 strategic retaliatory force will continue. Funding for the *Nike-Hercules* air defense missiles will largely complete this program, while funding for the *Talos, Terrier, Tartar,* and *Typhon* fleet air defense missiles will continue as additional guided missile ships join the fleet. Funds will also be devoted for continuing the procurement of large number of air-to-air missiles such as *Sparrow, Falcon,* and *Sidewinder.*

A wide variety of other missiles for support of the ground forces is planned for procurement in 1961. The *Bullpup* air-to-surface missile will be purchased in greater numbers. The highly flexible *Pershing* will continue to receive heavy emphasis. The tactical close-support rockets, *Little John* and an improved *Honest John,* will receive additional funding to provide medium and short-range ground support. A substantial procurement of *Hawk* missiles, together with the first production quantity of *Redeye*—a man-carried air defense missile—will be made in 1961, to improve the defense of our ground forces in the field against low-level air attack.

Missiles and related equipment will receive a substantial portion of 1961 budget funds for R&D, test, and evaluation. Large sums are provided for the improvement of the range, accuracy, and reliability of the *Polaris* missile. Funds are provided for the full-scale testing of the *Nike-Zeus* antimissile missile and for further developmental work on other Army tactical missiles, including *Pershing, Sergeant,* and *Mauler.*

• **Other military electronics important**—Electronic systems for other defense purposes are expanding in volume as well as in complexity. Defense electronics involve radar, infrared detection, microwave radio links, field computers, and centralized information processing stations at command posts. Advanced radar systems are providing earlier and better detection of high-speed missiles and vehicles. Electronic countermeasure equipment has been developed for both defensive and offensive systems and has led to the emergence of new types of electronic components.

The "Electronics and Communications" category absorbed $942 million (under the new budget structure) of the military electronic market during fiscal 1959. Expenditures within this area are expected to level off gradually during the immediate future.

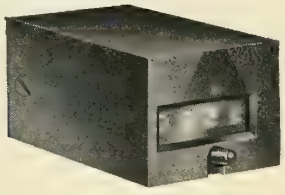
Additional funds were allocated in the 1961 budget for procurement of

Origin of Shipments of Military Electronic Equipment, by State, 1959

(Percent of total value of shipments)

State	Equipment Shipments
New York	31.28
California	16.36
Pennsylvania	7.67
Massachusetts	4.81
Maryland	4.62
Illinois	3.51
New Jersey	3.47
Arizona	3.27
Ohio	2.14
Texas	1.99
Minnesota	1.86
Michigan	1.27
Florida	.81
Missouri	.78
Indiana	.55
Connecticut	.54
Wisconsin	.42
Other	14.65*
Total	100.00

* *Contains one state with large military shipments which could not be shown separately without disclosing proprietary information.*



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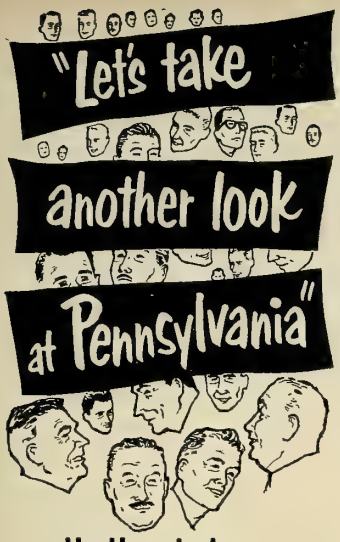
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large radars for two BMEWS stations, for the radar improvement program, and to extend the air weapons control system in overseas areas. Funds are also provided for the development of extensive command and control communications for air defense, SAC, and ground forces.

Electronic techniques make improved military operations possible in numerous other ways. In the field of combat surveillance, for example, radar, infrared, and television can be employed to survey battlefields and assist in the location of enemy targets. Infrared drones can map a battlefield area by detecting tanks, guns, trucks, and other heat sources. In the *Midas* project, infrared will be used to detect the launching of ICBM's.

Complex electronic equipment will continue to fulfill vital requirements on ships and submarines. The 1961 shipbuilding program includes funds for the construction of three guided missile frigates, two guided missile destroyers, three nuclear-powered submarines, five *Polaris* fleet ballistic missile submarines, and eight other ships. In addition to the three *Polaris* submarines scheduled for 1961, funding is provided for the purchases of long lead-time components for seven more to be started after 1961. (With those already launched and those building, the potential FBM submarine fleet will total 21.)

An additional 14 destroyers are slated for major modernization in 1961, the second annual increment of the fleet modernization program designed to improve antisubmarine warfare capability. ASW research will be continued at a high level, including development of both fixed and mobile detection and improved tracking equipment.

Electronic guidance and control equipment for space vehicles comprises a relatively new purchasing area. Sophisticated space programs such as satellite intercepters, strategic orbital systems, communications, surveillance, and navigation satellites will receive large budget allocations in future years. For the military space effort, the 1961 budget provides funds for early warning satellite systems *(Midas)*, reconnaissance *(Samos)*, communications *(Notus)*, and navigation *(Transit)*. Work will also continue on advanced guidance and communications techniques.

Ed. note—Copies of the 1961 Fact Book have been mailed to 350 member-companies of the EIA. Additional copies may be obtained from Association headquarters, 1721 DeSales St., NW, Washington 6, D.C., for 75 cents each.

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Space GSE Concepts Are Unique

Because of the peculiar demand for simplicity in the face of growing payload complexity, manufacturers must start design early

Manufacturers of ground support equipment for space vehicles must keep in mind two major considerations to successfully compete in this field:

1) GSE for space involves an entirely different design concept than that for conventional missile weapons systems.

2) Basic work must be started now in order to take advantage of coming opportunities in this field.

Space GSE differs in several ways from weapons system support. In the first place—and probably the strongest factor influencing design—is that space-probe vehicles are each unique. They are individually tailored to specific test objectives; and these objectives and the methods of meeting them may change radically from one vehicle to the next.

Since a space launch is always unique, GSE, in general, must also be unique. Changing the target of a space probe means changing the missile staging and, usually, the payload, requiring a recasting of the entire launch. The goals of the space probe are separately defined in each case with consequent great effect on the ground support equipment.

Secondly, an optimum balance between system simplicity and testing completeness must be reached early in the vehicle design.

• **Simplicity is basic**—Based on their experience with the NASA/AFBMD Project *Able* space probes, Space Technology Laboratories engineers came to the conclusion that simplicity is of prime importance. Checkout equipment used in this program is generally manually operated, since automated checkout would give no great advantage either in test time economy or the use of less qualified test personnel.

Further, automatically programed go/no-go data would be considerably less useful for evaluation because of the developmental nature of each system. Still further, the uniqueness of each space probe vehicle system makes the go/no-go approach in most cases impractical, since a flexible, judgmatical approach to checkout operation and countdown is required if the GSE is not to become an overwhelmingly large project in itself for each space launch.

Equipment must be designed to sense the vehicle state of readiness in a great number of ways so that diagnosis of the potential success of the launch can be made by intelligent evaluation of all the information available. This means, in short, that space probe checkout equipment must be operated by engineers.

For the one-of-a-kind space probe launches, STL found it more expedient and reliable and economical to use highly trained personnel than to spend time and money for the design of sophisticated equipment. The ground support of a weapon system accounts for appproximately 60% of a program budget; in the *Able* space projects the support program runs less than 10% of the total program budget.

The fact that the space probe launch is dealing with a multistage vehicle imposes three special problems in the support operations:

1) Electrical interface connections between stages must be checked to assure proper separation.

2) Staging transition section alignment must be checked during prelaunch assembly with specially designed support equipment of high accuracy.

3) The multistage vehicle must be considered as an overall system, and checkout procedures integrated and prepared with the system concept in mind.

A further consideration is that critical launch date and time place additional burdens on support equipment reliability. Often trajectory considerations make it necessary to restrict the time of launch to a period of a few minutes on a specific day. Such constraints demand highly reliable ground equipment.

Finally, one of the outstanding characteristics of a space probe support equipment program is the short design and development time allotted for each configuration. Elapsed time from contract go-ahead until launch has varied from three to six months in the Project *Able* programs.

• **Future requirements**—According to STL scientists, future space payloads will grow more complex and incorporate completely new subsystems such as inertial control devices and command attitude control systems. Increased efficiencies will be made possible by, for example, oriented solar cell arrays and directional antennas.

In every case, however, the gain in operating efficiencies will need to be weighed against the increase in complexity required in the support equipment. Although booster rockets and supplementary stages of higher performance are expected in the next few years, payload weight will be a severe restriction for some time. A minimum weight/maximum performance propulsion system in the final stage will therefore continue to have high priority.

Upper-stage cryogenic systems, fluorine systems, and the like will severely complicate the propellant loading on the ground, and the support problem for nuclear auxiliary power systems in the final stage will be considerable. On the basis of experience to date, however, it is reasonably certain that a continuation of the philosophy of simplicity, flexibility, reliability, and the quantitative nature of the ground support equipment for the space probes program will be continued.

Studies by Jet Propulsion Laboratory for NASA and the Army Ordnance Corps agree with the basic conclusions of the STL experience—especially as regards the differences between GSE for space exploration and that for weapons systems.

Other conclusions reached by the JPL studies:

• Problems related to rendezvous and orbital refueling are among the most critical in the coming period.

• The period immediately before us is one of intensive research and development and low production in the spacecraft GSE area.

• After 1967, lunar and planetary surface exploration equipment could develop into one of great interest and

reasonable production. Development of this equipment is a difficult task requiring long lead time and adequate funding.

Because of reliability, time, and cost of development, great efforts must be made to standardize all equipment sent into space. Decisions in favor of standardization must, however, be carefully measured to determine if real performance capability is being lost unnecessarily.

Engineering management must recognize these facts and considerations if it is to successfully produce the ground support equipment for space exploration.

products & processes

Tip-Sensitive Switch

Control Products, Inc. has developed a precision thermal switch which responds to tip temperature rather than shell temperature. Designated the "Tip-Stat," the new switch is most effectively used where inner temperature must be controlled.

Designed to operate within a temperature range of –20°F to 550°F, the switch employs a spring-loaded inner cartridge which is hermetically sealed. The switch, itself, is slow make and break based on a thermal bi-metal principle. The reaction time is less than 0.5 seconds and temperature differential is from 1 to 2 degrees. Repeatability of operation is ±1°F.

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Temp. Shock Chamber

A temperature shock chamber has been developed by Tenney Engineering for very rapid, automatic cycling of electronic components and small assemblies undergoing environmental tests.

Self-containing, the unit requires no manual handling and has no drawers to move; there is no removing of test objects until the testing is completed.

Switching from hot to cold, in a temperature range of –85° to +425°F, takes only 10 seconds, and recovery time to the set point takes only 20 minutes. The entire operation is controlled with an automatic programer.

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Direct View Storage Tube

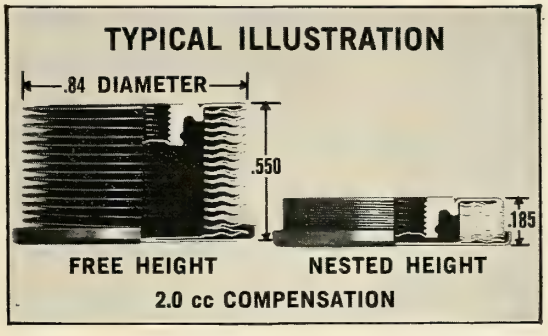
The smallest direct view storage tube with electrostatic deflection is being made by Allen B. DuMont Laboratories, Inc. Termed type K1938, the new Storatron is a 2¾-in. diameter tube with overall maximum length of 9 11/16-inches from the face to extremity of the 14-pin low-leakage type, conventional base. Applications for the small electrostatic Storatron are in narrow bandwidth video transmissions at

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Cold Cathode Vacuum Gage

A cold-cathode type discharge gage for the accurate and uniform measurement of high vacuum has been introduced by F. J. Stokes Corp. It has a wide range—from 10^{-1} to 10^{-8} mm. Hg.

A constant magnetic field confines the residual gases to insure proper measurement. A special ring anode design produces a more concentrated ion-discharge beam, which assures a cleaner tube and more accurate readings over a longer period of time.

Another feature of the gage is that both cathode and anode can be quickly and easily replaced when they become contaminated.

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Five-Ounce Shutoff Valve

Weighing only 5 oz., a lightweight manual shutoff valve from James, Pond & Clark, Inc. can handle pressures to 10,000 psi. Made of 303 stainless steel, the new valve is intended for use on test stands and similar equipment to control high-pressure systems containing air, hydrogen, nitrogen, oxygen, hydraulic fluid, etc.

Buna N "O" Rings in the valve backed up with Teflon provide a dead tight seal in the closed position and complete freedom from body leakage. System pressure protects the "O" Rings from damage when crossing a port. Each valve is pressure-tested at 20,000 psi and burst pressure is over 30,000 psi.

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Subminiature Servovalves

A miniaturized, high-performance electrohydraulic servovalve weighing only 5.12 oz. is being manufactured by MOOG Servocontrols, Inc. This valve features the nozzle-flapper hydraulic amplifier and mechanical feedback arrangement utilized by the firm's Series 31 servovalves. Its principles of operation are identical to the Series 31 servovalve.

The Series 30 servovalve uses a small second stage spool and bushing contained in a lightweight aluminum body. Its maximum flow capacity is 3 gpm at 3000 psi which is adequate for most low flow control systems.

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Filament-Wound Rings

Filament-wound fibre-glass rings, designed to provide internal support to fibre-glass tubes subjected to external pressure of 500 psi, have been developed by Apex Reinforced Plastics of Cleveland.

The rings, ¾" x ¾" x 20" OD, are wound from continuous filaments of fibre-glass by passing the glass through a thermosetting resin onto a split mold for support and cure. Rings contain 75% glass by weight. In this application, they provide 150,000 psi tensile strength.

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Space Simulation Chamber

Extreme range of temperature variations, from −100°F to +1000°F, is now available in an environmental test chamber manufactured by the American Research Corp.

Designed to simulate conditions which might be encountered by outer space vehicles, the chamber produces both high and low temperatures by radiation from all six sides, as well as by convection, thus reproducing true, high altitude conditions completely around the test specimen.

In addition, at any temperature and at any altitude up to 150,000 ft., the gradient throughout the chamber can be held as closely as ±5°F.

The chamber has a free test space of 4 in. x 4 in. x 4 in. and is equipped with mechanical refrigeration capable of dissipating a heat load at the rate of 7500 watts at −70°F.

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Research Focuses on Re-entry Problems

by John F. Judge

One of the major problems up for solution in the materials picture is how to bring back the larger and larger vehicles the U.S. will soon be tossing into space.

Firms such as General Electric, Avco, CTL Division of Studebaker Packard, Corning Glass and many others are hard at work in the many aspects of the concept of re-entry—which in some respects is another way of saying materials.

The controversies raging over the relative merits of re-entry vehicles actually involve specific tradeoff factors within each vehicle—a minute part of the whole of re-entry.

• **Definitions**—Re-entry is a generic term for a broad function, or mission, that may be accomplished by any number of vehicles, according to William S. Pellini, Metallurgical Department, Naval Research Laboratory.

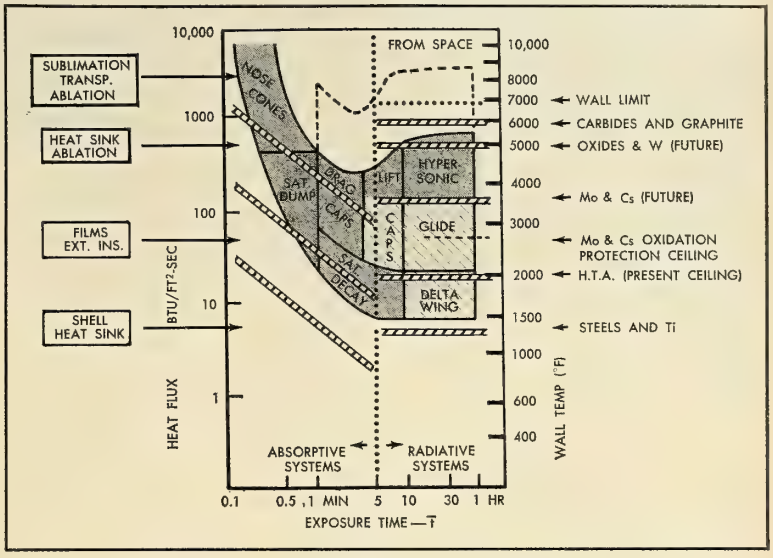
Re-entry, says Dr. L. Steg, manager, Aerosciences Laboratory, G. E.'s MSVD, is simply that flight phase where atmospheric effects become significant. This phase may last for several hours or less than a minute. The time difference is a function of the particular vehicle and its re-entry path.

Pellini, in a paper delivered to the Tri-Chapter meeting of the American Society for Metals last month, divided all such vehicles into two general classes—lift and drag. According to the metallurgist, the materials of construction are determined by the environment each must withstand. The principal characteristic of this environment is heat—its generation and transfer.

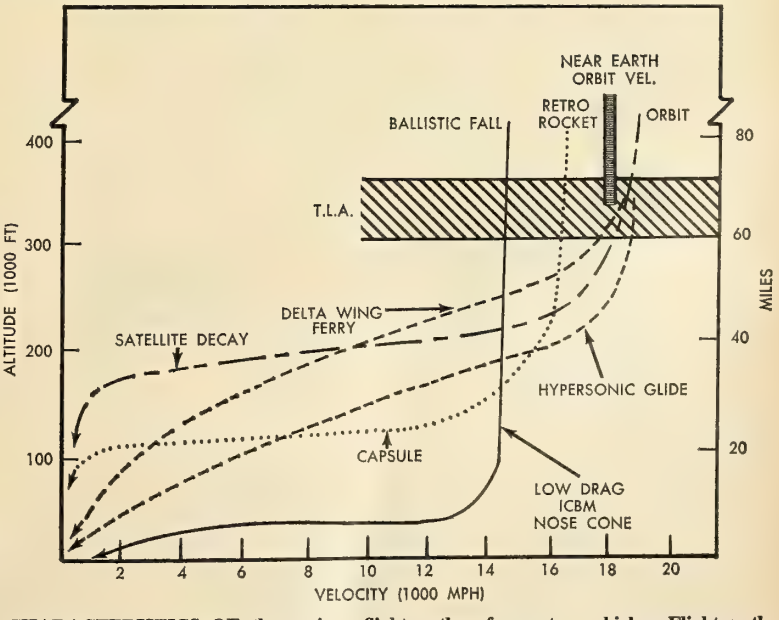
• **Earth's envelope**—The cause of all this consternation is a thin shell of gas enveloping the planet earth. In depth this shell is to the earth as the skin is to an apple. The greater part of this gas (99%) lies within 100,000 ft. of the ground. Aerodynamicists consider the significant limit to be somewhere between 300,000 and 350,000 ft. The mean free path of a molecule is less than 0.1 ft. at these altitudes and continuum flow conditions exist. From 350,000 to 400,000 ft. the mean free path of a molecule lies between 0.1 and 100 ft. and this is termed slip flow. Above 400,000 ft. free molecule flow exists (M.F.P. greater than 100 ft.)

According to Pellini, re-entry braking effects occur only during continuum conditions.

Re-entry velocities range from 6000 mph for a 400-mi. vertical drop, through 17,000 mph for a 400-mile-high orbiting satellite to 25,000 mph for spaceships. Ballistic nose cones fall in the area between vertical launch re-entry and tangential re-entry of satel-



OVERALL CORRELATION of environmental conditions, re-entry vehicles, and thermostructural materials in the concept of re-entry.



CHARACTERISTICS OF the various flight paths of re-entry vehicles. Flight path and vehicle form details determine actual aerodynamic heating.

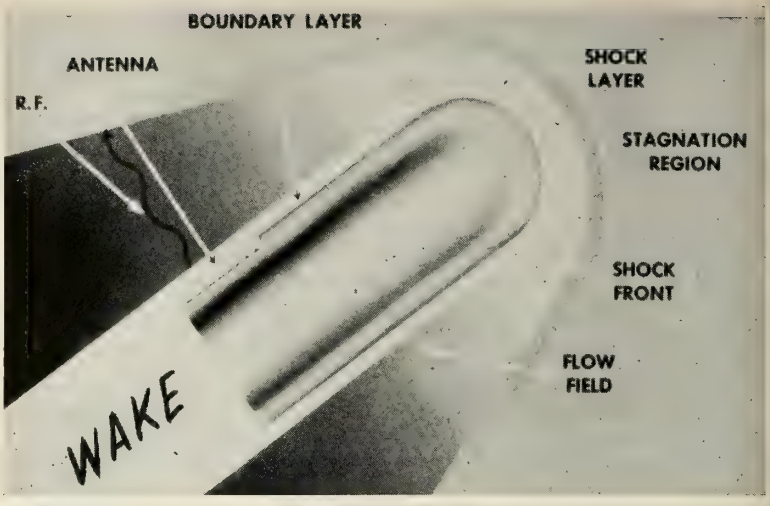
lites, says Pellini. They range from 10,000 mph (IRBM) to 15,500 mph (ICBM). In all cases, says Pellini, the kinetic energy fraction is the critical index of the re-entry problem of energy conversion and heat generation.

Steg says that the kinetic energy of a satellite falling from a 200-mile orbit is approximately 13,000 Btu/lb., and a vehicle arriving from an interplanetary orbit has about twice this energy. In comparison it takes 1000 Btu/lb. to vaporize water and 25,000 Btu/lb. to completely vaporize carbon.

But only about 0.5% of a vehicle's kinetic energy is absorbed by the body. The rest is handled by the air in the shock envelope surrounding the vehicle.

At a re-entry angle of 3°, there is a total heat input at the stagnation point of about 9000 Btu/ft.²/sec. and a heating rate of 100 Btu/ft.²/sec. Although this is but a small fraction of the total energy of the vehicle it is still formidable if one considers that a steam powerplant operates around 10 Btu/ft.²/sec. and an atomic reactor at 400 Btu/ft.²/sec. So even with the help of the buffering shock wave (which does create other problems) there is a severe temperature problem.

Pellini says that the overall aerodynamic features of re-entry bodies determine the flight path relationships between altitude and velocity. But the heating conditions are determined by the shape of the leading edges and noses.



SHOCK EFFECT produced by a body traveling through the atmosphere at supersonic speeds. Much of the heat never reaches the surface of the vehicle.

• **Shock effect**—A body traveling at supersonic speeds through the atmosphere carries with it a volume of air contained within a shock envelope. The molecules of gas tend to pile up against the surface of the bow creating a subsonic condition. This shock process entails a reduction of the relative velocity of the molecules from supersonic to subsonic flow and a high adiabatic compression—resulting in high air temperatures. These areas covered by the subsonic flow regions are referred to as stagnation points.

Pellini notes that ordinarily, heating conditions for a body are referenced to these stagnation points (which are much higher in temperature than the nearest point on the body) and "1 foot back" positions for the case of long bodies such as glide vehicles. The reason for this is that the leading edge is usually not a load-carrying member and is in a low stress area, while the "1 foot back" position is the area where considerations of stress become important.

By separating the wide variety of re-entry vehicles into classes, Pellini says it is possible to establish a thermal environment spectrum for the analysis of materials problems.

Pellini further categorizes lift and drag type vehicles as to the length of time exposed to the heating effect. Results of the analysis are:

• Nose cones—Develop heat fluxes from 500 to 5000 Btu/ft.²/sec. and higher for exposure times less than a minute.

• Satellite dump techniques—High entry angle, similar to nose cones but heating conditions are a little less severe in magnitude although the time is about the same.

• Manned drag capsules—(Also small satellite decay vehicles with small payloads) Exposure is higher, being of

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the order of several minutes, but because of differences in the altitudes of deceleration, heat flux values range from 10 to 20 Btu/ft.²/sec. for satellite decay and 50 to 400 Btu/ft.²/sec. for manned drag capsules.

• Lift capsules—Exposure times reach 5 to 10 minutes with an accentuation of nose and leading edge heating conditions over the larger nose stagnation point region of drag capsules.

• Hypersonic glide vehicles—Exposure times reach 1 hour and positions back may develop temperatures in the range of 2000 to 3500°F.

Pellini says that the amount of heat energy developed during re-entry is independent of the vehicles design and flight path. But the amount transferred to the body is closely related to these factors.

Drag vehicles absorb the least amount of heat although the temperatures generated in the gas envelope are extremely high. Lift vehicles have much lower envelop temperatures but absorb more heat because the input time is long.

• **Materials conceept**—Pellini divides thermal protection systems into two sections—absorptive systems involving gaseous mass transfer or heat sink, and radiative systems; which dissipate most of the convective heat input by radiation from the surface.

Absorptive systems are designed to dissipate heat without causing a high temperature rise in the structure, and are usually limited to short time usages because of weight considerations, according to Pellini.

Included in the absorptive systems are ablation methods, heavy wall heat sinks, sublimation systems and transpiration systems. Transpiration means cooling by the flow of gases or liquids through pores in the aerodynamic wall.

Steg points out that heat sink is not competitive with mass transfer cooling systems on a weight basis. The MSVD scientist says that ablation with vaporization cooling. ". . . represents a most attractive solution to the heating problem."

Radiation systems, according to Steg, becomes more and more interesting as the re-entry time lengthens. A thin radiating shield supported by insulation around the re-entry body is critically dependent upon the maximum heating rate encountered. A poorly guided re-entry, creating excessively high temperatures, would end in disaster.

Steg says that the optimum design here would probably include a material good for radiation but also with ablative properties. He mentions graphite in this connection.

Over a year ago, Pellini together with Dr. William Harris of the Ma-

SPACE COMMUNICATION ANTENNAS



ANDREW

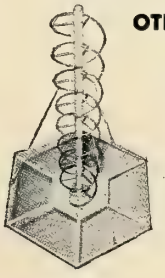
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215-265 mc	10.5 db	H 50140 A
215-265 mc	13 db	H 19110 A-2
260-320 mc	13 db	H 19110 A-3
320-400 mc	13 db	H 19110 A-4
400-500 mc	12 db	H 19110 A-5



DISCONE ANTENNAS

FREQUENCY	TYPE NUMBER
25-50 mc	50154
50-108 mc	51150
108-215 mc	19050-1
215-420 mc	19050-2
420-1000 mc	19050-3

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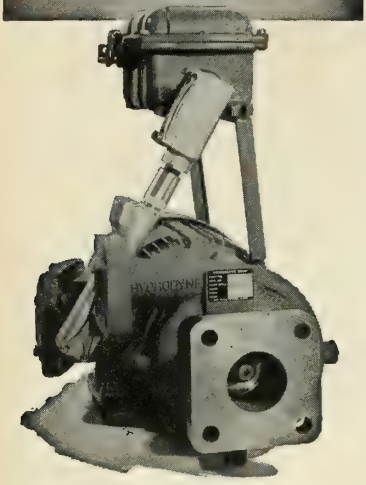
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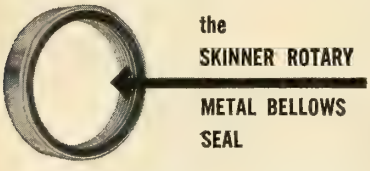
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Hydrodyne makes many types of hydraulic and pneumatic products... such as the cryogenic pump shown here. This particular pump, utilizing the famous Skinner Precision Bellows Seal, is designed for heavy duty cryogenic applications. These pumps have a capacity range of up to 1500 gpm. No heat transfer problem. Pump components are of various materials according to application. Illustrated is a Hydrodyne pump of this series with a capacity of 150 gpm, 20-foot rise, 6-foot suction head (NPSH), 2½-inch suction and 1½-inch discharge.



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An all metal bellows of various steel or nickel alloys, made with the sealing faces and mating rings of carbons, alloys, ceramics, and other materials, to meet specific temperature, corrosion and pressure requirements. Temperature range of —400°F to 1200°F; pressure range, 0 to 10,000 psi; and speeds to 80,000 rpm. Made by Hydrodyne's Skinner Seal Division.

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terials Advisory Board of the National Academy of Sciences, told a group of scientists that specific problems of applications of re-entry materials cannot be placed in context with the general problem because of communication difficulties between the materials and design fields.

A summarization of all of the materials applicable to re-entry problems would be meaningless, says Pellini, simply because it presents an impossibly broad front for attack and does not provide for assessment of the relative importance and degree of urgency of the many requirements.

Pellini says that the publicity given to crash programs for the developing of specific vehicles often results in an over concentration on a narrow front. "This situation will not be rectified until the materials field develops the necessary knowledge and sophistication that will provide for independent assessment of the materials requirements for the accomplishing of functions." concludes Pellini.

Steel Speed-up

Ford Process May Cut Output Time in Half

A ton of steel in half the time is the potential of a new twist in open hearth production at Ford Motor Co.

Still in the experimental stage, the process will apply only to the open hearth furnace and will not affect the cost of scrap steel or hot iron. The cost of rolling and shaping steel will also remain unchanged.

Basically the Ford process revises the conventional open hearth method by using a combination of fuel and oxygen—and burned lime instead of limestone.

Oxygen lances have been used for some time throughout the steel industry to hasten the open hearth process. This method usually resulted in increasing output for a 200 ton furnace from 20 to 30 tons per hour.

Ford used oxygen-fuel lances for several years. Even with the extra heat thus generated, the process is retarded by adding molten iron too quickly. By adding burned lime in place of the usual limestone, the firm has averaged 60 tons of high-quality steel per hour from a 200 ton furnace.

In 400-ton open hearth furnaces the yield has been around 100 tons per hour as compared to 40 tons using conventional oxygen processes.

Company spokesmen say that even if future experiments confirm the promise of the new process, Ford will continue to purchase the greater portion of its steel requirements from outside suppliers.

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products and processes

Teflon 'Spot Bonding'

A "spot bonding" technique has been developed by Plastic Associates, for attaching Teflon to itself or other materials. The method sharply reduces the weight of adhesive required and therefore preserves Teflon's important low-loss characteristics.

A major use of Teflon in electronic packaging design is as a dielectric in high-frequency circuits. The plastic has the highest "Q" of any known material, which means that little if any RF energy is absorbed in the plastic. However, when adhesives are used to assemble the Teflon-containing parts, the adhesive layer acts as a low-Q, energy-absorbing barrier.

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Permanent Magnet Alloy

A copper-nickel-iron permanent magnet alloy possessing high coercive force and energy product values has been developed by Hoskins Mfg. Co.

The alloy can be readily stamped, machined or otherwise formed by conventional methods into a wide variety of complex, intricately shaped parts which require no costly finishing operations.

Now being produced for volume commercial use, Hoskins *Cunife* is available as finished magnets formed or fabricated to meet specific design and application requirements. It is also offered as wire and strip in an extended range of sizes, shapes and widths to manufacturers equipped and qualified to fabricate their own parts without affecting the alloy's basic magnetic and physical properties.

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Miniature Torque Wrench

Designed for the small screws used on miniature or precision assemblies, tiny torque wrenches are being marketed by Techni-Tool Products, Inc.

The tool is particularly suited for jobs where torque setting is of extreme importance, such as in delicate assemblies for instrumentation, electronics, missile and aircraft control systems.

For use with socket head cap screws from 0 to ¼ in., the wrench is adjustable or can be pre-set for specific torque requirements. All units are easily interchangeable and can be quickly secured in the head.

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Small Impeller Pump

Hydrodyne Corp. has in production a small centrifugal impeller pump for heavy duty work in areas requiring subminiature equipment. Designed originally for Naval Ordnance, this unit delivers up to 8 gpm at 150 psi. It is designed to handle salt water and certain other corrosive fluids.

Normal temperature limits are −60°F to +350°F. Duty limit is 10 minutes. It is sealed at the shaft with the Skinner Rotary Face Seal, a product manufactured by Hydrodyne's Skinner Seal Division, which withstands pressures to 600 psi. Principal materials used in this pump include aluminum housing and bronze impeller. Power source is direct current electrical pump.

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Close Tolerance Mg Sheet

Magnesium sheet in special thickness tolerances for aircraft and missile use is being marketed by The Dow Metal Products Company, division of The Dow Chemical Company.

The closer tolerances are available in the standard thicknesses in AZ31B, HK31A and HM21A alloys in sheets up to 48 in. wide. They are one-half of standard tolerances for most thicknesses. In the 0.050, 0.063, 0.071, 0.080 and 0.090 in. thicknesses, for example, the close tolerance is ± 0.002 in., compared to a standard tolerance of ± 0.004 in.

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Modular Valve Mechanism

Several valve varieties of modular valve components are now available upon special order from James, Pond & Clark, Inc.

In effect, a modular valve component becomes a part of the assembly in which it is installed, and eliminates or reduces exterior pipe or tubing connections. Thus, it may be mounted in a pump housing, in a cored manifold or combined with other modular components in a neat and space-saving "little black box" control package.

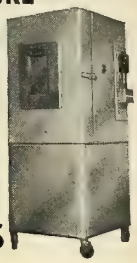
In most modular designs, the valve mechanism itself is retained in the modular body and sealed by an O-ring. This makes it possible to replace the basic valve mechanism without discarding the entire package. The modular components are available in check, bypass relief, shuttle and other valve types for operating pressures upward to 10,000 psi.

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Rocket Fuel Development Accelerates

Saturn, storables, hydrogen stages dominate scene; big solid, Nova, nuclear rocket stir interest

by Jay Holmes

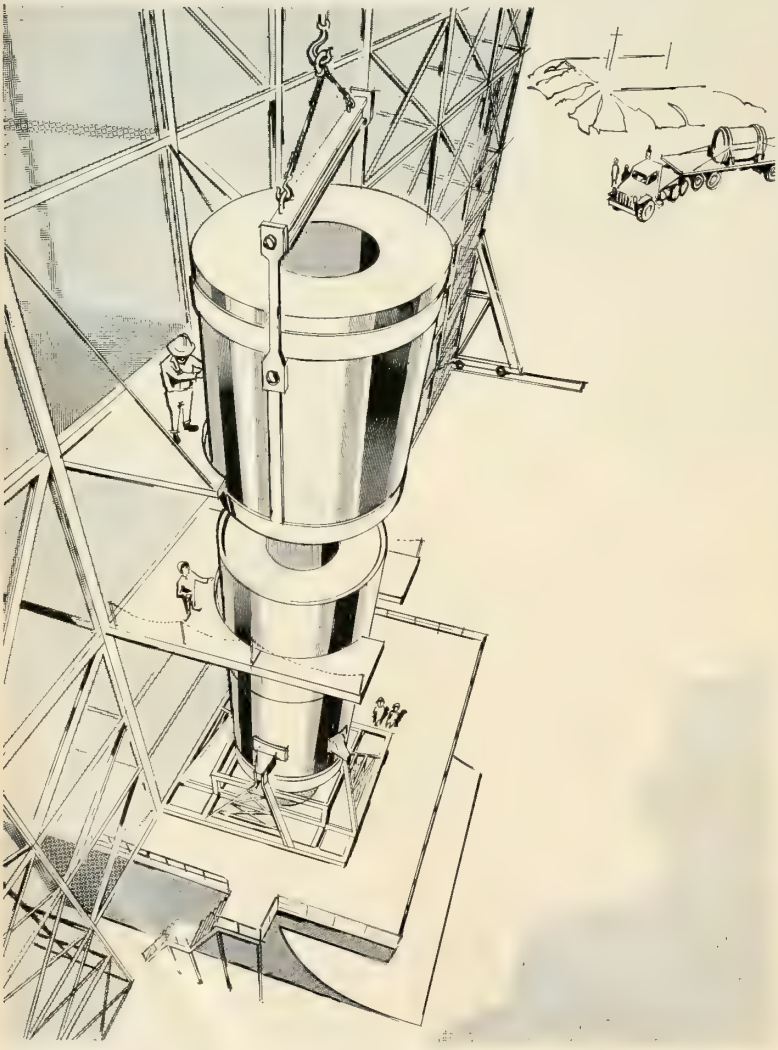
Rocket propulsion is entering an explosively rapid period of development. The activity is concentrated in three areas—with projects of the highest national priority in each area.

In the race for space, the development on the huge Project *Saturn* booster rocket overshadows everything else, both in sheer size and in dramatic impact.

In weapons, the shift to storable, instantly reacting systems goes on apace. More and more weapons are moving from liquid to solid propulsion. Those that remain liquid are switching from cryogenic to storable propellants.

In upper stages, the development for higher energy propellants is becoming ever more intense.

The high level of activity means a high level of business over the next few years, for the major propulsion contractors and for the companies large and small that supply them as sub and sub-sub contractors.



SEGMENTED SOLID booster may break solid-propellant size barrier. Diagram above is Grand Central Rocket Co. artist's conception.

Saturn, a cluster of eight Rocketdyne engines of the type used in the *Redstone, Jupiter, Thor* and *Atlas* missiles, will generate 1.5 million lbs. thrust for about 100 seconds—a total of 152 million pound-seconds of impulse. The propellants are a conventional combination of LOX and kerosene.

The project was granted a "DX" priority—the nation's highest—last winter after President Eisenhower decided to transfer control from the Army to the National Aeronautics and Space Administration. The first test of the eight-engine cluster—burning about eight seconds at 1.3 million lbs. thrust —was held April 29 at Redstone Arsenal, Ala.

• **Test next year**—The first flight test of the booster is scheduled for next spring at Cape Canaveral. The first flight is programed for a thrust level of 1.32 million lbs., burning for 115 seconds.

In its three-stage configuration—designated C-1—the *Saturn* vehicle will be able to put 28,000 to 30,000 lbs. of payload into a 300-mile orbit. The second stage will be a cluster of four LR-115 hydrogen-oxygen engines, which are now in late stages of development by Pratt & Whitney Division of United Aircraft. NASA awarded the stage development contract to Douglas Aircraft earlier this month.

The third stage will be a slightly modified *Centaur* vehicle, consisting of two LR-115 engines, under development by Convair Division of General Dynamics. Early versions of the LR-115 generate 15,000 lbs. thrust, thus the *Centaur* thrust is 30,000 lbs. However, the Douglas stage, designated *S-4,* will be able to take advantage of improvements in the engine that will

make possible a 20,000-lb. thrust level. Thus the cluster will generate 80,000 lbs. of thrust.

Since an 80K second stage does not take full advantage of the potential of the big *Saturn* booster, NASA has decided to build a bigger hydrogen-burning stage. Later versions of the *Saturn* vehicle will have a second stage consisting of a cluster of four 200,000-lb.-thrust engines generating 800,000 lbs. thrust—more than 13 times the power of the largest upper stage in existence today.

The later configuration—designated *C-2*—will use the Douglas *S-4* vehicle as its third stage. The fourth stage will be the modified *Centaur*. The first three stages of the *C-2* configuration are capable of putting 45,000 lbs. of payload in a 300-mile orbit. With higher stages, it will be able to put 9000 lbs. in a 24-hour orbit or soft-land 5000 lbs. on the moon.

The reason for use of hydrogen upper stages is the big jump in specific impulse. At a chamber pressure of 1000 psia and a 14.7 psi nozzle exit pressure, the I_{sp} for LOX-hydrogen is 391 seconds. This compares with an even 300 seconds for the conventional LOX-kerosene.

By shifting the top stage of a rocket from LOX-kerosene to LOX-hydrogen, a 50% increase of payload is attained. This new payload is raised by 50% as the next stage lower is shifted to hydrogen. The process continues through the vehicle.

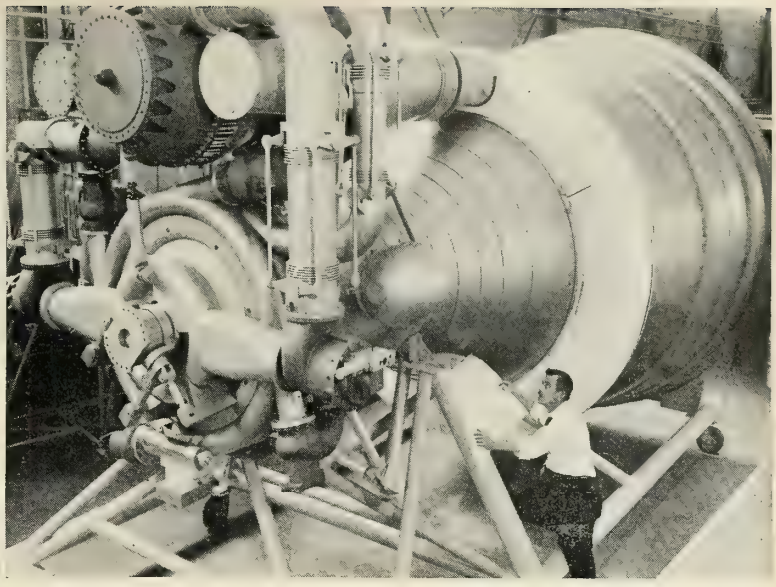
At present, the *Saturn* configuration has been shifted to hydrogen completely except for the booster. Shifting the booster was considered briefly last December, but it was recognized that such action would delay the program for several years. If the 200K engine develops rapidly, it seems certain that the proposal will be revived.

• **Launching scheduled**—There will be one *Saturn* launching in Fiscal Year 1961, four in FY 1962 and six in FY 1963 if the current NASA schedule is met.

Another program related to *Saturn* is the Project *Rover* nuclear rocket, under development jointly by NASA and the Atomic Energy Commission. The first test of *Kiwi-A*, a non-flying prototype of a *Rover* rocket, was a success last summer. Two further tests are scheduled for the coming summer.

Rover generates thrust by the heating of gaseous hydrogen as it passes through the bowels of a nuclear reactor. Based on the consumption of liquid hydrogen, specific impulse performance in the 700-800 second range is expected in early versions.

The schedule calls for completion of ground testing of the *Rover* rocket by 1963 and first flight tests in 1965.



GIANT LIQUID rocket under development at Rocketdyne will provide 1½ million lbs. thrust in single cell for NASA's *Nova* vehicle.

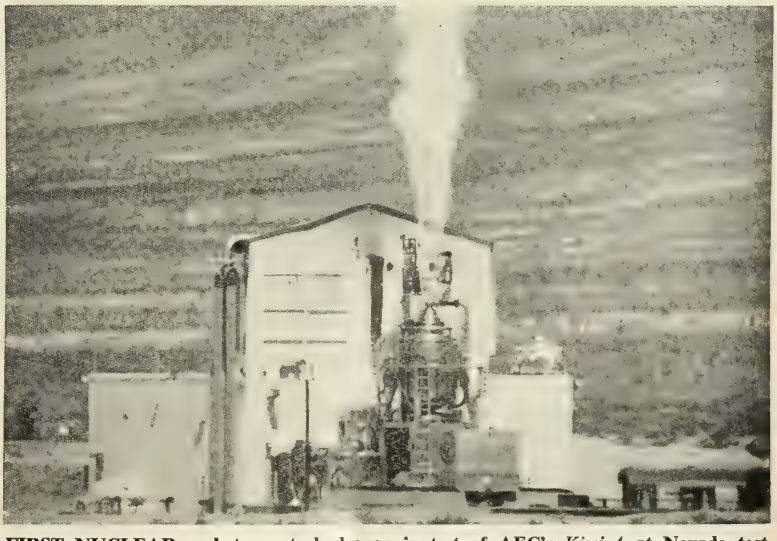
There is a technical dispute about the nature of the first flight test. AEC officials favor a ground launch for demonstration purposes. NASA officials prefer that the first test be firing of the rocket after it is launched in a stable orbit. A third possibility might be the firing of a nuclear rocket as an upper stage of *Saturn*.

NASA plans to contract with an industry group for a thorough study of methods of test and other technical problems about *Rover*.

The first application of the rocket probably will be as an upper stage for a late version of *Saturn*. Wernher von Braun has said that with a nuclear upper stage, *Saturn* could inject payloads of 72,000 lbs. in a 300-mile orbit, 32,000 lbs. in a 24-hour orbit and 14,800 lbs. to a soft landing on the moon.

Von Braun did not describe the characteristics of such a vehicle; however, the first flight *Rover* under AEC plans would weigh 40,000 lbs. and would generate a thrust of 52,000 lbs. at liftoff. AEC officials have not disclosed the length of the powered flight but it can be assumed that it would last six or seven minutes.

Such a vehicle could lift itself about 1000 miles straight up from the ground, according to AEC calcula-



FIRST NUCLEAR rocket spouts hydrogen in test of AEC's *Kiwi-A* at Nevada test site last summer. Two more tests are scheduled this summer.

tions, and burn up on re-entry into the atmosphere. On an orbital launching, the nuclear rocket might be used for a lunar or deep space probe.

Another big rocket development scheduled for the late '60s is the *Nova* vehicle. *Nova* is a series of concepts based on the F-1, a single-chamber LOX-kerosene engine of 1½ million lbs. thrust, which Rocketdyne is developing for NASA. The engine still has four or five years development ahead of it. Building a vehicle around the engine will take several years more. The NASA 10-year program calls for the first *Nova* flight by 1968.

The best known of the *Nova* concepts is a cluster of six F-1 engines to provide nine million lbs. thrust. Another possibility is one central F-1 surrounded by six or eight H-1's—the Rocketdyne engines that go into the *Saturn* cluster.

Maj. Gen. Don R. Ostrander, NASA director of launch vehicles, has said that *Nova* is facing increased competition from combinations with nuclear upper stages as the vehicle to follow *Saturn,* which will have the mission of landing a manned 10,000-lb. spacecraft on the moon, re-entering through the atmosphere and landing safely. NASA has programed such a mission for the early 1970's.

A third possibility for big booster rockets in this decade is the Air Force's Project 3059, a one-year program due to start soon to investigate the feasibility of very large solid-propelled rockets. Bids from six companies are being evaluated on a proposal to build a solid booster of about 100 million pound-seconds total impulse.

The Project 3059 booster would be about 2/3 as big as the *Saturn* booster. The Air Force has decided that it can go ahead with the feasibility study on its own authority. NASA propulsion experts will serve on a committee supervising and evaluating the work. However, if the study proves a success, the Air Force will seek approval from the Defense Department before going ahead with a full-fledged development program.

The industry is divided on how to build a big solid rocket. Three companies—Aerojet-General, Grand Central and United Technology—have proposed that it be cast into cylindrical metal segments at the factory and put together at the launch site. The whole rocket cannot be cast in one piece at the factory because it would be too big for transportation by rail or truck.

Two companies—Thiokol and Rocketdyne—propose mixing and casting the propellant at the launch site. It could not be learned which approach is favored by the sixth bidder, Hercules Powder Co.

If the Project 3059 concept becomes hardware, it will become competitive with *Titan* as booster powerplant for *Dyna-Soar.* Since *Dyna-Soar* is a military vehicle, the Air Force is impressed with the instant readiness and simplicity of solids for the assignment.

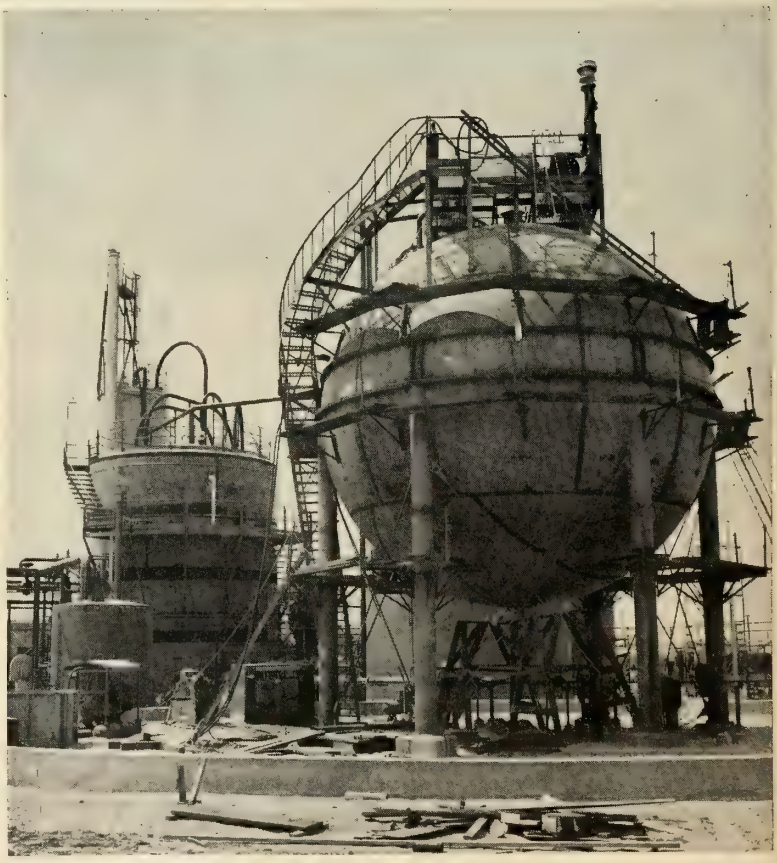
• **Titan improvement**—Meanwhile, however, *Titan* itself will be changing. The Air Force this spring gave the Martin Co. the go-ahead to redesign the missile for storable propellants. Aerojet-General already has made progress on converting the engines from LOX-kerosene to nitrogen tetroxide oxidizer and a 50-50 fuel mixture of hydrazine and unsymmetrical dimethylhydrazine (UDMH).

The new propellant combination will drop specific impulse by 12 seconds. At 1000 psia chamber pressure and shifting equilibrium, the storables give 288 seconds, compared with 300 for LOX-hydrocarbon. However, the increased density of the storables actually make it possible for *Titan* to do more of a job—either carry a bigger payload or fly farther.

Many other storable combinations are under investigation. Pentaborane, the "Zip" fuel involved in a jet-fuel program cancelled last summer, is causing a great stir in the rocket industry at present. Theoretical calculations and limited small-scale testing indicate that some combinations of oxidizers and pentaborane (B_5H_9) yield very high specific impulse values. With N_2O_4, for example, the figure is five seconds higher than with N_2H_4 and 10 seconds higher than with UDMH.

Hydrazine is ordinarily regarded as a fuel. However, an interesting new concept has evolved from its use as an oxidizer with pentaborane. The combustion of the two produces boron nitride and liberates hydrogen. Thus the average molecular weight of the

Linde Liquid Hydrogen Plant Rises



NATION'S LARGEST privately owned liquid hydrogen plant is nearing completion at Torrance, Calif. Linde Co. Division of Union Carbide is building the plant with daily capacity rated at 12,000 lbs. Linde will supply needs of National Aeronautics and Space Administration when it goes on stream this summer. Nation's only larger hydrogen plant is operated for Air Force by Air Products Inc. at West Palm Beach, Fla., Production rate of API plant is classified. (See story next page)

product gases is extremely low.

With a chamber pressure of 1000 psia, exit pressure of 14.7 psia and shifting equilibrium, the calculated specific impulse is 329 sec., 33 seconds higher than N_2O_4 and pentaborane.

One hint of the prime interest in pentaborane came earlier this month when Callery Chemical Co. said it expects to begin production at its Muskogee, Okla., plant by late summer. Employment will rise from the current 190 to about 300 at that time, the company said.

Work Begun On Liquid H_2 Complex at Nevada Test Site

Contractors have begun construction of the first liquid hydrogen complex for the Project *Rover* nuclear rocket program at Jackass Flats on the Nevada Nuclear Test Site.

In last summer's first test, designated *Kiwi-A*, gaseous hydrogen was pumped through a nuclear reactor. The same is true of two tests scheduled for this summer, *Kiwi-A Prime* and *Kiwi-A3*.

Air Products Inc. is prime contractor for engineering the liquid hydrogen complex at the new test site, designated Test Cell C. The first engine test at the new site is to be held some time in 1961.

Test Cell C will have storage capacity for 6 million cu. ft. of gaseous hydrogen under high pressure. In addition, there will be two 50,000-gallon spherical Dewar tanks for liquid hydrogen storage.

At present, liquid hydrogen is shipped into Nevada by truck from West Palm Beach, Fla., Allentown, Pa., and Bakersfield, Calif. To reduce shipping costs, as much as possible is brought in from the Stearns-Roger Manufacturing Co. plant in Bakersfield. However, the capacity of that plant is relatively small.

Air Products also ships some from its small plants in Painesville, Ohio, and Allentown, Pa. The remainder comes from the large plant API operates for the Air Force at West Palm Beach.

The situation will be alleviated somewhat when the Linde Co. puts on stream a 6-ton-a-day liquid hydrogen plant some time this summer. However, Douglas Aircraft Co. soon will be using fairly large quantities of liquid hydrogen in its development of the S-4 80,000-lb.-thrust upper stage for the *Saturn* system. In addition, Convair's consumption of liquid hydrogen in the *Centaur* program will be rising slightly.

Thus the demand for liquid hydrogen in the West is expected to remain ahead of the supply. It can be assumed that some thought may soon be given to establishing further supplies in that area.

Requirements for development of the NASA 200,000-lb.-thrust liquid hydrogen-LOX engine will merely accentuate the shortage in the West.

products & processes

High Temperature Valve

Marotta Valve Corp., Boonton, N. J., has introduced a variable orifice valve to control flow of gas up to 2000°F. The orifice diameter can be adjusted between .150 and .185 in.

Designed to handle gas output from a small solid-propellant gas generator, the valve weighs 9 oz. and measures 3 5/8 by 2½ in. Weight will vary according to material required for specific applications.

A two-way, normally closed valve, it is magnetically operated on 27-35 VDC with a continuous duty rating.

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A1 Stainless Coupling

A metallurgically bonded aluminum-stainless steel coupling—for joining pipes of the two metals without flanges or gaskets—is offered by Project Fabrication Corp. of College Point, N. Y.

P. F. C. has been manufacturing the couplings for five year under license from Hydrocarbon Research Inc. for use in its cryogenic plants. They are now available to industry in general.

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A new series of aluminum and stainless steel connectors qualified from –320 to 400°F is announced by E. B. Wigginis Oil Tool Co., Los Angeles.

Burst pressures are 7500 psig for aluminum and 12,000 psig for stainless. Line sizes are ¼ to 2 in. They are compatible with all exotic and cryogenic fluids except fluorine. Seals are fluorinated hydrocarbon throughout.

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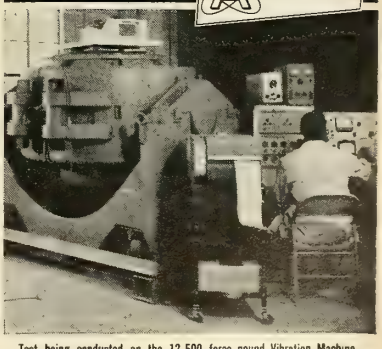
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The Bumpy Road to the ASW Market

An examination of how the selling job is complicated by Navy's profusion of managers and its demands for simplicity

by Donald E. Perry

Recognizing that many problems of undersea engineering parallel those in air and space, an increasing number of missile/space industries are expanding their research capability to open up new markets.

The most prevalent tactic is to set up separate ASW engineering departments, although many companies are also acquiring capability through mergers. One prime example is Lockheed Aircraft's acquisition of Stavid Engineering, long a leader in ASW electronics, and the Puget Sound Bridge & Drydock Co.

While ASW is by no means getting priority in funding, many in industry feel that emphasis will be increased if —and when—Russia gains the nuclear-powered ballistic missile submarine. Funding in Navy-wide ASW, including ships and planes, is $1.3 billion in the FY 1961 budget.

The breakdown:

Ship construction—$762.3 million

Aircraft—$340.1 million

Research & development—$180.5 million

Ordnance—$56 million

Electronic procurement—$25.5 million.

The House added $321 million to the overall ASW effort, $221 million for ships and another $100 million for R&D. If this is approved by the Senate, and if the Administration releases the funds, ASW R&D will total $280.5 million in FY '61.

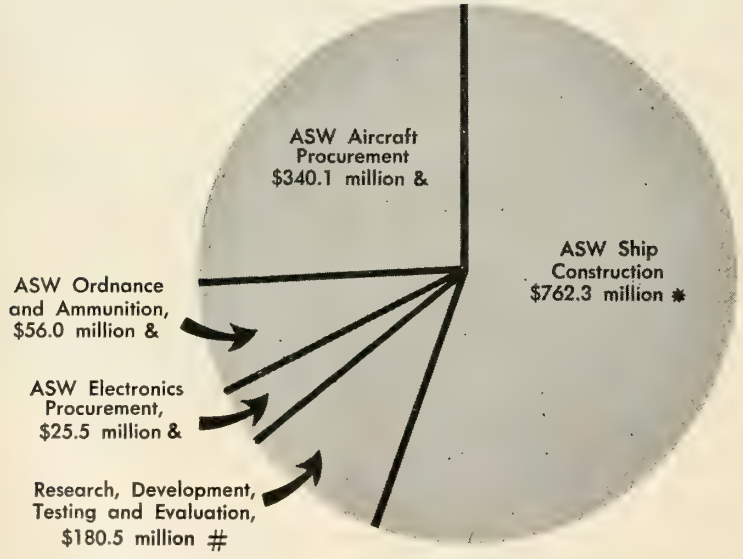
• Stress on simplicity—Many industry officials are finding that the Navy is a difficult customer when it comes to supplying ASW systems and equipment. The one thing it doesn't want is oversophistication, which it feels many firms in the missile/space industry want to provide. Reasons are rather obvious: money and maintenance. As Admiral Arleigh Burke, Chief of Naval Operations puts it:

"Complex equipments cost more to buy, to maintain, to operate. We need so many weapons in sea warfare, so many in ASW warfare alone, that we have to spread our dollars over a wide range of seagoing capabilities. The more each weapon costs, the fewer we can buy. The fewer we buy, the less capability we have in ASW, and in other vital areas. Even to approach the minimum numbers, weapons must stay low in cost. They must be simple . . . Gear that needs a master engineer to maintain it on a day-to-day basis has no place at sea."

Assuming that industry can come up with simple, easily maintainable ASW equipment, the road to selling it is still bumpy and hard. Unlike the *Polaris* fleet ballistic missile program, ASW has no single managership program—buying is split across the board into the various technical bureaus. It often develops that industry doesn't know where to go to sell an idea. Some sellers often go to the top—which alienates personnel of the cognizant bureau.

There is an ASW Research and Development Office in the Office of the Chief of Naval Operations, in the Bureau of Ships and the Bureau of Weapons, and on the staff of the Com-

FY 1961 ASW Portion of Navy Budget



THIS IS HOW the pie is split for the Navy's nearly $2 billion ASW market.

* Indicates the Navy's request before Congress this month added one more nuclear attack submarine than the original budget request and retained two proposed for elimination by Departmental adjustments to the budget. Three boat costs would be $171 million, plus $50 million more for two ASW destroyer escort vessels. Realistic figure for ASW ship construction would be $983.3 million, assuming Senate agrees with House bill, and Navy wants to spend the FY 1961 added funds. Navy also has $343 million authorized in previous years.

Indicates House also approved $100 million more in this category to speed the ASW program. Realistic figure would be $280.5 million.

& Indicates Navy's original budget requests which were not substantially changed by the House and are considered realistic.

mander Operations Test and Evaluation Force.

• **Where to go**—The Navy points out that if an unsoliciated proposal can be identified as having application to ASW it should be sent to one of the above offices. BuShips has cognizance over detection and communication equipment installed in ships. BuWeaps has cognizance of weapon systems—the weapon and its fire control equipment for ships and aircraft as well as the design of aircraft and their component parts.

The Office of Naval Research has cognizance over basic and applied research as well as component development where the direct application is not easily determined or the feasibility needs to be proven.

So if you have a proposal that can be identified under these general areas, it should be sent to the cognizant bureau or ONR. However, Vice Admiral J. T. Hayward, Deputy Chief of Naval Operations (Development), says if industry is at a loss as to where a certain proposal should go, it may be sent to his office and there it will either be turned over to the ASW Programs Division or to the Advanced Technology Group depending again on whether it is identifiable as an ASW project or solely a research program.

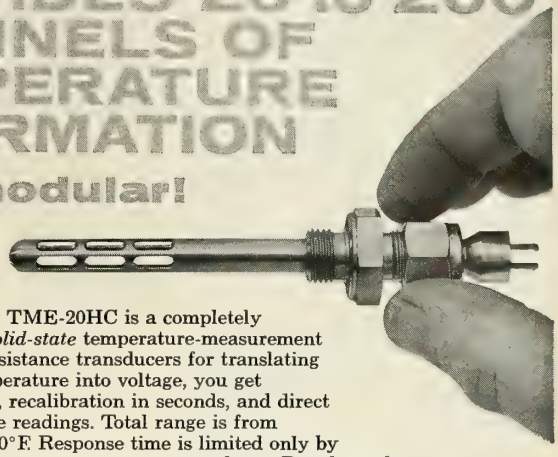
Navy has several criteria worthy of mention in evaluating proposals: (1) Is the proposal technically and scientifically sound? (2) Will the successful accomplishment of the proposal meet an operational requirement not already being met satisfactorily? (3) Is it economically and operationally acceptable? (4) Does it duplicate or complement work in progress? and (5) Does it have application to other problems not necessarily referred to in the proposal? Correct answers to these could mean a winning horse.

• **Ships and planes**—It takes tools to do the ASW task, and the biggest requirement is in ship construction and conversion, 56% of the Navy's ASW budget. The Navy wants to either buy or convert the following ships in FY 1961:

	million
3 DLG's (Guided Missile Frigate)	$231.6
2 DDG's Guided Missile Destroyer)	92.5
4 DE's (Destroyer Escort)	101
4 SSN's (Nuclear attack submarine)	343.2
1 AGOR (Oceanic research ship)	4.9
1 AG (Escort Research)	29.3
1 AG (Deep diving submarine)	25.8
14 DD's FRAM (Fleet Re-	

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The TME-20HC unit contains 20 channels, each adjustable for 0 to 5 volts output over a desired temperature range.

Associated TCE-20HC provides a convenient and accurate method of channel calibration. An airborne unit is also available... it's small and lightweight. Bulletin 501.

Arnoux Corporation

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TME-20HC

AIRBORNE MODEL

SPECIFICATIONS*

TME-20HC BALANCE AND POWER UNIT

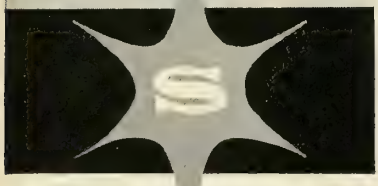
1. **Number of temperature channels:** 20
2. **Type of temperature transducers:** standard 20,000-ohm resistance
3. **Adjustment and monitoring circuits:** all necessary circuits incorporated
4. **Temperature-measurement range:** −325°F to +1000°F
5. **Temperature-measurement span:** each channel adjustable to any desired span
6. **Output voltage:** 0 to 5 vdc for 275°F minimum temperature span
7. **System stability:** 0.25% of full scale
8. **System ambient temperature range:** +20°F to +120°F
9. **Power requirements:** 105 to 125 vac, 60 cps, single phase
10. **Size and mounting:** 3.5 x 19 inch panel for standard rack mounting
11. **Finish:** Light grey per specification MIL-E-15090B

TCE-20HC CALIBRATION UNIT

1. **Calibration:** adjusts and calibrates up to 200 channels
2. **Readout:** visual on any data channel
3. **Calibration accuracy:** ±0.6°F
4. **Ambient temperature range:** +20°F to +120°F
5. **Size and mounting:** 5.25 x 19 inch panel for standard rack mounting
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habilitation and Modernization) 142.1
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Following ship construction and conversion, the next big dollar market is ASW aircraft procurement, $340.1 million. Buying will be for Sikorsky HSS-2 helicopters, Grumman S2F-3 fixed-wing carrier based aircraft, Lockheed turboprop P3V patrol plans, and Gyrodyne's gas-turbine-driven DSN-3 drone helicopters for destroyers.

• **RDT&E**—The House appropriations Subcommittee added $100 million to the Navy's request of $180.5 million for research, development, test and evaluation budget request. The subcommittee said it recognized the problem of lead time and "the importance of concerted action to develop improved ASW weapons now, rather than at a later date." In FY 1960 Congress appropriated $45 million above that requested for RDT&E. In the FY 1961 request, Navy had provided an ASW RDT&E priority list totalling $133,638,000. The subcommittee did not restrict the use of funds to the top $100 million category.

Bulk of the funds will be used for classification, detection and localization, the Navy's Number 1 bugaboo with no breakthroughs in sight. Weapons, ordnance and fire control would come in for the next biggest share, followed by vehicles and propulsion equipment and supporting equipment.

In electronics needs, major purchases will go in three categories: Variable depth sonars for the older destroyers; high-powered surface-ship sonar for newer destroyers ($22.015 million); and communication and training equipment ($3.467 million).

• **Probing deep**—Because the ASW effort depends on knowledge of the oceanic environment, the nation has a 10-year program of oceanic research which will cost about $1 billion, with FY 1961 spending to be about $56 million. Work is being stressed in the following areas:

- General circulation of the oceans.
- Horizontal and vertical diffusion or density stratification.
- Salinity and electrical conductivity.
- Compressibility and sound velocity.
- Characteristics of noise-producing animals.
- Topography of ocean bottoms.
- Reverberation.
- Exchange of energy at the ocean boundary.
- Transmission of light and electromagnetic radiation.
- Sound scatters and absorbers.
- Surface wave motion.

Navy will be spending $55.962 million for Ordnance and Ammunition to meet ASW requirements in FY 1961. Funds will go for missiles and their support; depth charges, Mk. 37, Mk. 44, Mk. 45 and Mk. 46 torpedoes and their support; in service support for existing torpedoes; the Mk. 57 mine; fleet service mine tests; FRAM support; and miscellaneous ASW ammunition.

products and processes

Mica Button Capacitors

Sangamo Electric Company has developed a new group of high-temperature silvered mica button capacitors designed for continuous operation in the wide temperature range of −55°C to +230°C. These capacitors are rated at 200 working volts DC in capacitance ratings from 50 to 4775 mmf. They are intended for use where the application calls for low distributed inductance and reliable performance characteristics in a high-temperature environment.

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Cathode Ray Tube

A cathode ray tube capable of high resolution photographic recording at altitudes up to 70,000 ft. is the latest from Sylvania's Electronic Tube Division.

The electron-optical system and fine grain screen of the new 5-in. tube enable it to achieve fine trace width (6000 line resolution), with conventional focusing and deflection units. Line width is less than 0.0008-inch.

Designated Type SC 2809, the tube has a flat, clear, non-browning optical glass faceplate for optimum photographic quality.

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Bifurcated Gold Contacts

Bifurcated gold contacts—for increased switch reliability and stabilized contact resistance in data processing, radar and radio circuits—are a feature of a new subminiature snap-action switch announced by Micro Switch division of Minneapolis-Honeywell Regulator Company.

The bifurcated contacts (two contact surfaces in each position) move with a wiping action to clean the surfaces with every cycle.

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Aerojet's Atlantic Group Deep in Undersea Research

FREDERICK, MD.—Aerojet-General Corporation's Atlantic Division may be small in comparison with its West Coast sisters at Azusa and Sacramento, but antisubmarine warfare systems under development or study here show advanced thinking.

With only about 60 employees and some 30,000 sq. feet of space—some of that waiting for expected contracts—the division is gearing its efforts to one principal criterion:

• The best way to find a submarine is to use another submarine.

This has been back of the division's plans and objectives ever since Aerojet picked up the former Ordnance Engineering Corp. facilities in 1957.

While the policy may run contrary to some accepted thinking that you have to use a mix of all three—submarines, aircraft and destroyers—the division is confident that much more can be done to improve the capability of the submarine itself as an antisubmarine device.

And the group here is not antidestroyer or antiaircraft, either. Rather, its main interest is in the medium itself—the ocean environment. It's working hand-in-glove with Aerojet's West Coast ASW Division, where the main concern is with underwater propulsion, hydro-dynamics and helicopter-towed minesweep devices.

• **Broad interests**—Atlantic Division delves into the whole field of underwater intelligence—detection, localization, classification, guidance and countermeasures.

Most of the work of the handful of mathematicians, electronic engineers, geophysicists and acousticians is classified, but a little can be told.

Due to some early pioneering work by the division's vice president, John V. Atanasoff, when he was at Naval Ordnance Laboratory, the group took a good look at shallow water propagation for use in acoustical mines. End result has been a healthy simulator contract from the Bureau of Ships.

The company went on the premise that the way to build a simulator was to get actual data from several environmental locations and use the averages as a means of simulation. While details are classified, presumably the simulator's acoustical generation gives an average of the propagational characteristics of sound underwater and is then tied into mine triggering.

The Navy made sound propagation measurements in "several" harbors to come up with average data. Acoustic sweep is played into the simulator by an Aerojet modification to an Ampex magnetic tape transport.

• **Other jobs**—The Division also recently acquired a BuShips Underwater IFF (Identification, Friend or Foe) contract. First part of about $100,000 study phase is almost complete.

It has put in-house money into studies in passive ranging and has several small study contracts from BuShips for countermeasures.

The Division also is tied in with the West Coast's ASW group's work in a relatively new proposal—measurement of undersea turbulence, which affects sound velocity and bearing accuracies much the same as a thermal layer affects amplitude. As such they are concerned with the physics of the sea and how it affects turbulence.

ASW Division has developed a turbulence meter which is undergoing evaluation by Navy. While it could have application in a complete detection system, it probably first will go into basic oceanographic research to provide more data on such things as eddies, and how the size of objects plays a part in their creation. Such basic knowledge in turn should lead to better detection systems.

Navy Asks Bids on JATOS First Bought from Aerojet

The Navy has asked for competitive bids on a new procurement of a JATO motor originally obtained from Aerojet-General under a negotiated contract.

Bids were requested from all major manufacturers early this year on the 5KS 4500 JATO (4500 lbs. thrust for 5 seconds). Originally, the closing date was March 10. This was extended, however, to April 29. The bids are now being evaluated and the Navy's Bureau of Weapons says it is hoped that the contract will be awarded by the end of May.

BuWeaps said the contract originally was negotiated with Aerojet because of the urgency of the program. Now that it does not have such a high priority, the bureau says, it is possible to take the time involved in advertising for competitive bids.

The 5KS 4500 JATO is a multipurpose motor primarily used for takeoff propulsion of Navy aircraft. Aerojet has completed delivery of several thousand under the original contract.

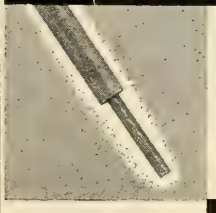
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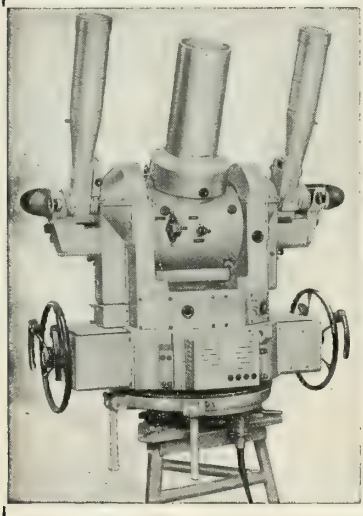
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memo from the publisher

This week's voluminous issue marks the third edition of M/R's Annual Missile Market and Product Guide. First published in Mid-April, 1958, under the title of Missile Market Guide and Directory, the Guide at that time listed 2613 companies and their products, and was mailed to 18,000 subscribers.

M/R's 1960 Guide lists 4903 companies involved in some form or other of missile/space work, together with the amazing total of 3216 different products which they manufacture or assemble. More than 32,500 copies of the Guide will be mailed out this year . . . approximately 1000 of those in single-copy sales between now and the time M/R's 1961 Guide appears.

The Guide is divided into two parts: the Purchasing Directory (we might even call it a "Seller's Guide"), beginning on the opposite page, which contains the 4903 company listings . . . including address, telephone number, names of key purchasing and sales personnel, and code numbers to indicate the areas in which each company is active; and the Product Directory, or Buyer's Guide, beginning on page 177, which lists 3216 parts and products . . . all of which are used somewhere within the $10-billion missile/space industry. Under each of the 3216 products is an alphabetical listing of the companies which manufacture that component.

Throughout both the purchasing and the Product Directories, listings for Guide advertisers appear in boldface type with an asterisk preceding the name.

To assure maximum accuracy in the massive job of tabulating all of the information about company listings and product classification, the services of Remington Rand Univac here in Washington, D.C., were employed. Without the phenomenal speed of this huge computer, the Guide probably would not have been mailed until late summer or early fall.

Each year the Guide is revised and updated, with some listings eliminated through exhaustive study of product categories by the M/R editorial staff, and with many added . . . not only by the staff but through suggestions from industry.

The ink on the pages of the 1958 Guide had hardly dried before we began to hear the outraged voices of dozens of companies throughout the industry who were inadvertently left out of the Guide listings. While this year's Guide is the most comprehensive yet published, somebody may have been overlooked. If so, let us hear from you.

Each year, some three months after the Guide is published, we survey a portion of the M/R subscriber list to learn whether or not we're on the right track. Returns from these surveys have prompted us to make a number of changes in the format of the Guide in an effort to make it the most readable and most comprehensive service of its kind in any field.

You may be getting a questionnaire to fill out to tell us what you think. But don't wait for that: if you've got a suggestion (or a complaint) tell us about it. Address all comments and requests for future listings to: Editor, Missile Market and Product Guide, 1001 Vermont Avenue, N.W., Washington 5, D.C.

Edwards Michelfeld



Army's Ground-to-Ground Pershing

MISSILE PURCHASING DIRECTORY

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MISSILE PURCHASING DIRECTORY

Listed on the following pages along with their address, phone number, and key purchasing and sales personnel, are almost 5,000 companies engaged in the missile industry. Codings appear at the end of each listing from which the area of company activity may be determined. These are explained in the lower right hand corner of every other page. Products manufactured by each company appear in the PRODUCT DIRECTORY which begins at the end of this section. Every effort has been made to obtain listings for all companies active in the missile business, but in an undertaking such as this, there are bound to be omissions. If we have omitted any company who should have been included, we are sorry—and hope that our readers will inform us for corrections in future editions. Write to: Editor, MISSILE MARKET & PRODUCT GUIDE, American Aviation Publications, 1001 Vermont Ave., N. W., Washington, D.C.

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Dir.-Purch: George A. Beck
Gen. Sales Mgr.: F. E. Howell

A&P METAL PRODUCTS MFG. CORP.
111 Bloomingdale Rd., Hicksville, L. I., N. Y. (Tel. WEIls 1-1575)
Purch. Agent: L. J. Wepy
Dir.-Sales: Michael C. Presnick M

A. P. M. CORP.
252 Hawthorne Ave., Yonkers 5, N. Y. (Tel. YOnkers 8-2010)
Purch. Agent: John O'Mara
Sales Mgr.: Riva Solins MS, RD

A. P. W. CO.
72 W. Main St., Rockaway, N. J. (Tel. OAkwood 7-0643)
Prop.: Arthur Pfeil
Sales Repres.: Henry J. Abbott

ASCOP DIV., ELECTRO-MECHANICAL RESEARCH, INC.
Princeton, N. J. (Tel. Swinburn 9-1000)
Buyers: Robert J. Marcy, Edwin W. Dawson, S. Harmon
V. P.-Sales: Thomas E. Stewart TT, RD

AVDEL
210 S. Victory Blvd., P. O. Box 391, Burbank, Calif. (Tel. VIctoria 9-4631)
Purch. Agent: J. R. Moger
Dir.-Sales: E. F. Nason

ABALON PRECISION MFG. CORP.
540 Casanova St., New York 59, N. Y. (Tel. LUdlow 9-5682)
Purch. Agent: Lon Orent

ABBOTT BALL CO., THE
Railroad Pl., Hartford 10, Conn. (Tel. JAckson 3-4231)
Purch. Agent: Edmund Tirone
Mgr.-Mktg.: E. H. Berges, Jr.

ABBOTT SCREW & MFG. CO.
6525 N. Clark St., Chicago 26, Ill. (Tel. ROgers Park 1-8400)
Purch. Agent: Joseph H. Spiegel
V. P.-Sales: Max Cordell
Sales Mgr.: Hal Glaser M

ABESTO CORP.
49 Ackerman St., Bloomfield, N. J. (Tel. ED 8-6814)
Purch. Agent: R. W. Krumscheid
Dir.-Sales: G. L. Humphreys M

***ABRAMS INSTRUMENT CORP.**
606 E. Shiawassee St., Lansing 1, Mich. (Tel. IVanhoe 4-9441)
Purch. Agent: C. E. Adams
Asst. Purch. Agent: F. Conner
V. P.-Sales: C. J. Arksey
*(See advertisement this issue)

ABRASIVE DRESSING TOOL CO.
14528 Second Blvd., Detroit 3, Mich. (Tel. TOwnsend 8-6000)
Pres.: Jerry Krandall M

ACADEMY OF AERONAUTICS
La Guardia Airport, Flushing 71, N. Y. (Tel. HA 9-6600)
Pres.: Charles Jones
Dean: Walter M. Hartung
Chairman, Admissions: George W. Brush

ACCESSORY CONTROLS & EQUIPMENT CORP.
805 Bloomfield Ave., Windsor, Conn. (Tel. MUrdock 8-4986)
V. P.-Purch.: John J. Kardys
Purch. Agent: C. A. Putini
Dir.-Sales: Clifford L. Osterling M

ACCESSORY PRODUCTS CO., DIV.-TEXTRON INC.
616 W. Whittier Blvd., Whittier, Calif. (Tel. OXbow 3-3747)
Purch. Agent: Jerry Hudson
Sales Mgr.: O. A. Cordes MS, CT, RD

ACCURATE ELECTRONICS CORP.
169 S. Abbe Rd., Elyria, O. (Tel. ENdicott 5-1211)
Pres.: J. F. Seybold
Plt. Engr.: T. J. Lakocy G, CT, TT

ACCURATE INSTRUMENT CO.
2418 W. Alabama, Houston 6, Texas (Tel. JA 6-4947)
V. P.-Purch.: David W. Kemptner
Pres.: James G. Sears

ACCURATE MFG. CO.
Hepworth Place, Garfield, N.J. (Tel. GRegory 3-2900)
Pres.: V. A. DeMattia
Dir.-Sales: A. W. Rista M

ACCURATE SPECIALTIES CO. INC.
37-11 57th St., Woodside 77, N. Y. (Tel. TWining 9-5757)
Purch. Agent: Lawrence Diamond
Asst. Purch. Agent & Sales Mgr.: Irving M. Solotoff
Buyer: Robert MacIsaac M

ACE COIL & ELECTRONICS CO.
917 Lincoln Hwy., Metuchen, N. J. (Tel. LIberty 8-3580)
Purch. Agent: A. D. Meyer
Buyer: I. M. MacDonald
Sales Mgr.: Fred Sampson M

***ACE DRILL BUSHING CO. INC.**
5407 Fountain Ave., Los Angeles 29, Calif. (Tel. HO 9-8253)
V. P.-Mfg.: George Clement
Mgr.-Mktg.: Robert Ferris PS
*(See advertisement this issue)

ACE ELECTRONICS ASSOCIATES, INC.
99 Dover St., Somerville 44, Mass. (Tel. SOmerset 6-5130)
Pres.: Aaron N. Solomon
Sales Admin.: John J. Kennedy
Sales Mgr.: George Berman G, RD

ACE ENGRG. & MACHINE CO., INC.
Tomlinson Rd., Huntingdon Valley, Pa. (Tel. WIlson 7-1900)
Dir.-Purch.: Frances M. Fay
Purch. Agent: Charles E. Kienzle
Sales Mgr.: Charles C. Borden S

ACE PLASTIC CO.
91-30 Van Wyck Expressway, Jamaica 35, N. Y. (Tel. JA 3-5500)
Purch. Agent: Irving Steinberg
Dir.-Sales: Sidney Seidman

ACE PRODUCTS CO.
1820 N. 12th St., P. O. Box 784, Toledo 1, O. (Tel. CHerry 3-6513)
Purch. Mgr.: Emory A. Fall

ACE SPRING MFG. CO., INC.
141 32nd St., Brooklyn 32, N. Y. (Tel. Sterling 8-0100)
Dir.-Sales: L. Edwards M

ACHESON COLLOIDS CO., DIV.-ACHESON INDUSTRIES, INC.
1952 Washington Ave., Port Huron, Mich. (Tel. YUkon 4-4171)
Sales Mgr.: Arthur T. Olsson
Purch. Agent: D. L. Keith M

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

ACKERMAN ENGRAVERS, INC.
458 Broadway, New York 13, N. Y. (Tel. BArclay 7-1479)
Pres.: Bernard Strianese
Gen. Mgr.: Michael Strianese **MS, G, CT, TT, RD**

ACKERMAN-GOULD CO. INC.
10 Neil Ct., P. O. Box 188, Oceanside, N. Y. (Tel. ORiole 8-4110)
Purch. Agent: Anthony Fiorey
Secy.-Treas.: Herman Gould

ACKERMAN JOHNSON CO.
625 W. Jackson Blvd., Chicago 6, Ill. (Tel. RAndolph 6-2816)
Purch. Agent: E. W. Enyart
Sales Mgr.: V. G. Probst **S, M**

ACME BRASS FOUNDRY CO. OF SAN ANTONIO, INC.
716 Wyoming St., San Antonio 3, Texas (Tel. CApitol 7-4601)
Gen. Mgr.: Steve Margozewitz
Sales Mgr.: Mrs. Agnes M. Mahula **M**

ACME CHAIN CORP.
821 Main St., Holyoke, Mass. (Tel. JE 2-9458)
Purch. Agent: Richard Munroe
Sales Mgr.: John D. Hayden **M**

ACME ELECTRIC CORP.
20 Water St., Cuba, N. Y. (Tel. Cuba 4)
Dir.-Purch.: A. J. Rudy
Dir.-Sales: J. D. Hall **CT, TT, RD**

ACME INDUSTRIAL CO.
200-222 N. Laflin St., Chicago 7, Ill. (Tel. MOnroe 6-4122)
Purch. Agent: Ronald Farrell
V. P.-Sales: Warner T. Bracken **RD**

ACME WIRE CO.
1255 Dixwell Ave., New Haven 14, Conn. (Tel. LO 2-2171)
Purch. Agent: Walter Rausch
Asst. Purch. Agent: Robert Kowalczyk
Gen. Sales Mgr.: James Galvin
Pres.: H. B. Bassett **M**

ACME-NEWPORT STEEL CO.
9th & Lowell Sts., Newport, Ky. (Tel. COlonial 1-5620)
Dir.-Purch.: H. M. Baker
V. P.-Sales: C. M. Riefkin **M**

ACORN BEARING CO.
66 Stanley, New Britain, Conn. (Tel. BA 9-0839)
Dir.-Purch.: D. E. Malona

ACOUSTICA ASSOCIATES, INC.
10400 Aviation Blvd., Los Angeles 45, Calif. (Tel. ORchard 0-3393)
Purch. Agent: P. Masley
Buyers: R. Sanchez & R. Hackworth **PS, MS, CT, RD**

ACRO DIV., ROBERTSHAW-FULTON CONTROLS
2040 E. Main St., Columbus 16, O. (Tel. CL 3-8531)
Purch. Agent: A. Lofferty
Sales Mgr.: Tom Smith **M**

ACROMAG, INC.
22515 Telegraph Rd., Southfield (Detroit), Mich. (Tel. ELgin 7-0030)
Gen. Mgr.: Robert G. Hennings
Dir.-Sales: Henry W. Patton

ACROMARK CO., THE
445 Morrell St., Elizabeth 4, N. J. (Tel. ELizabeth 2-6500)
Purch. Agent: M. A. Palmiere
Gen. Sales Mgr.: W. R. Heine, Jr. **M**

ACTIONCRAFT PRODUCTS
2 Yennicock Ave., Port Washington, N. Y. (Tel. PO 7-4500)
Purch. Agent: B. Lazich
Asst. Purch. Agent: M. Briggs
Sales Mgr.: W. J. Murphy **M**

ACTON LABORATORIES INC.
533 Main St., Acton, Mass. (Tel. COlonial 3-7756)
Prod. Mgr.: Richard A. Hall
Gen. Mgr.: Leroy C. Bower, Jr. **CT, RD**

ACTUATION RESEARCH CORP.
416 N. Glendale Ave., Glendale 6, Calif. (Tel. CHapman 5-6866)
Mat. Coordinator: B. G. Mueller
Sales Mgr.: E. H. Mitchell **MS, RD**

ACTUATOR PRODUCTS, DIV.-GEARTRONICS CORP.
36 Nashua St., Woburn, Mass. (Tel. WEIls 3-1400)
Purch. Agent: Albert N. Galante
Sales Mgr.: John H. Lyman

ACUSHNET PROCESS CO.
Belleville Ave., P. O. Box 916, New Bedford, Mass. (Tel. WYman 3-1711)
Dir.-Purch.: W. J. Roemer
Purch. Agent: C. R. Hinkley
Sales Mgr.: Holmes M. Dyer **M**

ADAGE, INC.
292 Main St., Cambridge 42, Mass. (Tel. UN 4-6620)
Purch. Agent: Richard J. McLernon
Dir.-Sales: J. Burgess Jamieson **CT**

ADAM METAL SUPPLY INC.
4-63 48th Ave., Long Island City 1, N. Y. (Tel. STillwell 6-7737)
V. P.-Purch.: Jules Brody
Dir.-Sales: William Malcus **M**

ADAMS RITE MFG. CO.
540 W. Chevy Chase Dr., Glendale 4, Calif. (Tel. CHapman 5-1095)
Dir.-Purch.: R. Harvey
Sales Mgr.: C. J. Schleeweiss
Dir.-Dev.: Donnell Grizzard

ADEL PRECISION PRODUCTS, DIV.-GENERAL METALS CORP.
1444 Washington Ave., Huntington, W. Va. (Tel. JA 2-7345)
Purch. Agent: D. V. Reynolds
Sales Mgr.: H. G. Shy

ADEL PRECISION PRODUCTS OF CALIF., DIV.-GENERAL METALS CORP.
10777 Vanowen St., Burbank, Calif. (Tel. TRiangle 7-2611)
Purch. Agent: A. Haines
Mgr.-Engrg. & Sales: W. J. Drummy
Chief Engr.: L. W. Topham
Gen. Mgr.: W. J. Yuss **MS, G**

ADEPT INDUSTRIES INC.
1636 W. Hunting Park Ave., Philadelphia 40, Pa. (Tel. DAvenport 4-6800)
Purch. Agent: Sidney Whitman
Sales: John F. Sohl

ADHESIVE ENGRG. DIV.-HILLER AIRCRAFT CORP.
1411 Industrial Rd., San Carlos, Calif. (Tel. LYtel 1-2686)
Purch. Agent: W. E. Schneider
Tech. Sales Mgr.: Robert W. Gaul **M, RD**

ADLER ELECTRONICS, INC.
One Le Fevre Lane, New Rochelle, N. Y. (Tel. NEw Rochelle 6-1620)
Dir.-Purch.: Eugene Laks
Buyer: Fred Meyers
V. P.-Mktg.: Alfred Strogoff **MS, CT, TT, RD**

ADMIRAL CORP.
3800 W. Cortland St., Chicago 47, Ill. (Tel. SPaulding 2-0100)
V. P.-Purch.: Frank J. Kazda
Purch. Agent, Govt. Div.: A. De Franceschi
V. P., Govt. Div.: Thomas J. Lloyd **TT, RD**

ADVANCE CARBON & ELECTRIC MFG. CO.
2505 Mariposa St., San Francisco 10, Calif. (Tel. HEmlock 1-4034)
Dir.-Purch.: Boyd Bithell
Sales Mgr.: W. J. Crader **PS, MS, M, G, TT**

ADVANCE INDUSTRIAL X-RAY LABS., INC.
3538 Fowler St., Los Angeles 63, Calif. (Tel. AN 8-1721)
V. P.-Purch.: E. H. Wisdom
Gen. Mgr.: Ed Martindale **CT**

ADVANCE INDUSTRIES, INC.
640 Memorial Dr., Cambridge 39, Mass. (Tel. UNiversity 4-6800)
Dir.-Purch.: Oscar S. Lightbody
Buyers: Allan J. Joseph & Chester W. Dryden
V. P.-Sales: Robert L. Johnston **MS, G, CT, TT, RD**

ADVANCE INSTRUMENT CORP.
1109 6th Ave., Neptune, N. J. (Tel. PRospect 4-3700)
Pres.: Martin Tepper
Purch. Agent: Harry Bishop **MS, CT, TT, RD**

ADVANCE RELAYS, ELECTRONICS DIV., ELGIN NATIONAL WATCH CO.
2435 N. Naomi St., Burbank, Calif. (Tel. VI 9-1446)
Purch. Agent: J. Shrieber
Gen. Sales Mgr.: Gene Straube

ADVANCED ELECTRONICS, INC.
94 Silas Deane Hwy., Rocky Hill, Conn. (Tel. JAckson 9-6881)
Purch.: Alfred Dinunzio
Sales: Sam Friedman **MS, CT**

ADVANCED ENGRG. DIV., D. S. KENNEDY & CO.
P. O. Box 1711, Monterey, Calif. (Tel. FRontier 3-2461)
Sales Mgr.: Howard H. Hubbard **RD**

ADVANCED PRODUCTS CO., THE
59 Broadway, North Haven, Conn. (Tel. CEdar 9-1664)
Treas.: Arthur Hostage
Sales Mgr.: S. Robert Pulleyn **S, PS, MS**

***ADVANCED TECHNOLOGY LABS.**
369 Whismen Rd., Mountain View, Calif.
*(See advertisement this issue)

AEMCO INC.
10 State St., Mankato, Minn. (Tel. 5153)
Purch. Agent: A. P. Pitzl
Asst. Purch. Agent: D. W. Wrucke
Sales Mgr.: J. F. Krost **TT**

AER, INC.
871 E. Washington Blvd., Pasadena, Calif. (Tel. SY 4-9725)
Dir.-Purch. & Sales: Robert E. Oliver **RD**

AERIAL MACHINE & TOOL CORP.
38-27 30th St., Long Island City 1, N. Y. (Tel. RA 9-2425)
Dir.-Purch. & Sales: B. Kurz **M**

AERO BOLT & SCREW CO., INC.
25 W. Hartsdale Ave., Hartsdale, N. Y. (Tel. ROckwell 1-0210)
Dir. Purch.: A. J. Babboni
Sales Dept.: A. Oliver & F. Di Biase **M**

AERO ELECTRONICS CORP.
1745 W. 134th St., Gardena, Calif. (Tel. FAculty 1-2196)
Purch. Agent: Jim Fagan, (Tel. FA 1-3311)
Tech. Dir.: Jim Green
Gen. Mgr.: Steve Taylor **M**

AERO GASKET CORP.
763 Hanover Rd., Meriden, Conn. (Tel. BEverly 5-3361)
Dir.-Purch.: Rhoda Hurwitz
Dir.-Sales: Raymond C. Schmitt **PS**

AERO INSTRUMENT CO.
11423 Vanowen St., North Hollywood, Calif. (Tel. TRiangle 7-5433)
Pres.: T. O. Cox
Asst. Secy.: Mrs. L. Hough **MS, CT**

AERO LEATHER PRODUCTS CO.
1740 W. 59th St., Los Angeles 47, Calif. (Tel. PLeasant 3-1461)
V. P.-Purch.: C. E. Seymour
Gen. Sales Mgr.: W. E. Seymour

AERO MFG. & MACH. CO., INC.
2724 9th St., Muskegon Heights, Mich. (Tel. PE 3-1251)
V. P.-Purch.: O. U. Johnson
Non-Prod.: G. M. Brown
V. P.-Sales: H. A. Kreifeldt **S, PS, MS, G**

AERO RESEARCH INSTRUMENT CO. INC.
315 N. Aberdeen St., Chicago 7, Ill. (Tel. TAylor 9-6400)
Dir.-Purch.: Ben Scadron
Dir.-Sales: M. Scadron **CT, RD**

AERO SPARES, INC.
69-08 Woodside Ave., Woodside 77, N. Y. (Tel. HI 6-4880)
Acting Purch. Agent: Bob Boyd
Buyers: Julia Ford & Pete Vaughn
Dir.-Sales: George Vaughn **MS**

AERO SUPPLY MFG. INC.
611 W. Main St., Corry, Pa. (Tel. 2-8261)
Purch. Agent: P. E. Dwyer
Buyer: Dean Houser
V. P.-Sales & Engrg.: E. F. Pain **PS, MS, G, RD**

AEROCAL DIV., AERONCA MFG. CORP.
24751 Crenshaw Blvd., Torrance, Calif. (Tel. DAvenport 6-8220)
Mgr.-Materiel: A. J. Mulford
Purch. Agent: J. M. Crawford
Dir.-Tech. Services: D. N. Ninteman **S, MS, RD**

AEROCHEM RESEARCH LABS., INC.
P. O. Box 12, Princeton, N. J. (Tel. WAlnut 1-7070)
Gen. Mgr.: George R. Bent, II **R D**

AEROFLEX LABS., DIV., AEROFLEX CORP.
34-06 Skillman Ave., Long Island City 1, N. Y. (Tel. STillwell 6-3315)
Purch. Agent: P. Peterson
Buyer: W. Barilla
Prod. Control: H. Cranfill
V. P.-Sales: R. G. Sanders **MS, G, CT, RD**

AEROIL PRODUCTS CO., INC.
55 Wesley St., South Hackensack, N. J. (Tel. Dlamond 3-5200)
Dir.-Purch.: Emil Treumper
Dir.-Sales: Joseph Holperin **S, M**

***AEROJET-GENERAL CORP.**
Box 296, Azusa, Calif. (Tel. CUmberland 3-6111, EDgewood 4-6211)
Mgr.-Proc.: William Mullock
Gen. Purch. Agent: F. W. Henion
Proc. Specialist: V. R. Miller
V. P.-Customer Relations: W. L. Gore
*(See advertisement this issue) **PS, MS, G, CT, RD**

AEROJET-GENERAL CORP., DOWNEY PLANT
11711 Woodruff Ave., Downey, Calif. (Tel. TOpaz 1-9711, SPruce 3-0130)
Mgr.-Materiel Div.: R. W. Lassman
Comm. Purch. & Proc. Services: I. G. Funk
Customer Relations, Aero. Div.: O. W. Grow
Customer Relations, Ord. Div.: W. G. Weigel **S, MS, RD**

AEROLITE ELECTRONICS CORP.
2207 Summit Ave., Union City, N. J. (Tel. UNion 3-2955)
Purch. Agent: John Doheny
Sales Mgr.: Victor G. Matto **PS, M, CT**

AEROLUX LIGHT CORP.
653 11th Ave., New York 36, N. Y. (Tel. CIrcle 6-5324)
P. J. Kayott **M, RD**

AERONAUTICAL ELECTRONICS, INC.
Box 6527, Raleigh, North Carolina (Tel. TEmple 4-7381)
Purch. Agent: J. R. Whitaker
Sales Mgr.: A. F. Marthens **MS, CT**

AERONAUTICAL MACHINISTS INC.
386 Mountain Grove St., Bridgeport 5, Conn. (Tel. FOrest 6-4791)
Product Analyst: Michael Demci
V. P.-Purch.: Arthur J. Gleason
Pres.: Matthew Kuziak **MS**

AERONCA MFG. CORP.
1712 Germantown Rd. Middletown, O. (Tel. GArden 2-2751)
Dir.-Purch.: R. M. Paul
Dir.-Material Negotiation Section: Thomas Brunjes
V. P.-Tech. Services Div.: Ray F. Hermes **S, M, G, RD**

AERONCA MFG. CORP., AEROSPACE DIV.
Hilltop & Frederick Rds., Baltimore 28, Md. (Tel. RIdgeway 7-0200)
Purch. Agent: G. M. Swesey
Sales Engr.: C. Harvey
Dir.-Mktg.: J. Wascavage **MS, G, CT, TT, RD, HSE**

AERONUTRONIC, DIV.-FORD MOTOR CO.
Ford Rd., Newport Beach, Calif. (Tel. ORiole 5-1234)
Mktg. Mgr.: S. D. Wanlass
Mktg., Computer Operations: R. F. Geiger
Mktg., Tactical Weapon Systems Operations: H. K. Weiss
Mktg. Mgr., Space Technology Operations: J. C. Christian
Systems Mktg., Range Systems Operations: R. T. Barrett
Gen. Purch. Agent, Material: C. D. Graef
Purch. Agent, Subcontracts & Electronics: G. S. Cadice
Purch. Agent, Supplies & Facilities: D. W. Coulter

AEROPRODUCTS OPERATIONS, ALLISON DIV., GENERAL MOTORS CORP.
Municipal Airport, Dayton, O. (Tel. TWinoaks 8-4661)
Mgr.-Purch.: J. E. Baird
Asst. Purch. Agent: W. S. Neff
Purch. Parts Buyer: F. A. White
Mgr.-Sales, Serv. & Contracts: C. E. Dixon

AEROPROJECTS INC.
310 E. Rosedale Ave., West Chester, Pa. (Tel. OWen 6-4710)
Purch. Agent: Fred Wood
Sales Mgr.: D. D. Kirkpatrick **S, M, RD**

AEROQUIP CORP., GENERAL LOGISTICS DIV.
2929 Floyd St., Burbank, Calif. (Tel. VIctoria 9-5831)
Purch. Agent: M. J. Kalajian
Gen. Sales Mgr.: Richard W. Mosher **MS**

AEROQUIP CORP., JACKSON DIV.
300 S. East Ave., Jackson, Mich. (Tel. STate 2-0361)
Purch. Mgr.: L. A. Greene
Gen. Sales Mgr.: F. W. Schwier **S, PS, MS, CT, RD**

AEROSCIENCE, INC.
3015 S. Kilson Dr., Santa Ana, Calif. (Tel. KImberly 9-1101)
Purch. Agent: R. M. Hall
Gen. Sales Mgr.: W. C. Vanbebber **MS, CT, RD**

AERO-STAT CO., THE
8021 S. Western Ave., Los Angeles 47, Calif. (Tel. PLeasant 3-1919)
Engr.: Louis Brownlee
Pres.: Joseph A. Iaia **M**

AEROTEC INDUSTRIES, INC., AIRCRAFT EQUIPMENT DIV.
Pemberwick Rd. & Comly Ave., Greenwich, Conn. (Tel. JEfferson 1-8400)
Dir.-Planning & Proc.: Harold Anderson
V. P. & Mgr.: J. V. Oliveau
Sales Mgr.: T. W. Walker **M, S**

AERO-TEST EQUIPMENT CO., INC.
8401 Chancellor Row, Dallas 7, Texas (Tel. FLeetwood 7-6271)
Purch. Agent: E. L. Wilks
Chief Estimator: W. O. Price
Sales Mgr.: Ken Bishop **MS, CT**

AERO-TEST EQUIPMENT CO., INC.
8401 Chancellor Row, Dallas 7, Texas. (Tel. FLeetwood 7-6271)
Purch. Agent: E. L. Wilks
Chief Estimator: W. O. Price
Sales Mgr.: Ken Bishop **MS, CT**

AEROTRON SUPPLY CO.
13611 S. Normandie Ave., Gardena, Calif. (Tel. FR 1-5911)
V. P.-Purch.: John L. Scales
V. P.: Richard J. Greer **M**

AEROVOX CORP.
740 Belleville Ave., New Bedford, Mass. (Tel. WYman 4-9661)
Purch. Agent: Robert Crabbe
Buyers: Edward Hickey, John Warren, Fred Graeben, Joe Desjarins
V. P.-Sales: Frank Marshall **M**

AETNA BALL & ROLLER BEARING CO., DIV.-PARKERSBURG-AETNA CORP.
4600 W. Schubert Ave., Chicago 39, Ill. (Tel. CApitol 7-2410)
Purch. Agent: G. M. Karm
Asst. Purch. Agent: R. W. Zitzewitz
Sales Mgr.: H. F. Wendt **M**

AETNA ELECTRONICS CORP.
Readington Rd., North Branch, N. J. (Tel. RA 5-1000)
Purch. Agent: Robert McDonald
Dir.-Sales: Henry J. Buser, Jr. **CT**

AGRICULTURAL AVIATION ENGRG. CO. INC.
858 Scott St., Santa Clara, Calif. (Tel. CH 8-6075)
Operations Mgr.: Phillip R. Pickell
Adm. Mgr.: George S. Sanders **MS, RD**

AINSLIE CORP.
531 Pond St., S. Braintree 85, Mass. (Tel. VIctor 8-0850)
Purch. Agent: L. D. Ainslie
Sales: H. W. Ainslie **S, MS, G, TT**

AIR FILTER CORP.
4554 W. Woolworth Ave., Milwaukee 18, Wis. (Tel. FLagstone 3-5800)
V. P.-Purch.: R. E. Zahn
Dir.-Sales: W. H. Welty **M, HSE**

AIR LOGISTICS CORP.
3600 E. Foothill Blvd., Pasadena, Calif. (Tel. SYcamore 6-7191)
Chief Purch. Agent: C. J. Wilson
V. P.-Engrg.: C. J. Breitwieser **MS, CT, RD**

AIR PRODUCTS, INC.
Allentown, Pa. (Tel. Express 5-3311)
Gen. Purch. Mgr.: F. B. Drake
Purch. Agent: A. Wilson
Gen. Sales Mgr., Process Equip. Div.: Gordon Kiddoo **PS, MS, M, G, RD, HSE**

AIR REDUCTION SALES CO., DIV.-AIR REDUCTION CO., INC.
150 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 2-6700)
Dir.-Purch.: E. R. Humann
Mgr., Mktg.: E. S. Twining, Jr. **S, HSE**

AIR RESEARCH & DEVELOPMENT COMMAND
Assistant for Procurement Sources, Directorate of Procurement, HQ, Andrews Air Force Base, Washington 25, D. C. (Tel. REdwood 5-8900)
DCS/M: Brig. Gen. Lee Fulton
Dir.-Proc.: Col. J. B. Prodgers
Dep. Dir.-Proc.: R. Miedel
Chief, Proc. Surv. Div.: C. Meyer **S, PS, MS, M, G, CT, TT, RD, HSE**

AIR SPEED TOOL CO.
1502 W. Slauson Ave., Los Angeles 47, Calif. (Tel. PLeasant 2-8340)
Gen. Mgr.: H. J. Thiessen
Asst. Gen. Mgr.: R. G. Zimmerman
Purch.: H. L. Johnson **S, MS, PS**

AIRATERRA
620 Paula Ave., Glendale 1, Calif. (Tel. CHapman 5-8521)
Purch. Agent: Leo Harris
Sales Mgr.: Donald A. Benbow **PS, MS, M, G, RD**

AIRBORNE ACCESSORIES CORP.
1414 Chestnut Ave., Hillside 5, N. J. (Tel. MU 8-0250)
Purch. Agent: P. Marantz
Pres. & Gen. Mgr.: W. Cortlyn Rhodes **MS**

AIRBORNE INSTRUMENTS LAB., DIV.-CUTLER-HAMMER, INC.
Comac Rd., Deer Park, N. Y. (Tel. MYrtle 2-6100)
Dir.-Procurement: George Hansen
Dir.-Mktg.: M. J. Rowe **CT, RD, HSE**

AIRBORNE RESEARCH & DEVELOPMENT CORP.
7530 San Fernando Rd., Sun Valley, Calif. (Tel. TR 7-9647)
Purch. Agent: T. Roberts
Dir.-Sales: R. H. Hahn **RD**

AIRCOM INC.
48 Cummington St., Boston 15, Mass. (Tel. CO 7-9115)
Chief Engr.: Robert A. Rivers
Sales Mgr.: Edward J. Stack **MS, G, TT, RD, HSE**

AIRCRAFT ACCESSORY TURBINE DEPT., GENERAL ELECTRIC CO.
950 Western Ave., Lynn 3, Mass. (Tel. LYnn 3-6000)
Purch. Agent: W. M. Badger
Buyer (Forgings, Castings): M. W. Dilloway
Buyer (Bearing, Sales, Hardware): J. P. Condon
Field Sales Mgr.: W. F. Moore

AIRCRAFT ARMAMENTS, INC.
Cockeysville, Md. (Tel. NOrmandy 6-1400)
Chief-Procurement: Blaine M. Swartz
Dir.-Sales: Marvin J. Kahn **S, MS, CT, TT, RD**

AIRCRAFT COMPONENTS, INC.
755 Woodland Ave., Twin Cities Airport, Benton Harbor, Mich. (Tel. WAlnut 5-8861)
Pres.: C. O. Zollar
Sales Mgr.: C. R. Raines
Asst. Sales Mgr.: R. C. Williams

AIRCRAFT EQUIPMENT DIV.-CONSOLIDATED DIESEL ELECTRIC CORP.
880 Canal St., Stamford, Conn. (Tel. DAvis 5-2261)
Dir.-Opns.: E. J. Minar
Purch. Agent: J. A. Adams
V. P. & Gen. Mgr.: J. I. Davis

AIRCRAFT EQUIPMENT TESTING CO., INC.
1812 Fleet St., Baltimore 31, Md. (Tel. ORleans 5-8337)
Pres.: Harry P. Kupiec **CT, RD**

AIRCRAFT FITTING CO., THE
701 N. Federal Hwy., Dania, Fla. (Tel. WAbash 3-2331)
Dir.-Purch.: Paul Hummel
Sales Mgr.: H. P. Borger **M**

AIRCRAFT INSTRUMENTS CO.
King of Prussia Rd. at Mongomery Lane, Radnor, Pa. (Tel. MUrray 8-0151)
Dir.-Purch.: George Peterson, Jr.
Purch. Agent: H. Miller
Chief Engr.: W. Betten **MS**

AIRCRAFT POROUS MEDIA, INC., SUB.-PALL CORP.
30 Sea Cliff Ave., Glen Cove, N. Y. (Tel. ORiole 1-4000)
Purch. Agent: N. Friedman
Sales Mgr.: J. A. Whitwell **M**

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

AIRCRAFT TOOLS, INC.
9030 Bellanca Ave., Los Angeles, Calif. (Tel. OR 8-3432)
Purch. Agent: William Avey
Asst. Purch. Agent: Paul Dowd
Buyer: D. Jackson
V. P.-Sales: H. W. Dellett MS

AIRDROME PARTS CO.
922 W. Hyde Park Blvd., Inglewood 3, Calif. (Tel. ORegon 8-7133)
Purch. & Prod. Mgr.: Harold D. Stout
Sales Mgr.: Walter J. Parker MS, RD

***AIRESEARCH MFG. OF ARIZONA**
402 S. 36th St., Phoenix, Ariz. (Tel. BRidge 5-6311)
Mgr.-Purch.: Herb Bjornberg
Mgr.-Sales: S. D. Whitaker PS, MS
*(See advertisement this issue)

***AIRESEARCH MFG. CO. DIV., THE GARRETT CORP.**
9851 Sepulveda Blvd., Los Angeles 45, Calif. (Tel. SP 6-1010)
Purch. Mgr.: B. Schindler
Sales Mgr.: P. M. Bartlett MS, G, RD, HSE
*(See advertisement this issue)

AIRETOOL MFG. CO., THE
300 S. Center St., Springfield, Ohio (Tel. FAirfax 3-4988)
Dir.-Purch.: Harold Gilliam
Dir.-Sales: I. T. Thornson M

AIRFLYTE ELECTRONICS CO.
535 Ave. A, Bayonne, N. J. (Tel. HEmlock 6-2230)
Purch. Agent: Ben Novy
Buyer: D. Pintauro
Sales Dir.: Milton Feinman MS, TT

AIRHARDWARE, INC.
14845 Oxnard St., Van Nuys, Calif. (Tel. STate 5-1591)
Purch. Agent: Ralph Gabrielson
Buyer: Carl J. Bild
Sales Mgr.: Stephen J. Bild M

AIR-MARINE MOTORS, INC.
369 Bayview Ave., Amityville, N. Y. (Tel. AMityville 4-3700)
Purch. Agent: Paul Harrington
Gen. Sales Mgr.: David H. Thomas
Sales Mgr. (E/C Div.): William Sly G, RD

AIR-MAZE CORP.
25000 Miles Rd., Cleveland 28, O. (Tel. MOntrose 2-8000)
Dir.-Purch.: James Carson
Sales Mgr.: John M. Clem

AIRPAX ELECTRONICS INC., CAMBRIDGE DIV.
Cambridge, Md. (Tel. ACademy 8-4600)
Purch. Agent: Evon Harding MS

AIRPAX ELECTRONICS INC., SEMINOLE DIV.
Fort Lauderdale, Fla. (Tel. LUdlow 3-6160)
Purch. Agents: Ewald Spedden & R. Dondelinger
Gen. Sales Mgr.: H. A. Cook MS, TT, RD

AIRTEMP DIV., CHRYSLER CORP.
1610 Webster St., Dayton 1, Ohio (Tel. BAldwin 3-2141)
Purch. Agent: H. M. Coy
Purch. Supvr.: C. L. Buck G

AIRTRON, DIV.-LITTON INDUSTRIES
200 E. Hanover Ave., Morris Plains, N. J. (Tel. JEfferson 9-5500)
Dir.-Purch.: J. Corrigan
Dir.-Sales & Mktg.: G. P. Tanquary MS, G, CT, TT, RD

AIRWORK CORP.
5245 N. W. 36th St., Miami Springs, Fla. (Tel. TUxedo 7-8176)
Connector Sales: R. R. Read PS

AKRON BRASS MFG. CO., INC.
Wooster, Ohio (Tel. HOward 2-0070)
Purch. Agent: F. B. Watson
V. P.-Sales: Harold Strain

ALAC, INC.
365 W. Arden St., Glendale, Calif. (Tel. CHapman 5-3787)
Dir.-Purch.: Arthur Le Stourgeon
Sales Mgr.: M. J. Johnson M

ALAD ALUMINUM LADDER CORP.
7260 Melrose Ave., Los Angeles 46, Calif. (Tel. WEbster 4-5000)
Gen. Sales Mgr.: F. A. von Baum
Dir.-Purch.: William S. Hambly, 1448 Signal Dr., Pomona, Calif. (Tel. NAtional 2-2478)

ALADDIN ELECTRONICS, DIV.-ALADDIN INDUSTRIES INC.
705 Murfreesboro Rd., Nashville 10, Tenn. (Tel. CHapel 2-3411)
Sales Office Mgr.: F. G. Bassler
Chief Engr.: P. E. Dicker
Purch. Agent: William B. Patterson
V. P. & Gen. Mgr.-Sales: W. W. Stifler M, RD

ALBANO CO. INC.
549-555 W. 54th St., New York 19, N. Y. (Tel. PLaza 7-5887)
Purch. Agent: G. Strump
Dir.-Sales: J. R. Creveling S, M

ALBERTSON & CO., INC.
3100 Lowell Ave., Sioux City 4, Iowa (Tel. 2-0525)
Purch. Agent: Marvin H. Andersen
Asst. Purch. Agent: M. L. Andersen
Sales Mgr.: D. E. Jacobsen

ALBION INDUSTRIES, INC.
816 N. Clark St., Albion, Mich. (Tel. NAtional 9-3965)
Purch. Agent: C. W. Burns
Gen. Mgr.: J. F. Karmalski

ALCAR INSTRUMENTS, INC.
411 Robbins Ave., Trenton 8, N. J. (Tel. OWen 5-6342)
Prod. Mgr.: J. F. Tibolla
Dir.-Sales: Dr. Hugh H. Darby M, CT, RD

ALCO PRODUCTS, INC.
P. O. Box 1065, Schenectady 1, N. Y. (Tel. FRanklin 7-3311)
Dir.-Procurement: E. J. Van Valkenburgh
Sales Mgr., Nuclear & Defense Products: A. T. Lawrance

ALCO VALVE CO.
865 Kingsland Ave., St. Louis 30, Mo. (Tel. PArkview 5-2460)
Proc. Dir.: W. F. Helfrich
Buyers: Wm. C. Calvin & Jack DeCormier
Mgr.-Aircraft Sales: W. F. Lochmoeller S, PS, MS

ALDEN PRODUCTS CO.
154 N. Main St., Brockton, Mass. (Tel. JUniper 3-0160)
Purch. Agent: A. E. Illsley
Sales Mgr.: Russ Hawkins MS, M, G, RD

ALFAX PAPER & ENGRG. CO. INC.
Washington St., Westboro, Mass. (Tel. FOrest 6-4467)
Chief Engr.-Purch.: E. D. Cross
Plant Mgr.-Sales: S. C. Sviokla TT, RD

ALFRED ELECTRONICS
897 Commercial St., Palo Alto, Calif. (Tel. DAvenport 6-6496)
V. P.-Purch.: Al Jew
Buyer: Merle Spade
Sales Mgr.: Paul N. Fulton CT

ALITE DIV., U. S. STONEWARE CO.
P. O. Box 119, Orrville, Ohio (Tel. Smithville, MO 9-2271) M

ALL AMERICAN ENGRG. CO.
Box 1247, DuPont Airport, Wilmington 99, Del. (Tel. WYman 4-0951)
Purch. Agent: John F. Stocki
Head, Military Proj.: Chuck J. Daniels
V. P.-Sales: Robert B. Cotton PS, MS, CT, TT, RD

ALL AMERICAN TOOL & MFG. CO.
8027 Lawndale Ave., Skokie, Ill. (Tel. ORchard 3-7084)
Gen. Mgr.-Purch.: S. K. Hein
Chief Engr.-Purch. & Sales: Robert O. Hein

ALL BORO METAL PRODUCTS CO., INC.
610 Fenimore Rd., Mamaroneck, N. Y. (Tel. OWens 8-0104)
V. P.-Purch.: H. B. Maxwell
Purch.: J. J. Schnapp & H. M. Sterling M

ALL CHROME MFG. CO.
2610 Willo Lane, Costa Mesa, Calif. (Tel. LI 8-4265)
Dir.-Purch.: D. Harrison
Dir.-Sales: R. Harrison

ALL PRODUCTS CO.
P. O. Box 110, Mineral Wells, Tex. (Tel. FAirfax 5-3301)
Purch. Agent: Harry Opanowitz S, G, TT, RD

ALL SPECS CORP.
245 Fourth St., Passaic, N. J. (Tel. GRegory 1-4700)
Dir.-Purch.: H. Mohrwinkel
Dir.-Sales: H. London M

ALL STAR PRODUCTS INC.
P. O. Box 487, Defiance, Ohio (Tel. 2-1065)
Dir.-Purch.: D. P. Ingle
V. P. & Sales Mgr.: W. F. Reiter G, CT, TT, RD

ALLARD INSTRUMENT CORP.
146 E. Second St., Mineola, L. I., N. Y. (Tel. Ploneer 6-5895)
Prod. Mgr.: Norman M. Herman
Pres.: Alfred Skrobisch

ALLEGANY INSTRUMENT CO., INC.
1091 Wills Mountain, Cumberland, Md. (Tel. PArkview 4-1200)
Purch. Agent: Miss Helen Whiteman
Sales Mgr.: John B. Zornig

ALLEGHENY BALLISTICS LAB.
Cumberland, Md.

ALLEGHENY ELECTRONIC CHEMICALS CO.
Hooker-Fulton Bldg., Bradford, Pa. (Tel. FOrest 2-3586)
Plant Mgr.: Thayer Rudd
Sales Mgr.: Norman J. Egli M

ALLEGHENY LUDLUM STEEL CORP.
Oliver Bldg., Pittsburgh 22, Pa. (Tel. COurt 1-5300)
V. P.-Purch.: L. H. Bittner
V. P.-Sales: W. B. Pierce M

H. D. ALLEN MFG.
3201 Casitas Ave., Los Angeles 39, Calif. (Tel. NOrmandy 1-6961)
Purch. Agent: H. D. Allen
Dir.-Sales: S. Allen S, RD

***R. C. ALLEN AIRCRAFT INSTRUMENT DIV., R. C. ALLEN BUSINESS MACHINES, INC.**
333 Commerce Ave., S. W., Grand Rapids 2, Mich. (Tel. GLendale 6-8541)
Purch. Agent: H. Vern Frielink
Div. Mgr.: G. T. Harrison
Chief Engr.: Ralph H. Johnston
Sales Mgr.: T. J. Wilson, Jr. G
*(See advertisement this issue)

ALLEN AIRCRAFT PRODUCTS, INC.
Ravenna, O. (Tel. AX 6-9621)
Purch. Agent: Russ Lengs
Sales Mgr.: Wm. H. Salladay PS, MS

ALLEN ELECTRIC & EQUIPMENT CO.
4101 N. Pitcher St., Kalamazoo, Mich. (Tel. FIreside 5-8531)
Dir.-Purch.: J. E. Donahue
Gen. Sales Mgr., Govt. & Indsl. Div.: W. L. McMichael CT

ALLEN MFG. CO.
Drawer 570, Hartford 1, Conn. (Tel. CH 2-8511)
Purch. Agent: Wm. A. MacDonald
V. P.-Sales: W. D. Horner PS

ALLENAIR CORP.
255 E. Second St., Mineola, N. Y. (Tel. Ploneer 7-5450)
Dir.-Purch.: A. K. Allen
Sales Mgr.: A. C. Kelly

ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV.
40 Rector St., New York 6, N. Y. (Tel. HAnover 2-7300)
Dir.-Purch.: W. B. Machmer, Jr.
Mgr.-Purch.: J. A. Simpson
Sales Mgr.: G. T. Stribling

ALLIED CHEMICAL CORP., NATIONAL ANILINE DIV.
40 Rector St., New York 6, N. Y. (Tel. HAnover 2-7300)
Sales: P. L. Oertel

ALLIED CHEMICAL CORP., NITROGEN DIV.
40 Rector St., New York 6, N. Y. (Tel. HAnover 2-7300)
Purch. Agent: L. L. Nance
V. P.-Sales: M. E. Hunter RD

ALLIED CONTROL CO., INC.
2 E. End Ave., New York 21, N. Y. (Tel. BUtterfield 8-7403)
Purch. Agent: C. A. Jeckel
Purch. Agent: Carl Holland, Plantsville, Conn. (Tel. MArket 8-9654)
Gen. Sales Mgr.: Edward Bachorik

ALLIED DECALS, INC.
20700 Miles Ave., Cleveland 28, O. (Tel. GReenwood 5-1500)
Dir.-Purch.: Raymond L. Saks
V. P.-Sales: Alfred L. Matyi M

ALLIED ENGRAVING & STAMPING CO.
701 Seneca St., Buffalo 10, N. Y. (Tel. CL 3725)
Pres.: D. Karnofsky S

ALLIED INTERNATIONAL CO.
230 Park Ave., New York 17, N. Y. (Tel. MU 9-6126)
Dir.-Purch.: Ed Nemeth
Sales Mgr.: Lyman Bullard M, G, CT

ALLIED PLASTICS SUPPLY CORP.
75 Cliff St., New York 38, N. Y. (Tel. BEekman 3-7377)
Pres.-Sales: Morton B. Mavrick
V. P.-Purch.: Raymond O. Vetter M

ALLIED PRECISION PRODUCTS, INC.
600 San Christopher St., Dunedin, Fla. (Tel. 81-5311)
Pres.: B. C. Skinner
V. P.: Ben Skinner

ALLIED PRODUCTS CORP.
12677 Burt Rd., Detroit 23, Mich. (Tel. KE 2-8600)
Purch. Agent: W. H. Hetrick
Buyer: C. Murdock
Sales Engr.: W. L. Culligan M

ALLIED RESEARCH ASSOCIATES, INC.
43 Leon St., Boston 15, Mass. (Tel. GArrison 7-2434)
Purch. Mgr.: Martin Granville
Buyer: James McGuire
V. P.: Norman Buchbinder
Mgr., Development Planning: A. R. Seville
S, PS, MS, M, G, CT, TT, RD, HSE

ALLIED RESEARCH & ENGRG., DIV.-ALLIED RECORD MFG. CO.
6916 Santa Monica Blvd., Hollywood 38, Calif. (Tel. HOllywood 2-1251)
Purch. Agent: Jack Kalk
Sales Mgr.: Bruce C. Jones S, G, RD

ALLIED RESEARCH PRODUCTS, INC.
4004 E. Monument St., Baltimore 5, Md. (Tel. PE 2-9070)
Purch. Agent: H. C. Quast
V. P.-Sales: J. A. Cairns
Buyers: C. J. Reilly & B. F. Monroe, Detroit, Mich. (Tel. TU 3-0100) M

ALLIED WITAN CO. INC.
12500 Bellair Rd., Cleveland 35, O. (Tel. WInton 1-2800)
Purch. Agent: S. J. Gibel
Sales Mgr.: George Gibel MS, CT

ALLIES' PRODUCTS CORP.
P. O. Box 188, Kendall Branch, Miami 56, Fla. (Tel. CEdar 5-5424)
Sales Mgr.: Miss Hazel I. Brown

ALLIS-CHALMERS
Milwaukee 1, Wisc. (Tel. SPring 4-3600)
Dir.-Purch.: K. R. Geist
Dir.-Sales: C. W. Schweers M

ALLISON DIV., GENERAL MOTORS CORP.
P. O. Box 894, Indianapolis, Ind. (Tel. CHapel 4-1511)
Purch. Agent: C. A. Osborne
Mgr., Aircraft Sales & Contracts: William O. Watson
PS, MS, M, RD

ALLISON LABS. INC.
11301 E. Ocean Ave., La Habra, Calif. (Tel. OWen 1-0115)
Chief Engr.: D. E. O'Donnell RD

ALLISON STEEL MFG. CO.
19th Ave. & SP Tracks, P. O. Box 6067, Phoenix, Ariz. (Tel. ALpine 8-7731)
Purch. Agent: L. M. Farr
Sales Mgr.: E. J. Peake S, MS

ALLISON-CAMPBELL DIV., AMERICAN CHAIN & CABLE CO., INC.
929 Connecticut Ave., Bridgeport, Conn.

ALLMETAL SCREW PRODUCTS CO., INC.
821 Stewart Ave., Garden City, L. I., N. Y. (Tel. Pioneer 1-1200)
Dir.-Purch.: P. Fishman
Purch. Agent: J. Segal
Buyer: F. Risteyn
Sales Mgr.: S. R. Marsh M

ALLOY BELLOWS INC.
18123 Roseland Rd., Cleveland 12, O. (Tel. IVanhoe 6-3990)
Dir.-Purch.: J. T. Kanuch
Pres.: R. W. Pettersson M, RD

***ALLOY METALS CO.**
10621 Capital Ave., Oak Park 37, Mich.
Sales Mgr.: M. R. Gilman
*(See advertisement this issue)

ALLOY PRODUCTS CORP.
1045 Perkins Ave., Waukesha, Wis. (Tel. LIberty 2-6604)
Purch. Agent: R. J. Hess
V. P.-Sales: W. J. Wachowitz, Jr. S

ALLOY STEEL PRODUCTS CO.
1300 W. Elizabeth Ave., Linden, N. J. (Tel. WAbash 5-4600)
Purch. Agent: R. Giles
Gen. Sales Mgr.: R. E. Boller, Jr. MS

ALLOYD CORP., THE
35 Cambridge Pkwy., Cambridge 42, Mass. (Tel. UNiversity 8-6900)
Purch. Agent: Hillard Morgan
Tech. Service: Nicholas Doyle, Jr.
Controller: Cosmo Camoscio
Dir.-Sales: R. L. McLaughlin M, RD

ALLOYS UNLIMITED INC.
21 — 09 43rd Ave., Long Island City 1, N. Y. (Tel. STillwell 6-4480)
Purch. Agent: Jerome Blaho
V. P.-Sales: G. S. Coleman M, RD

ALL-STATE WELDING ALLOYS CO., INC.
249 Ferris Ave., White Plains, N. Y. (Tel. WH 8-4646)
Purch. Dir.: Charles J. Oleson
Pres.: Thomas D. Nast
Gen. Sales Mgr.: Lee S. Wade M

ALL-TRONICS, INC.
45 Bond St., Westbury, N. Y. (Tel. EDgewood 3-3090)
Purch. Agent: Theodore Silvia
Sales Mgr.: Stephen E. Bullock, Jr.
Pres.: Harold P. Westman, Jr. M, CT

ALPAR MFG. CORP.
220 Demeter St., Palo Alto, Calif. (Tel. DAvenport 6-8105)
Purch. Agent: C. R. Parmenter
Sales Mgr.: R. V. Laustrup S

ALPHA METALS, INC.
60 A Water St., Jersey City 4, N. J. (Tel. HEnderson 4-6778)
Field Mgr.: Martin A. Boyle M

ALPHA MOLYKOTE CORP., THE
65 Harvard Ave., Stamford, Conn. (Tel. FI 8-3724)
V. P.-Purch.: C. E. Sonntag
Dir.-Sales: David M. Noltie M

ALPHA WIRE CORP.
200 Varick St., New York 14, N. Y. (Tel. ALgonquin 5-5400)
Purch. Agent: Sheldon Ellenoff
Asst. Purch. Agent: John Gallagher
Dir.-Sales: Jack Kirschbaum
S, PS, MS, M, G, CT, TT, RD, HSE

ALPINE ELECTRONIC COMPONENTS, INC.
Wolcott Rd., Waterbury, Conn. (Tel. PLaza 7-1449)
Pres.: Thomas E. Rowlison
V. P.-Sales: Richard H. Sceery TT

ALPITEC, INC.
49 Gleason Ave., Stamford, Conn. (Tel. FIreside 8-7788)
Pres.: P. Piter
Dir.-Sales: I. Peters S, G, CT, TT, RD

ALSOP ENGRG. CORP.
Mill St., Milldale, Conn. (Tel. MArket 8-9661)
Purch. Agent: John F. Beatson
Gen. Mgr.: Raymond F. Harland M

ALTAIR INC.
19 Hillside Ave., Terryville, Conn. (Tel. LUdlow 3-1343)
Purch. Agent: L. E. Odell
Sales Mgr.: J. J. Mancusi, Jr. S, MS, G

ALTAMIL CORP.
225 Oregon St., El Segundo, Calif. (Tel. EAstgate 2-5520)
Divisions: Tullahoma, Tenn., Martinsville & Brazil, Ind.
V. P.-Sales: B. P. Gibbons

ALTHOR PRODUCTS
2301 Benson Ave., Brooklyn 14, N. Y. (Tel. ESplanade 3-7444)
Purch. Agent: I. Thorn
Sales Mgr.: J. Kessler M

ALTO SCIENTIFIC CO., INC.
855 Commercial St., Palo Alto, Calif. (Tel. DAvenport 1-3434)
Purch. Agent: Miss V. Barrett
Gen. Mgr.-Sales: David Cherry CT, RD

ALUMINIUM LIMITED SALES, INC.
630 Fifth Ave., New York 20, N. Y. (Tel. JUdson 6-5120)
Sales Mgr.: Robert E. Young M

ALUMINUM ALLOYS CORP.
6650 W. Walton, Detroit 10, Mich. (Tel. TYler 8-5300)
V. P. & Gen. Mgr.: Stanley R. Day S, PS, MS, G

ALUMINUM CO. OF AMERICA
1501 Alcoa Bldg., Pittsburgh 19, Pa. (Tel. ATlantic 1-4545)
V. P.-Purch.: R. O. Keefer
Gen. Purch. Agent: T. O. English
Asst. Gen. Purch. Agent: L. B. Neubert
V. P.-Sales: R. B. McKee M, RD

ALVO NUT & BOLT CO. INC.
1601 Grande Vista, Los Angeles 23, Calif. (Tel. ANgelus 2-5131)
Dir.-Purch.: R. E. Miller
Purch. Agent: B. Pantel
Sales Mgr.: D. Smith

ALWAC COMPUTER, DIV.-EL-TRONICS INC.
13040 S. Cerise Ave., Hawthorne, Calif. (Tel. OR 8-5774)
Buyer: L. Rusth
Gen. Sales Mgr.: C. A. Pena CT

AMATOM ELECTRONIC HARDWARE CO. INC.
88 Drake Ave., New Rochelle, N. Y. (Tel. BEverly 5-4441)
Asst. to Pres.: R. Mazzulli
Buyer & Stock Control Ch.: C. Damore
V. P.-Sales: N. D. Frank MS, M, CT

AMBROID CO. INC.
Box 30, Weymouth 88, Mass. (Tel. EDgewater 5-6658)
Sales & Adv. Mgr.: A. E. Laneau
V. P.-Purch.: Lee L. Blyler M

AMCEL PROPULSION INC.
Box 3049, Asheville, N. C. (Tel. ALpine 3-6464)
Gen. Accountant: Frank G. Roberts, Jr.
Contract Relations Mgr.: Henry A. Kitselman, Jr.
PS, M, RD

AMCHEM PRODUCTS INC.
Brookside Ave., Ambler, Pa. (Tel. MItchell 6-1700)
Dir.-Purch.: E. A. Snyder
Purch. Agent: W. M. Wilson
Dir.-Mktg.: J. O. J. Shellenberger M

AMCO ENGRG. CO.
7333 W. Ainslie St., Chicago 31, Ill. (Tel. UN 7-8500)
Purch. Agent: Gary Fredericks
Sales Mgr.: Robert C. Komarek S

AMERAC INC.
Dunham Rd., Beverly, Mass. (Tel. WAlker 2-8610)
Buyer: Edward J. Bernard
Treas.: E. A. Hoggard CT, RD

AMERICAN AEROPHYSICS CORP.
6824 Brynhurst, Los Angeles 43, Calif. (Tel. PL 3-1148)
Dir.-Purch.: Norman Singer
Purch.: Bill Blackmore
Dir.-Sales: C. B. Spratt

AMERICAN AGILE CORP.
P. O. Box 168, Bedford, O. (Tel. MO 2-6900)
Purch. Agent: V. S. Balogh
Exec. V. P. & Gen. Mgr.-Sales: C. F. Freeman
S, MS, M, RD

AMERICAN AIR FILTER CO., DEFENSE PRODUCTS DIV.
310 3rd St., Rock Island, Ill. (Tel. 8-9311)
Purch. Agent: M. L. Marlaire
Buyer: H. Martin
Sales: R. Andersen MS, RD

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

AMERICAN ALUMINUM CO.
230 Sheffield St., Mountainside, N. J. (Tel. ADams 3-3500)
Dir.-Purch.: E. B. Hayden
Exec. V. P.-Sales: M. H. Klausmann **M, RD**

AMERICAN BERYLLIUM CO.
P. O. Box 3142, Sarasota, Fla. (Tel. ELgin 5-5105)
Purch. Agent: George A. Adley **M**

AMERICAN BRAKE SHOE CO.
530 Fifth Ave., New York 36, N. Y. (Tel. OX 7-7000)
Purch. Agent: F. B. Newbert **S, MS, M, RD**

AMERICAN BRAKE SHOE CO., ENGINEERED CASTING DIV.
10 Mt. Read Blvd., Rochester 11, N. Y. (Tel. FAirview 8-1881)
Defense Prod. Mgr.: Richard A. Pinto
Sales V. P.: P. H. Clapp **S, PS, MS, M, RD**

AMERICAN BRAKE SHOE CO., KELLOGG DIV.
97 Humboldt St., Rochester 9, N. Y. (Tel. BUtler 8-2020)
Purch. Agent: D. S. Judd
Asst. V. P.-Sales: R. N. Crossley **M**

AMERICAN BRASS CO., THE
414 Meadow St., Waterbury 20, Conn. (Tel. PLaza 4-1121)
Gen. Purch. Agent: E. A. Lane
Gen. Sales Mgr.: E. B. Tracy **M**

AMERICAN BRAZING ALLOYS CORP.
P. O. Box 11, Pelham, N. Y. (Tel. MO 4-5858)
Sales Mgr.: Mike Ross **M**

AMERICAN CAR & FOUNDRY DIV., ACF INDUSTRIES, INC.
750 Third Ave., New York 17, N. Y. (Tel. YUkon 6-8600)
V. P.-Purch.: P. B. Hoyt
V. P.-Mktg.: J. E. Angst **S, PS, MS, RD**

AMERICAN CHAIN & CABLE CO., INC.
271 S. Pennsylvania St., Wilkes-Barre, Pa.

AMERICAN CHAIN DIV., AMERICAN CHAIN & CABLE CO., INC.
454 E. Princess St., York, Pa.

AMERICAN CONCERTONE, DIV.-AMERICAN ELECTRONICS, INC.
9449 W. Jefferson Blvd., Culver City, Calif. (Tel. UPton 0-7245)
Purch.: Larry Styrvoky
Magnetic Tape Recorder Appl. Engr.: K. M. Williamson **RD**

AMERICAN CONVEYOR CO.
2133 S. Christiana Ave., Chicago 23, Ill. (Tel. LAwndale 1-2144)
Purch. Agent: George J. Handa
Sales Engr.: D. C. Colletti **S**

AMERICAN CORD & WEBBING CO., INC.
374 Broadway, New York 13, N. Y. (Tel. BEekman 3-2326)
Pres.: J. Krauss
V. P.-Sales: R. H. Shapiro **M**

AMERICAN CYSTOSCOPE MAKERS, INC.
8 Pelham Pkwy., Pelham Manor, N. Y. (Tel. PE 8-4800)
Purch. Agent: F. J. Scotti
Dir.-Sales: R. V. Lange

AMERICAN DISTRICT TELEGRAPH CO.
155 Sixth Ave., New York 13, N. Y. (Tel. AL 5-0200)
Gen. Supvr., Materials & Mfg.: C. D. Ott
V. P.-Sales: A. E. Smith

AMERICAN ELECTRIC CABLE CO.
181 Appleton St., Holyoke, Mass. (Tel. JEfferson 9-9893)
Treas.-Purch.: M. A. Feinstein
Sales Mgr.: M. McIntyre **M**

AMERICAN ELECTRICAL HEATER CO.
6110 Cass Ave., Detroit 2, Mich. (Tel. TRinity 5-2505)
Purch. Agent: Helen Wilson
Pres.-Sales: Robert A. Kuhn

AMERICAN ELECTRONIC LABS., INC.
121 N. Seventh St., Philadelphia 6, Pa. (Tel. WAlnut 5-8780)
Head-Purch.: Seymour Kalos
Buyers: Jack Wojcik, William White
Sales Mgr.: Robert D. Freedman **CT, RD**

AMERICAN ELECTRONICS, INC.
1725 W. 6th St., Los Angeles 17, Calif. (Tel. DUnkirk 5-7401)
Mgr., Mktg. & Sales: Jack McNutt **MS, G, CT, TT, RD**

AMERICAN ELECTRONICS, INCORPORATED
9503 W. Jefferson Blvd., Culver City, Calif. (Tel. UP 0-5581)
Purch. Agent: W. Healy
Mgr., Customer Relations: Jack S. Gasaway **G**

AMERICAN ELECTRONICS, INC., ELECTRIC MACHINERY & EQUIPMENT DIV.
2112 N. Chico Ave., El Monte, Calif. (Tel. CUmberland 3-7151)
Purch. Agent: R. A. Haeuser
Asst. Purch. Agent: Al Glick
Sr. Buyer: Paul McDonough
Buyers: Sid Trowbridge & Frank O'Neil

AMERICAN ELECTRONICS, INC., INSTRUMENT DIV.
9503 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-5581)
Buyer: William F. Healey
Mktg. Service Adm.: Albert Izuel
Mgr.-Field Engrg. & Sales: Jack S. Gasaway

AMERICAN ELECTRONICS, INC., NUCLEAR DIV.
9459 W. Jefferson Blvd., Culver City, Calif. (Tel. UPton 0-5471)
Purch. Agent: Mary Wallin
Mktg. Mgr.: J. W. Ranftl **CT, RD**

AMERICAN ELECTRONICS, INC., TALLER-COOPER DIV. & DATA SYSTEMS DIV.
75 Front St., Brooklyn 1, N. Y. (Tel. UL 8-0500)
Purch. Agent: A. Fettig
Gen. Sales Mgr.: J. Zastro **MS, G, CT, TT, RD**

AMERICAN ELITE, INC.
48–50 34th St., Long Island City 1, N. Y. (Tel. STillwell 6-8713)
V. P.-Sales: Ben Jacobs **M**

AMERICAN FELDMUEHLE CORP.
11 W. 42nd St., New York 36, N. Y. (Tel. PE 6-9751)
Sales Engr.: M. H. Riep
Pres.: R. F. Wild

AMERICAN FELT CO.
11 Glenville Rd., Glenville, Conn. (Tel. JEfferson 1-8700)
Dir.-Procure.: K. R. Peattie
Gen. Purch. Agent: G. P. McShane
Gen. Sales Mgr.: R. Power Fraser **PS, MS, M, RD**

AMERICAN GAS FURNACE CO.
140 Spring St., Elizabeth, N. J. (Tel. EL 2-2120)
Purch. Agent: W. Mitterman
Sales Mgr.: F. C. Schaefer

AMERICAN GREASE STICK CO.
Muskegon, Mich. (Tel. 32-101)
Purch. Agent: C. W. Smith
Asst. Purch. Agent: L. E. Petty
Sales Mgr.: Leo S. Rosen

AMERICAN INSTITUTE FOR RESEARCH
210 Amberson Ave., Pittsburgh 32, Pa. (Tel. MUseum 1-3000)
Pres.: John C. Flanagan
Assoc. Dir.-Research: Harley O. Preston
Exec. Scientist: John D. Folley, Jr.
Sr. Res. Scientist: James W. Altman **HSE**

AMERICAN INSTRUMENT CO., INC.
8030 Georgia Ave., Silver Spring, Md. (Tel. JUniper 9-1727)
Purch. Agent: T. Good
Sales Mgr.: Harry Huck
Mktg.: Stanley Dosik **MS, CT**

AMERICAN INSULATOR CORP.
New Freedom, Pa. (Tel. GLen Rock 4211)
Purch. Agent: A. L. Bortner
Sales Mgr.: Barto L. Attig **M**

AMERICAN LADDER & SCAFFOLD CO., INC.
5505 N. W. 7th Ave., Miami, Fla. (Tel. PLaza 4-2663)
Pres.: Melvin Goldfein
Sales Mgr.: Ruth Brown **M**

AMERICAN LAFRANCE DIV.-STERLING PRECISION CORP.
100 E. LaFrance St., Elmira, N. Y. (Tel. RE 4-8181)
Dir.-Purch.: F. A. Rauh
V. P.-Sales: G. J. Halpin, Sr.

AMERICAN LATEX PRODUCTS CORP.
3341 W. El Segundo Blvd., Hawthorne, Calif. (Tel. OSborne 6-0141)
Purch. Agent: Norman Schaub
Sales Mgr.: G. M. Schmoeller **S, PS, MS, M, RD**

AMERICAN LAVA CORP.
Chattanooga 5, Tenn. (Tel. AMhurst 5-3411)
Purch. Agent: C. R. Hughes
Sales Mgr.: E. D. Bell

AMERICAN LEONIC MFG. CO.
3001 Walnut St., Westinghouse Bldg., Philadelphia 4, Pa. (Tel. BA 2-4452)
Dir.-Sales: Walter C. Koenig
Exec. V. P.-Purch.: R. Blumberg **M**

AMERICAN MACHINE & FOUNDRY CO.
7501 Natchez Ave., Niles 48, Ill. (Tel. Niles 7-7000)
Purch. Mgr.: R. Van Avera
New Programs Mgr.: D. L. Arenson **MS, RD, HSE**

AMERICAN MACHINE & FOUNDRY CO., GOVERNMENT PRODUCTS GROUP
1701 K St., N. W., Washington 6, D. C. (Tel. METropolitan 8-6505); 261 Madison Ave., New York 16, N. Y. (Tel. MUrray Hill 7-3100)
Mgr.-Customer Services: J. H. Blades **MS, M, CT, RD, HSE**

AMERICAN MACHINE & FOUNDRY CO., GREENWICH ENGRG. DIV.
11 Bruce Pl., Greenwich, Conn. (Tel. NOrmandy 1-7400)
Proc. Mgr.: S. R. Bradley
Asst. Proc. Mgr.: C. Arcularius
Purch. Supvr.: W. J. Dunn
Subcontract Supvr.: F. J. Farrell
Mgr., New Programs: J. N. Albaugh, Jr. **MS, TT, RD, HSE**

AMERICAN MEASUREMENT & CONTROL, INC.
240 Calvary St., Waltham 54, Mass. (Tel. TWinbrook 4-6212)
V. P.-Purch.: A. E. McCoy
Mktg. Mgr.: K. S. Knapton **MS, G, CT, RD**

AMERICAN MICROPHONE MFG. CO., DIV.–G–C TEXTRON ELECTRONICS
400 S. Wyman St., Rockford, Ill. (Tel. WOodland 8-9661)
Purch. Agent: George Kampmeier
Buyers: Stanley Anderson & Donald Bogdonas
Sales Mgr.: Dan O'Connell

AMERICAN MISSILE PRODUCTS CO., INC.
15233 Grevillea Ave., Lawndale, Calif. (Tel. OSborne 9-1401)
Purch. Agent: Sidney S. Jordan
Buyers: Charlotte Ward & Dorothy Cavenaugh
Sales Mgr.: Ruben H. Hundley **CT, TT, RD**

AMERICAN MONORAIL CO., THE
1111 E. 200th St., Cleveland 17, Ohio (Tel. IVanhoe 6-5000)
Dir.-Purch.: J. C. Roth
V. P.-Mktg.: C. L. Fell

AMERICAN NICKEL ALLOY MFG. CORP.
30 Vesey St., New York, N. Y. (Tel. COrtland 7-6420)
Asst. Secy.: W. B. Lobbenberg
Secy.: Albert Sulzbach **M**

AMERICAN OIL & SUPPLY CO.
238 Wilson Ave., Newark 5, N. J. (Tel. MA 2-0250)
Purch. Agent: W. M. Hoffmann
Sales Mgr.: W. O. Holleman **M**

AMERICAN OPTICAL CO.
461 Doughty Blvd., Inwood 96, L. I., N. Y. (Tel. CEdarhurst 9-8700)
Purch. Agent: J. Bender
Dir.-Sales: Howard Karp **S, MS, M, G, CT, TT, RD**

AMERICAN OPTICAL CO., INSTRUMENT DIV.
Optical Ave., Keene, N. H. (Tel. ELmwood 2-3202)
Purch. Agent: George Howarth
Sales Mgr.: W. E. Folland

AMERICAN OPTICAL CO., SAFETY PRODUCTS DIV.
96 Mechanic St., Dept. 4634D, Southbridge, Mass. (Tel. POrter 4-3211)
Dir.-Purch.: J. A. Choiniere
Buyers: R. G. Nichols & J. E. Larson
Sales Mgr.: J. T. Monahan **M, CT**

AMERICAN PAULIN SYSTEM
1524 S. Flower St., Los Angeles 15, Calif. (Tel. RIchmond 9-0013)
Dir.-Sales: Arch F. Munter

AMERICAN POTASH & CHEMICAL CORP.
3000 W. Sixth St., Los Angeles 54, Calif. (Tel. DUnkirk 2-8231)
Sr. Buyer: Howard A. Bell
Gen. Sales Mgr.: William M. Clines
V. P.-Mktg.: W. J. F. Francis **M, RD**

AMERICAN POTASH & CHEMICAL CORP., NATIONAL NORTHERN DIV.
3000 W. 6th St., Los Angeles 54, Calif. (Tel.

DUnkirk 2-8231)
West Coast Sales Mgr.: J. C. Venito
Purch. Dept., King St., West Hanover, Mass. (Tel. TRiangle 8-4776)
Gen. Mgr.: H. W. Yeagley
Purch. Agent: Manuel Gonsaleves
East Coast Sales Mgr.: A. T. Fuller
Dir.-Purch.: T. H. Wrigley (Tel. TRiangle 8-4770)
Mgr.-Tech. Services: A. T. Fuller, Jr. (Tel. TRiangle 8-4770) **PS, MS, M, RD**

AMERICAN POWER JET CO.
705 Grand Ave., Ridgefield, N. J. (Tel. WH 5-8203) **RD, HSE**

AMERICAN PRINTED CIRCUITS CO., INC.
104 Forrest St., Metuchen, N. J. (Tel. LIberty 8-5777)
V. P.-Purch.: Mrs. Betty M. Weaver
Dir.-Sales: Howard L. Toft **G, RD, HSE**

AMERICAN PRODUCTS MFG. CO.
8127-33 Oleander St., New Orleans 18, La.

AMERICAN RADAR COMPONENTS INC.
415 E. Main St., Denville, N. J. (Tel. OAkwood 7-5530)
Dir.-Purch.: John P. Hundley

AMERICAN RECTIFIER CORP.
95 Lafayette St., New York 13, N. Y. (Tel. WOrth 6-3350)
Pres.: Samual Heller, P. E.
Prod. Dept.: William Bellotti
Sales Mgr.: V. R. Goldsmith **MS, CT, RD**

AMERICAN RESEARCH CORP.
Rt. 6, Farmington, Conn. (Tel. ORchard 7-2693)
Dir.-Purch.: Ted Augustyn
Dir.-Sales: Jack Shamroth **RD**

AMERICAN RESEARCH & MFG. CORP.
920 Halpine Ave., Rockville, Md. (Tel. HAzelwood 7-7116)
Purch. Agent: Robert J. Taylor
Chief, Planning & Dev.: George A. Beiser **S, MS, CT, RD**

AMERICAN ROCKET CO.
P. O. Box 1112, Wyandotte, Mich. (Tel. LOgan 5-3408)
Pres.: Alfred J. Zaehringer

AMERICAN SCREW CO.
1680 W. Main St., Willimantic, Conn. (Tel. HArrison 3-6331)
Purch. Agent: Wallace A. Smedley
Buyer: J. Grant Tuttle
Gen. Sales Mgr.: J. J. Coy

AMERICAN SILVER CO., INC.
36-07 Prince St., Flushing 54, N. Y. (Tel. FLushing 3-8012)
Purch. Agent: Mrs. N. Sullivan
Sales: M. Sherman **M**

AMERICAN SMELTING & REFINING CO.
120 Broadway, New York 5, N. Y. (Tel. REctor 2-9500)
V. P.-Purch.: F. H. Eichler
V. P.-Sales: S. D. Strauss **M**

AMERICAN SOLDER & FLUX CO.
19th & Willard Sts., Philadelphia, Pa. (Tel. BAldwin 6-1800)
Gen. Mgr.: M. H. Matz
Sales Mgr.: J. J. McBride

AMERICAN SPEEDLIGHT CORP.
63-01 Metropolitan Ave., Middle Village 79, N. Y. (Tel. EMpire 6-3000)
Purch. Agent: Pat Tagariello
Sales Mgr.: Howard Warner **TT, RD**

AMERICAN STANDARD INDUSTRIAL DIV.
Detroit 32, Mich. (Tel. WEbster 3-9665)
Dir.-Purch.: John J. Rich
V. P.-Mktg.: John F. Tobin
Purch. Agent: Bert Becker, Columbus 7, Ohio (Tel. HIckory 3-6561)
Buyer: Bruce Drumm (Tel. HIckory 3-6561) **MS**

AMERICAN STANDARD PRODUCTS, INC.
3030 Main St., Hartford, Conn. (Tel. CHapel 9-7707)
Purch. Agent: Bernard Cantor
Sales Mgr.: William B. Lindholm
Buyer: George Nelson

***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Hohman & Hoffman Sts., Hammond, Ind. (Tel. WEstmore 1-1900)
Purch. Agent: D. L. Koontz
Asst. Purch. Agent: Gerrit Huitsing
Buyer: Joseph Yosai
Sales Mgr.: L. L. Phelps **MS**
*(See advertisement this issue)

AMERICAN STEEL & WIRE DIV.-UNITED STATES STEEL CORP.
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, O. (Tel. TOwer 1-2000)
Purch. Agent: R. W. Berrett
Prod. Planning & Dev. Div.-Aircraft & Missiles: H. F. Powders
V. P.-Sales: E. A. Murray

AMERICAN SUPER-TEMPERATURE WIRES, INC.
34 W. Canal St., Winooski, Vt. (Tel. UNiversity 2-9636)
Purch. Agent: Charles Bellmare
Sales Mgr.: Richard D. Hoyt, 195 Nassau St., Princeton, N. J. (Tel. WAlnut 4-4450) **M**

AMERICAN THERMO ELECTRIC CO.
1023 N. Fuller Ave., Los Angeles 46, Calif. (Tel. HOllywood 4-1632)
Purch. Agent: A. Levy

AMERICAN TOOL CO.
205 E. Water St., Kalamazoo, Mich. (Tel. FIreside 5-6191)
Purch. Dept.: Ivan J. King & Wadsworth Bissell
Plant Mgr.: Harry J. Johnson **PS**

AMERICAN TRADAIR CORP.
3401 30 St., Long Island City 6, N. Y. (Tel. EMpire 1-1414)
Sales Mgr.: C. R. Beaton **M, RD**

AMERICAN TUBE BENDING CO., INC.
5 Lawrence St., P. O. Box 1841, New Haven 8, Conn. (Tel. STate 7-2131)
Purch. Agent: William Ulrich
Sales Mgr.: Charles T. Novak

AMERICAN TUBING CO., INC.
2209 Chico Ave., El Monte, Calif. (Tel. CU 3-6587)
Gen. Mgr.: V. R. Powell
Sales Mgr.: C. E. Chamberlin **S, PS**

AMERICAN WELDING & MFG. CO., THE
534 Dietz Rd., Warren, O. (Tel. EXpress 3-2531)
Purch. Agent: C. A. Miller
Buyers: G. L. Madigan, R. E. Nelson & D. W. Parker
Sales Mgr.: Frank J. Shanaberg
Assts. to Sales Mgr.: V. H. Lake & Warren Gressle **S, PS, M**

B. C. AMES CO.
131 Lexington St., Waltham 54, Mass. (Tel. TWinbrook 3-0095)
Purch. Agent: B. C. Ames
Dir.-Sales: H. B. Kruse **RD**

AMGLO CORP.
4333 N. Ravenswood Ave., Chicago 13, Ill. (Tel. BUckingham 1-2727)
Purch.: C. M. Bobka **G, CT, TT**

AMOCO CHEMICALS CORP.
910 S. Michigan Ave., Chicago 80, Ill. (Tel. HArrison 7-8886)
Dir.-Purch.: G. A. Pangburn
Supvr.-Propellant: E. P. Easterday **PS**

AMPCO METAL, INC.
1759 S. 38th St., Milwaukee 46, Wisc. (Tel. MItchell 5-3750) **M**

AMPEREX ELECTRONIC CORP.
230 Duffy Ave., Hicksville, N. Y. (Tel. WElls 1-6200)
Purch. Agent: Arnold Fricke
Gen. Sales Mgr.: Frank Randall **M**

AMPERITE CO. INC.
561 Broadway, New York 12, N. Y. (Tel. CAnal 6-1446)
Gen. Mgr.: S. Ruttenberg
Asst. Mgr.: T. Whalen
Sales: E. Repetti

AMPEX DATA PRODUCTS CO.
934 Charter St., Redwood City, Calif. (Tel. EMerson 9-7111)
Purch. Agent: James Walsh
Assistants: Frank Masi & Dave Viergiver
Mgr.-Mktg., Computer Products Div.: Russell Dubois
Mgr.-Mktg., Instrumentation Prod. Div.: Gene Rogers **MS, CT, TT, RD, HSE**

AMPEX MAGNETIC TAPE PRODUCTS
P. O. Box 190, Opelika, Ala. (Tel. SHerwood 5-7643)
Purch. Agent: Thad McEachin
Mktg. Mgr.: J. Reynolds Carey

AMPHENOL CABLE & WIRE DIV., AMPHENOL-BORG ELECTRONICS CORP.
S. Harlem Ave. at 63rd St., Chicago 38, Ill. (Tel. BIshop 2-1000)
Purch. Agent: Arthur B. Geiger
Sales Mgr.: Robert W. Felber

AMPHENOL WESTERN DIV., AMPHENOL-BORG ELECTRONICS CORP.
9201 Independence Ave., Chatsworth, Calif. (Tel. DIamond 1-0710)
Buyer: Robert Brady
District Sales Mgr.: John Koys

AMPHENOL-BORG ELECTRONICS CORP.
1830 S. 54th Ave., Chicago 50, Ill. (Tel. BIshop 2-1000)
Purch. Mgr.: John B. Leahy
Sales Mgr.: Herbert F. Motz **S, PS, MS, G**

AMPLEX DIV.-CHRYSLER CORP.
P. O. Box 2718, Detroit 31, Mich. (Tel. WAlnut 1-6733)
Sales Mgr.: W. L. Martin

AMTHOR TESTING INSTRUMENT CO., INC.
45 Van Sinderen Ave., Brooklyn 7, N. Y. (Tel. DIckens 6-8841)
Sales Mgr.: Al Littmann **M**

ANACHROME DIV., ANADITE, INC.
10647 S. Garfield Ave., South Gate, Calif. (Tel. SPruce 3-4140)
Dir.-Sales: Ron Cunningham

ANACONDA METAL HOSE DIV., THE AMERICAN BRASS CO.
698 S. Main St., Waterbury 20, Conn. (Tel. PLaza 4-1121)
Sales Mgr.: W. B. Hammond
Div. Purch. Agent: W. S. Edwards **MS**

ANACONDA WIRE & CABLE CO.
25 Broadway, New York 4, N. Y. (Tel. HAnover 2-6300)
Gen. Purch. Agent: W. I. Westlake
V. P.-Mktg. & Sales: J. L. Tindale
Mgr.-Sales, Govt. Agencies: W. T. Smith **M, RD**

ANADITE INC.
10630 Sessler St., South Gate, Calif. (Tel. SPruce 3-4210)
Purch. Agent: Clarence Edwards
Dir.-Sales: Ron Cunningham

ANAHEIM ELECTRONICS DIV., ELECTRONIC ENGRG. CO. OF CALIF.
1601 E. Chestnut St., Santa Ana, Calif. (Tel. KI 7-5501)
Purch. Agent: Arthur Harman
Div. Mgr.: R. T. Arnold
Sales Mgr.: W. R. McQuiston **MS, CT, RD**

ANALOGUE CONTROLS, INC.
200 Frank Rd., Hicksville, N. Y. (Tel. OVerbrook 1-7300)
Dir.-Purch.: Abe Barbanel
Sales Mgr.: Jerome E. Levine **MS, G, TT, RD**

ANALYTICAL INSTRUMENTS, INC.
R. F. D. 2, Cedar Lake, Bristol, Conn. (Tel. Bristol, LUdlow 2-6941)
Pres.: James G. McClure

ANALYTICAL MEASUREMENTS, INC.
585 Main St., Chatham, N. J. (Tel. MErcury 5-7474)
Pres.: Frank G. Paully **CT**

ANCHOR COUPLING CO. INC.
342 N. Fourth St., Libertyville, Ill. (Tel. EMpire 2-1360)
Sales Mgr.: J. D. Luebkeman

ANCHOR FENCE DIV.-ANCHOR POST PRODUCTS, INC.
6500 Eastern Ave., Baltimore 24, Md. (Tel. MEdford 3-6500)
Purch. Agent: G. Wist
V. P.-Prod.: J. C. Case
V. P.-Sales: R. R. Brannan

ANCHOR METAL CO. INC.
966 Meeker Ave., Brooklyn, N. Y. (Tel. ST 2-7090)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch.: Walter R. Cole, Edwin Kent
Sales: H. Drapkin

ANCHOR METAL SPINNING CO., THE
46 Fluhart Ave., Dayton 8, O. (Tel. BAldwin 8-2107)
Purch. Agent: M. Robertson
Engr.: A. Saldoff
Sales Mgr.: William Semmelman **S, MS, RD**

ANCHOR PACKING CO., THE
401 N. Broad St., Philadelphia 8, Pa. (Tel. WAlnut 2-1343)
Secy.-Treas.: J. H. Maston
Gen. Sales Mgr.: B. B. Reagon (Tel. Harrison 7-5432, Chicago) **M**

ANCHOR PLASTICS CO., INC.
36-36 36th St., Long Island City 6, N. Y. (Tel. RAvenswood 9-1494)
Pres. & Sales Mgr.: R. A. Fisch **M**

ANCHOR SPECIALTY MFG. CO. INC.
300 Hollister Rd., Teterboro, N. J. (Tel. AT 8-1939)
Purch.: Wm. Zablocky **RD**

ANDERSEN LABS. INC.
501 New Park Ave., West Hartford 10, Conn. (Tel. ADams 6-1281)
Purch. Agent: Don Chase
Asst. Gen. Mgr.: H. W. Stewart **RD**

ANDERSON AIRCRAFT CO.
Spring St., North Dighton, Mass. (Tel. VAn Dyke 4-8611)
Purch. Agent: Robert H. Leeming
Dir.-Sales: Albert Gramm **S**

ANDERSON CHEMICAL CO., DIV.-STAUFFER CHEMICAL CO.
Weston, Mich. (Tel. GEneva 6-2322)
Purch. Agent: G. D. Sharpe
Dir.-Sales: H. G. Deters **M, RD**

ANDERSON, GREENWOOD & CO.
5425 Rice Ave., Houston 36, Texas (Tel. MAdison 3-2343)
Purch. Agent: C. J. Scallon (Tel. MAdison 3-8956)
Sales Mgr.: W. W. Hering **PS, MS, CT, RD**

ANDERSON OIL & CHEMICAL CO., INC.
P. O. Box 111, Portland, Conn. (Tel. DIamond 7-2555)
Purch. Agent: Mrs. H. M. McLean
Gen. Mgr.-Sales: T. M. Purtell **M**

***ANDREW CORP.**
363 E. 75th St., Chicago 19, Ill. (Tel. TRiangle 4-4400)
Purch. Agent: John Cornyn
Sales Mgr.: C. Robert Lane **G, TT, RD**
*(See advertisement this issue)

***ANNIN CO., THE**
1040 S. Vail Ave., Montebello, Calif. (Tel. RAymond 3-9351)
Purch. Agent: N. A. Jacobs
Sales Mgr.: H. C. Earle, Jr.
*(See advertisement this issue)

R. B. ANNIS CO.
1101 N. Delaware St., Indianapolis 2, Ind. (Tel. ME 5-2838)
Purch. Agent: R. K. Caskey
Dir.-Sales: R. B. Annis **G**

***ANOCUT ENGRG. CO.**
631 W. Washington St., Chicago 6, Ill.
*(See advertisement this issue)

ARTHUR ANSLEY MFG. CO.
New Hope, Pa. (Tel. AXtel 7-2711)
Purch. Agent: Arthur C. Ansley **MS, G, CT, TT**

ANSONIA WIRE & CABLE CO., THE
111 Martin St., Ashton, R. I. (Tel. PAwtucket 6-6300)
Purch. Agent: Roland C. Genereux
V. P.-Indsl. Sales: John L. Marsh
V. P.-Govt. & Telephone Sales: Tilden E. Thompson **S, MS, M, CT, TT**

ANSUL CHEMICAL CO.
1 Stanton St., Marinette, Wisc. (Tel. REdwood 5-7411)
Tech. Dir.: A. B. Guise **M**

ANTARA CHEMICALS, DIV.-GENERAL ANILINE & FILM CORP.
435 Hudson St., New York 14, N. Y. (Tel. WAtkins 4-0600)
Mgr.-Purch.: S. Colman
Sales Mgr.: J. M. Cloney **M**

ANTENNA SPECIALISTS CO., THE
12435 Euclid Ave., Cleveland 6, O. (Tel. SWeetbriar 1-7878)
Purch. Agent: J. G. Freeh
Pres.: M. Friedberg

ANTI-CORROSIVE METAL PRODUCTS CO., INC.
P. O. Box 1894, Albany, N. Y. (Tel. PErshing 2-7711)
V. P.-Purch.: Frank Legnard
Pres.: B. T. Brennan **M**

ANTLAB INC.
6330 Proprietors Rd., Worthington, O. (Tel. TUxedo 5-5396)
Purch. Agent: Kenneth L. Riggle
Buyers: Odell H. Wellman & L. E. Dunbar
Pres.: Morris M. Robison **S, TT**

ANTON ELECTRONIC LABS., INC.
1226 Flushing Ave., Brooklyn 37, N. Y. (Tel. EVergreen 6-5715)
Purch. Agent: Bernard Neveloff
Dir.-Sales: George Weinman

APAHOUSER CORP. OF N. E.
1312 Boylston St., Boston 15, Mass. (Tel. KE 6-1223)
Purch. Agent: D. A. Ramler
Buyer: J. Berler
Sales Mgr.: Fred Gately

APEX MACHINE CO.
14-13 118th St., College Point 56, N. Y. (Tel. FL 8-2010)
Sales Mgr.: A. Robert Coningsby, Jr.

APEX MACHINE & TOOL CO., THE
P. O. Box 952, Dayton 1, O. (Tel. BAldwin 2-7871)
Purch. Agent: Elwood Meyer
Dir.-Sales: C. A. Lange **S, MS**

APEX REINFORCED PLASTICS, DIV.-WHITE SEWING MACHINE CORP.
Washington & Elm Sts., Cleveland 13, O. (Tel. CHerry 1-7834)
Purch. Agent: John Clyne
Dir.-Research & Sales: William Patterson **PS, MS, RD**

APEX TOOL CO., INC., THE
325 Cherry St., Bridgeport 5, Conn. (Tel. ED 4-6121)
Pres.: A. W. Anderson
Engr.: R. J. Burandt

APPLIED DESIGN CO.
2465 Sheridan Dr., Tonawanda (Buffalo), N. Y. (Tel. ATwater 9000)
Purch. Agent: D. J. Stanish
V. P.-Contracts: H. E. Hill **S, MS, M, RD**

APPLIED DYNAMICS CORP.
330 Bear Hill Rd., Waltham 54, Mass. (Tel. TWinbrook 4-7010)
V. P.-Purch.: R. G. Ahlquist
Sales Mgr.: B. J. Warren **MS, CT**

APPLIED ELECTRONICS CORP. OF N. J.
22 Center St., Metuchen, N. J. (Tel. LIberty 9-1500)
Purch. Agent: Henry Setzer
Sales Mgr.: Taft Russell **G, CT, TT, RD**

APPLIED PHYSICS CORP.
2724 S. Peck Rd., Monrovia, Calif. (Tel. HIllcrest 6-7181)
Mgr.-Materiel: Scott Metcalf
Dir.-Sales: Robert W. Moulton **RD**

APPLIED RADIATION CORP.
2404 N. Main St., Walnut Creek, Calif. (Tel. YEllowstone 5-2250)
Purch. Agent: Howard D. Layson
Dir.-Sales: S. A. Wenk **CT, RD**

APPLIED RESEARCH INC.
76 S. Bayles Ave., Port Washington, N. Y. (Tel. POrt Washington 7-8707)
Buyer: Ruth Seiter
Secy.-Treas.: N. M. Poulos **MS, G, RD**

APPLIED RESEARCH LABS., INC.
3717 Park Place, Glendale, Calif. (Tel. CHapman 5-5524)
Material Mgr.: J. D. McKim (Tel. CHurchill 9-6193)
Buyers: James Reddy & Donald Minton (Tel. CHurchill 9-6193)
Gen. Sales Mgr.: William E. Davis **CT, RD**

ARBEKA WEBBING CO.
1135 Roosevelt Ave., Pawtucket, R. I. (Tel. PA 6-5600)
V. P. & Gen. Mgr.: W. D. Cuthbertson, Jr. **M**

ARCAIR CO.
P. O. Box 431, Lancaster, Ohio (Tel. Olive 3-5618)
Office Mgr.: John Gaskins
Purch. Dept.: Pat Sullivan
Sales Mgr.: E. J. Lehmkuhl

ARCH GEAR WORKS INC.
97 Holmes St., North Quincy, Mass. (Tel. GR 1-9600) and 4336 E. 10th Court, Hialeah, Fla. (Tel. MUrray 8-2528)
Purch. Agent, Quincy: R. M. Allen
Purch. Agent, Hialeah: A. E. Carroll
Sales Mgr.: R. W. Gray (Tel. CEdar 5-5296)

ARCO CO., THE
7301 Bessemer Ave., Cleveland 27, O. (Tel. MIchigan 1-1170)
Purch. Agent: Lon Esther
Asst. Purch. Agent: George Otto
Sales Mgr.-Maintenance Sales: L. G. Olds
Sales Mgr.-Prod. Finishes: John French
Sales Mgr.-Structural Coatings: Dan G. Kloss **M**

ARDE-PORTLAND, INC.
75 Austin St., Newark 2, N. J. (Tel. BIgelow 8-8500)
Dir.-Purch.: Joseph Price
Dir.-Sales: Grady McKee **PS, RD**

ARDMORE PRODUCTS DIV., AMCO CORP.
1825 Shermer Rd., Northbrook, Ill. (Tel. CR 2-5000)
Operations Mgr.: Harold Cowley
Buyer: Joseph Kelly
Gen. Mgr.: E. J. Doyle, Jr. **MS**

ARENBERG ULTRASONIC LAB., INC.
94 Green St., Jamaica Plain 30, Mass. (Tel. JA 2-8640)
Pres.: David L. Arenberg **RD**

ARENS CONTROLS, INC.
2017 Greenleaf St., Evanston, Ill. (Tel. DAvis 8-4700)
Purch. Agent: Fred W. Green
Sales: William Buschart

ARIES LABORATORIES, INC.
225 Greenwich Ave., Stamford, Conn. (Tel. RAvenswood 9-9001)
Purch. Agent: H. Grisar
Sales Mgr.: W. Stern **M, RD**

ARISTOCRAT PLASTICS, INC.
23-25 Sussex Ave., Newark, N. J. (Tel. MItchell 3-6110)
Pres.: Arthur Meier

ARKAY ENGRG., INC.
1630 Euclid St., Santa Monica, Calif. (Tel. EXbrook 3-6959)
Chief Engr.: K. M. Rehler **CT, RD**

ARKWIN INDUSTRIES, INC.
648 Main St., Westbury, L. I., N. Y. (Tel. EDgewood 3-2640)
Purch. Agent: Hank Bauer
Contracts Admin.: Arnold Lowell
Sales Mgr.: Louis J. Smith **S, PS, MS, G, RD**

ARMA DIV., AMERICAN BOSCH ARMA CORP.
Roosevelt Field, Hempstead, N. Y. (Tel. Pioneer 2-2000)
Mgr.-Procurement: J. L. Krause
Corporate Dir.-Purch.: W. M. Maughan

ARMAMENT DIV., UNIVERSAL MATCH CORP.
472 Paul Ave., St. Louis 35, Mo. (Tel. JAckson 2-1620)
Dir.-Purch.: J. M. Darrow
Asst. Purch. Agent: John Wright
Sr. Buyer: R. D. Hays
Dir., Armament Div.: Walter Funk, Jr. **MS, G, CT, RD, HSE**

ARMATT, INC.
237 Oak St., P. O. Box 204, Glastonbury, Conn. (Tel. ME 3-9429)
V. P.-Purch.: Armand E. Lemieux
Pres.: Matthew F. Wilkas
Dir.-Sales: Charles Darling **RD**

ARMCO STEEL CORP.
703 Curtis St., Middletown, O. (Tel. GArden 2-2711)
Purch.: J. S. Thomas
Sales: W. B. Quail

ARMEL ELECTRONICS, INC.
840 Fifth Ave., Brooklyn 32, N. Y. (Tel. STerling 8-0422)
Purch. Agent: A. K. Niemi
Sales Mgr.: D. J. Gustafson **MS, G, CT, TT, RD**

ARMOUR ALLIANCE INDUSTRIES
16123 Armour St., N. E., Alliance, O. (Tel. TAlbot 1-3510)
Purch. Agent: H. M. Wilson, Jr.
Gen. Sales Mgr., Coated Abrasives Div.: R. L. Heiniger
Gen. Sales Mgr., Cushioning Prod. Div.: J. E.

Krausfeldt
Gen. Sales Mgr., Indsl. Adhesives Div.: W. K. Rich M

ARMOUR INDUSTRIAL CHEMICAL CO.
110 N. Wacker Dr., Chicago 6, Ill. (Tel. ANdover 3-5200)
Purch. Mgr.: Al Marvin
Dir.-Sales: B. W. Graham M, RD

ARMSTRONG-BLUM MFG. CO.
5700 W. Bloomingdale Ave., Chicago 39, Ill. (Tel. MErrimac 7-4000)
Purch. Agent: Francis A. Blum
Sales Mgr.: G. M. Hess

ARMSTRONG CORK CO.
W. Liberty St., Lancaster, Pa. (Tel. EXpress 7-0611)
Gen. Purch. Agent: M. L. Lampe
Asst. Gen. Purch. Agent: W. A. Abel
Gen. Sales Mgr.: W. B. Tucker M

ARMSTRONG PRODUCTS CO.
P. O. Box I-MG, Warsaw, Ind. (Tel. AMherst 7-3226)
Mgr.: F. E. Harrison M

ARNAV AIRCRAFT ASSOCIATES, INC.
32 Industrial Ave., Little Ferry, N. J. (Tel. HUbbard 9-8600)
V. P.-Purch.: M. A. Murray
Sales Mgr.: J. M. Muchmikoff
Mgr., West Coast Plant: H. Deets, 121 Main St., El Segundo, Calif. (Tel. EAstgate 2-4433) PS, MS

ARNO ADHESIVE TAPES, INC.
U. S. 20 at Ohio St., Michigan City, Ind. (Tel. TRiangle 4-3235)
Purch. Agent: R. L. Scholl
Sales Mgr.: D. W. Burke M

ARNOLD ENGRG. CO., THE
P. O. Box G, Marengo, Ill. (Tel. Chicago ANdover 3-6300; Marengo JOrdan 8-7251)
Purch. Agent: R. L. Pottinger
Buyer: J. Strain
V. P.-Sales: Benjamin Falk M

ARNOLD MAGNETICS CORP.
6050 W. Jefferson Blvd., Los Angeles 16, Calif. (Tel. VE 7-5313)
Buyer: Irene Bertini
Dir.-Sales: Jack Batte

ARNOLT CORP.
Warsaw, Ind. (Tel. AMhurst 7-7111)
Dir.-Purch.: Roger H. Davis
Purch. Agent: Carl D. Schultz
V. P.-Military Liaison: H. M. Henderson

***ARNOUX CORP.**
11924 W. Washington Blvd., Los Angeles 66, Calif. (Tel. UPton 0-5371)
Purch. Agent: George Pesner
Asst. Purch. Agents: Conrad Doerr & Ray Colbern
Dir.-Mktg.: Michael Dodak MS, G, CT, TT, RD
*(See advertisement this issue)

ARO EQUIPMENT CORP., THE
Enterprise & Trevitt Sts., Bryan, Ohio (Tel. 6-1161)
Purch. Supvr.: David Nixon
Buyers: Gail Smith & C. E. De Groff
Contracts Admin.: A. Austin MS, CT, RD, HSE

ARO, INC.
Arnold Air Force Sta., Tenn. (Tel. GL 5-2611)
Mgr.-Procurement: J. G. Crigler
Asst. Mgr.-Procurement: Charles M. Solomon RD

ARO-FIREWEL CO. INC., SUB.-THE ARO EQUIP. CORP.
3695 Broadway, Buffalo 25, N. Y. (Tel. REgent 0440)
Purch. Agent: Robert Saltzman
Buyer: Stanley Mazurkiewicz
Buyer-Expediter: Donald Flynn
V. P.-Aviation Sales: John G. Goodell RD, HSE

ARONSON MACHINE CO., INC.
Box 307, W. Main St., Arcade, N. Y. (Tel. 276)
Purch. Agent: Theodore Stokaylo
Buyer: George Karcanes
Gen. Sales Mgr.: Charles W. Dempsey MS

ARRO EXPANSION BOLT CO.
Box 388, Marion, Ohio (Tel. DU 3-1154)
Purch. Agent: Ray W. Coy
Sales Mgr.: John J. Dugan S

ARROW TOOL CO. INC.
36 Mill St., Wethersfield, Conn. (Tel. JAckson 9-2507)
V. P.-Purch.: David Dewhurst
Buyer: Joseph Burgess
Sales Mgr.: Robert E. Walsh MS, G, RD

ARROW-HART & HEGEMAN ELECTRIC CO., THE
103 Hawthorn St., Hartford 6, Conn. (Tel. CHapel 9-8471)
Purch. Agent: N. P. Belcourt
V. P.-Sales: F. L. Mathes

ARROWHEAD PRODUCTS, DIV.-FEDERAL-MOGUL-BOWER BEARINGS, INC.
2300 Curry St., Box 1890, Long Beach 1, Calif. (Tel. NEvada 6-0571)
Purch. Agent: Charles Smith
Sales: Arnold J. Dovey S, MS, RD, HSE

ART SPECIALTY CO.
3720 N. Milwaukee Ave., Chicago, Ill. (Tel. KIldare 5-6607)
Purch. & Sales: Robert Nattenberg

ART WIRE & STAMPING CO.
227 High St., Newark 2, N. J. (Tel. HUmboldt 4-2100)
Purch. Agent: Fred Riedmuller
Sales: Nils Johnson M

ARTISAN ELECTRONICS CORP.
171 Ridgedale Ave., Morristown, N. J. (Tel. JEfferson 8-8500)
V. P.-Purch.: Sheldon Masser
Sales Mgr.: Daniel Drench

ARTISAN METAL WORKS CO.
11400 Madison Ave., Cleveland 2, Ohio (Tel. LAkewood 1-6173)
Purch. Agent: W. D. Ford
Chief Estimator: P. Siliko
Pres.: D. A. MacRitchie

ARTRA ALUMINUM FOUNDRY & MFG. CO. INC.
202 Transit St., St. Charles, Mo. (Tel. RAndolph 4-1885)
Purch. Agent: Thomas Everson
Sales Engr.: William J. Becker M

ARWOOD CORP.
321 W. 44th St., New York 36, N. Y. (Tel. JUdson 2-4210)
Purch. Agent: F. W. Wacker
V. P.-Sales: William O. Sweeny S, PS, MS, G

ASHEVILLE-SCHOONMAKER MICA CO.
271 Church St., New York 13, N. Y. (Tel. WOrth 6-4550)
Purch. Agent: Joseph E. Sesny
Dir.-Sales: J. Fuller Brown

ASHLAND OIL & REFINING CO.
1409 Winchester Ave., Ashland Ky. (Tel. EAst 4-1111)
Dir.-Purch.: J. K. Barron
Purch.: J. S. Hannah, D. T. Dunn, Wilburn Caskey
V. P.-Sales: F. M. Moffitt

***ASKANIA-WERKE, U. S. BRANCH OFFICE**
4913 Cordell Ave., Bethesda, Md. (Tel. OLiver 4-6060)
Mgr.: Dr. Juergen Witthoeft TT
*(See advertisement this issue)

ASSEMBLY PRODUCTS, INC.
Wilson Mills Rd., Chesterland, O. (Tel. HAmilton 3-3131)
Purch. Agent: Robert Foltz
V. P.-Sales: Robert H. Pugsley CT

ASSOCIATED AMERICAN WINDING MACHINERY INC.
750 St. Ann's Ave., New York 56, N. Y. (Tel. CYpress 2-5050)
Chief Purch. Agent: B. Hammerman
Sales Mgr.: G. B. Franklin

ASSOCIATED CO., INC.
1441 S. McLean Blvd., Wichita 13, Kans. (Tel. HO 4-6379)
Purch. Agent: E. B. Long
Exec. V. P.-Sales: W. W. Grisamore S, MS

ASSOCIATED CONTROL EQUIPMENT, INC.
853 4th Ave., Coraopolis, Pa. (Tel. AMherst 4-8161)
Pres.: C. A. Dally

ASSOCIATED ENGRG. CORP.
65 Kent St., Brookline 46, Mass. (Tel. ASpinwall 7-4664)
Purch. Agent: L. R. Demarkles
Dir.-Sales: F. K. Chin M

ASSOCIATED ENGRG. & MFG. CORP.
210 M Stone House Rd., Glen Ridge, N. J. (Tel. PIlgrim 3-8899)
Dir.-Purch.: V. B. Fox
Mgr.: Frank Rhodes M

ASSOCIATED ENGINEERS, INC.
P. O. Box 1628, Springfield, Mass. (Tel. RE 4-6431)
Purch. Agent: A. E. Chalfin
Buyers: Harold Quigley, Lou Gelineau & Joe Kane
V. P.-Sales: John Flaskamper S, MS, G, CT, RD

ASSOCIATED GASKETS, INC.
P. O. Box 898, Riparian St., Bridgeport 1, Conn. (Tel. FOrest 6-4318)
V. P.-Purch.: Julian J. Kliolz
Sales Mgr.: John T. Hanusovsky

ASSOCIATED RESEARCH, INC.
3789 W. Belmont Ave., Chicago 18, Ill. (Tel. COrnelia 7-4040)
Purch. Agent: J. W. Bente
V. P.-Sales: Richard W. Inman CT

ASSOCIATED SPECIALTIES CO.
1751 Main St., Orefield, Pa. (Tel. EX 5-1275)
Purch. Agent: G. L. Allerton
Sales Mgr.: V. Laudenslager CT

ASSOCIATED SPRING CORP., OHIO DIV.
1825 E. First St., Dayton 3, Ohio (Tel. CLearwater 3-5135)
Purch. Agent: Raymond C. Chenoweth
Sales Mgr.: John B. Barr

ASSOCIATED SUPPLIERS CO.
2425 San Fernando Rd., Los Angeles 65, Calif. M

ASSOCIATED TECHNICAL SALES CO.
3629 N. Dixie Dr., Dayton 14, Ohio (Tel. CR 5-7441)
Dir.-Sales: Gerald A. Greene M

***ASSOCIATED TESTING LABS., INC.**
135 Clinton Rd., Caldwell, N. J. (Tel. CApital 6-7407)
Purch. Agent: Charles Guerriere
Dir.-Engrg.: William Tonkowich
Chief Product Engr.: John W. Fricke
Sales Mgr.-Engrg.: Bernard Novack MS, CT, HSE
*(See advertisement this issue)

ASTRA TECH
P. O. Box 988, 3014 S. Halladay St., Santa Ana, Calif. (Tel. KImberly 5-9477)
Dir.-Purch.: Stan Studebaker
Prod. Mgr.: Ralph Martin
Sales Mgr.: Jack Prebst MS, CT, RD

ASTRAVAC CORP.
1011-D Industrial Way, Burlingame, Calif. (Tel. DIamond 2-6048)
Pres.: P. A. Peller
Secy.-Treas.: M. B. Stern

***ASTRO-ELECTRONIC PRODUCTS DIV., RADIO CORP. OF AMERICA**
P. O. Box 800, Princeton, N. J. (Tel. WAlnut 4-2700)
Purch. Agent: H. W. Hutchinson
Mgr.-Mktg.: Barton Kreuzer TT, RD, HSE
*(See advertisement this issue)

ASTRON CORP.
255 Grant Ave., East Newark, N. J. (Tel. HUmboldt 2-7800)
Purch. Agent: George M. Sexton
Gen. Sales Mgr.: Irving I. Ser

RAYMOND ATCHLEY, INC.
2339 Cotner Ave., Los Angeles 64, Calif. (Tel. GR 9-8626)
Purch. Agent: Jack Syrus
Pres.: Raymond Atchley
Sales Mgr.: Jack Pegram RD

ATKINS & MERRILL, INC.
Boston Post Rd., South Sudbury, Mass. (Tel. HIlltop 3-8822)
Purch. Agent: Robert Johnson
Buyer: Lee Goodbar
Dir.-Model Sales: Donald L. Atkins
Dir.-Reinforced Plastics Sales: Arthur V. Boyce S, HSE

ATKOMATIC VALVE CO., INC.
545 W. Abbott St., Indianapolis 25, Ind. (Tel. MElrose 8-6545)
Treas.: Robert A. Morris
Sales Mgr.: Mark W. Lowe PS, MS, M

ATLANTIC METAL HOSE CO., INC.
308 Dyckman St., New York City 34, N. Y. (Tel. LOrraine 9-5400)
Purch. Agent: David M. Fuchs
V. P.-Sales: Edwin W. Driedger M, CT

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout &*Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

ATLANTIC RESEARCH CORP.
Shirley Hwy. at Edsall Rd., Alexandria, Va. (Tel. FLeetwood 4-3400)
Purch. Agent: Wilbur H. Smith
Purch. Agent-Subcontracts: Nigel Harlan
Mgr.-Development: Philip K. Reily **PS, M, RD**

ATLAS BRASS FOUNDRY
1901 Santa Fe Ave., Los Angeles 21, Calif. (Tel. MAdison 7-6695)
Secy.: K. A. Johnston
Pres.: R. F. Treuer **M**

ATLAS COIL INC.
63 Main St., Ansonia, Conn. (Tel. RE 5-4628)
Purch. Agent: Harold Kaye

ATLAS DROP FORGE CO.
209 W. Mt. Hope Ave., Lansing 4, Mich. (Tel. IV 4-5341)
Purch. Agent: A. O. Peterson
Sales Mgr.: F. Holland **M**

ATLAS ENGRG. CO. INC.
176 Blue Hill Ave., Roxbury, Mass. (Tel. HIghlands 5-7100)
Purch. Agent: John Ward
Sales Mgr.: Marshall Karesky **MS, M, G, RD**

ATLAS ENGRG. CORP.
26 Custer St., West Hartford 10, Conn. (Tel. CHapel 6-5651)
Pres.: R. C. Biggers

ATLAS INDUSTRIAL CORP.
849 39th St., Brooklyn 32, N. Y. (Tel. GE 5-5520)
Pres.: J. P. Reinhardt

ATLAS PRECISION PRODUCTS CO.
3801 Castor Ave., Philadelphia 24, Pa. (Tel. JEfferson 5-3700)
Purch. Agent: Robert States
Buyers: D. Wynkoop & E. Mingen
Gen. Sales Mgr.: James Kenny **G, CT, TT**

ATLAS SCREW & SPECIALTY CO.
450 Broome St., New York 13, N. Y. (Tel. NOrth 6-0600)
Purch. Agent: Irwin Koplan, 396 Jelliff Ave., Newark, N. J. (Tel. BIgelow 8-3000)
V. P.-Sales: V. J. Merz

ATLAS SOUND CORP.
1449 39th St., Brooklyn 18, N. Y. (Tel. GEdney 8-5500)
Purch. Agent: C. R. Blumenthal
Asst. Purch. Agent: J. Wansbury
Sales Mgr.: R. C. Reinhardt

ATLAS TACK CORP.
Fairhaven, Mass. (Tel. New Bedford, WY 7-9491)
Dir.-Purch.: J. A. McCarthy
Sales Mgr.: H. S. Callahan **M**

ATLEE CORP.
47 Prospect St., Woburn, Mass. (Tel. WEIls 3-5390)
Purch. Agent: Robert A. Joyce
Dir.-Mktg.: Dan E. Baker

ATTLEBORO REFINING CO., INC.
142 Union St., Attleboro, Mass. (Tel. CAstle 2-3705)
V. P.-Purch.: Edward F. Towle
V. P.-Sales: John H. Quebman **M**

AUBURN MFG. CO., THE
Stack St., Middletown, Conn. (Tel. DIamond 6-6631)
Purch. Agent & Sales Mgr.: M. B. Weiner **M**

AUBURN SPARK PLUG CO., INC.
89 York St., Auburn, N. Y. (Tel. 2-9501)
V. P.-Purch.: A. R. Nolin
Supt.: Leo Bates
Sales Mgr.: A. W. DeChard **PS**

AUDIO DEVICES, INC.
444 Madison Ave., New York 22, N. Y. (Tel. PLaza 1-6640)
Purch. Agent: Ellis Mays
V. P.-Sales: Bryce Haynes **TT**

AUDIO INSTRUMENT CO., INC.
135 W. 14th St., New York 11, N. Y. (Tel. ORegon 5-7820)
Sales Mgr.: C. J. LeBel

AUDIO-MASTER CORP.
17 E. 45th St., New York 17, N. Y. (Tel. OXford 7-0725)
Purch.: Herbert Rosen

AUGAT BROTHERS, INC.
33 Perry Ave., Attleboro, Mass. (Tel. 1-2202)
Purch. Agent: Raymond Piette
Sales: Robert S. Laurence **MS**

AUSTENAL CO., DIV.-HOWE SOUND CO.
224 E. 39th St., New York 16, N. Y. (Tel. OXford 7-5656)
Dir.-Purch.: Anne D. Repko
Sales Mgr.: R. L. Wiseman **PS**

AUSTENAL CO., DIV.-HOWE SOUND CO., MICROCAST PRODUCTS
224 E. 39th St., New York 16, N. Y. (Tel. OXford 7-5656)
Dir.-Purch.: Ann D. Repko
V. P.-Sales: Robert L. Wiseman **S, PS, MS**

AUSTIN-WESTERN, CONSTR. EQUIP. DIV.-BALDWIN-LIMA-HAMILTON CORP.
601 N. Farnsworth Ave., Aurora, Ill. (Tel. 7-8753)
Dir.-Purch.: J. D. McMakin
Asst. Gen. Mgr.-Sales: H. P. Lockhart **MS**

AUTO SPECIALTIES MFG. CO., INC.
St. Joseph, Mich. (Tel. YUkon 3-2521)
Dir.-Procurement: E. Millhouse
Asst. Dir.-Procurement: C. Miller
Chief Buyer: K. Bingham
Mgr.-Mil. Contracts: Harry A. Harter **PS, MS**

AUTO-CONTROL LABS., INC.
333 S. Hindry Ave., Inglewood 1, Calif. (Tel. ORegon 8-4934)
Purch. Agent: John Elledge
Sales Mgr.: John M. Buchwitz **MS, CT**

AUTOMATIC ELECTRIC SALES CORP.
Northlake, Ill. (Tel. FIIlmore 5-7111)
Gen. Purch. Agent: W. S. Cadwell
Pres.: D. H. Deaver **M**

AUTOMATIC RADIO MFG. CO., INC.
122 Brookline Ave., Boston, Mass. (Tel. CO 6-1420)
Dir.-Purch.: Frank Housman
Purch. Agent: Harry Rosenman
Material Coordinator: Leo Maltzman
Sales Mgr.: E. L. Housman **M**

AUTOMATIC SWITCH CO.
Hanover Rd., Florham Park, N. J. (Tel. FRontier 7-4600, New York City — DIgby 4-3765)
Purch. Agent: Harold W. Hyland
V. P.-Valve Sales: R. F. McCormick
V. P.-Switch Dept.: F. P. Spinelli **MS**

AUTOMATIC TIMING & CONTROLS, INC.
King of Prussia, Pa. (Tel. BRoadway 9-1100)
Dir.-Purch.: H. Seiple
Asst.: F. Mack
V. P.-Sales: W. W. Winters **MS, M, G, CT, RD**

AUTOMATION INDUSTRIES, INC.
401 E. Green St., Pasadena, Calif. (Tel. SY 3-8169)
Purch. Agent: Gale Bradley
Gen. Mgr.: R. E. Kleint
Chief Engr.: A. W. Crowell **M, RD**

AUTOMATION PRODUCTS, INC.
3030 Max Roy St., Houston 24, Tex. (Tel. UN 9-1485)
Purch. Agent: J. Neighbors
Sales Mgr.: Quin M. Baker

AUTOMETRIC CORP.
1501 Broadway, New York, N. Y. (Tel. BRyant 9-8700)
Mgr.-Mktg.: B. R. Ungerleider
Purch. Agent: Larry Rubin, 507 W. 33rd St., New York 1, N. Y. (Tel. PEnnsylvania 6-4200) **RD**

AUTOMOTIVE & AIRCRAFT DIV.-AMERICAN CHAIN & CABLE CO., INC.
601 Stephenson Bldg., Detroit 2, Mich. (Tel. TRinity 5-4104)
Purch.: H. C. Wendelcke, Adrian, Mich. (Tel. COlfax 5-8161)
V. P.-Sales Mgr.: Harry Williams **M**

AUTONETICS, DIV.-NORTH AMERICAN AVIATION, INC.
9150 E. Imperial Hwy., Downey, Calif. (Tel. SPruce 3-2233)
Dir.-Material: C. R. Raftery
Asst. to Dir.: S. D. Zemansky
Dir.-Mktg.: W. F. Hafstrom
Purch. Agent: H. L. Epperly, (Tel. NEwmark 2-5721) **M, CT, RD**

AUTOSCREW CO. INC.
216-222 W. 18th St., New York 11, N. Y. (Tel. WAtkins 9-1291)
Pres.: Henry C. Levi
Sales Mgr.: Thomas A. Dragos **M**

AUTOTRON, INC.
3629 N. Vermilion St., Danville, Ill. (Tel. HIckory 6-0650)
Pres.: Werner A. Gieseke

AUTOTRONICS INC.
Box 208, Florissant, Mo. (Tel. TEmple 7-3565)
V. P.-Purch. & Sales: E. F. White
Production Mgr.: A. F. Boaus
Chief Engr.: C. A. Jackson
Pres.: A. J. Thompson
Sales Mgr.: Art Lee **PS, G, TT, RD**

AUTO-VALVE INC.
1705 Guenther Rd., Dayton 27, O. (Tel. TEmple 7-4165)
Buyer: James R. Clark
Pres.: Anthony P. Barcus

AVCO CORP., CROSLEY DIV.
1329 Arlington St., Cincinnati 25, O. (Tel. KIrby 1-6600)
Dir.-Purch.: G. L. Schafstall
V. P.-Mktg., Defense Products: Dr. L. C. Maier, Jr.
Dir.-Mktg., Airborne Electronics & Fire Control: T. J. Michel
Dir.-Mktg., Missiles: T. M. O'Donnell
Dir.-Mktg., Ordnance: L. E. Beniter
Dir.-Mktg., Ground Electronics & Comm.: E. J. Hopley **S, MS, TT, RD**

AVCO CORP., NASHVILLE DIV.
Nashville 1, Tenn. (Tel. ALpine 4-9551)
Purch. Agent: D. C. Hergert
Gen. Mktg. Mgr.-Structures: Henry Ritter **S, M, RD**

AVCO CORP., RESEARCH & ADVANCED DEVELOPMENT DIV.
201 Lowell St., Wilmington, Mass. (Tel. OLiver 8-8915)
Mgr., Materials Control Dept.: Glenn W. Inman
V. P. & Tech. Dir.: Dr. J. A. Kyger
V. P.: Dr. C. J. Burton
Dir.-Mktg.: E. D. Kenna, Jr. **S, PS, MS, M, G, CT, TT, RD**

AVCO-EVERETT RESEARCH LAB.
2385 Revere Beach Pkwy., Everett 49, Mass. (Tel. DUnkirk 9-2300)
Materiel Mgr.: Harold Bloom

AVIATION INSTRUMENT MFG. CORP.
P. O. Box 12248, Houston 17, Texas (Tel. HUdson 4-2896)
Pres.: Everett L. Anderson
Prod. Mgr.: M. D. McDonald
Buyer: Robert Kenworthy
V. P.-Sales: C. C. Holt **G**

AVIATION TEXTILE ASSOCIATES
22125 Telegraph Hwy., Southfield, Mich.
V. P.-Purch.: H. W. Foster
Pres.: W. T. Greig **M, RD**

AVICA CORP.
Box 180, Newport, R. I. (Tel. VI 6-9100)
Mgr.-Purch.: Dana J. Mulholland
V. P.'s Purch.: Richard S. Weiss & Leo F. Gill
Sales Mgr.: Charles T. Dewick **S**

AVIEN, INC.
58-15 Northern Blvd., Woodside 77, N. Y. (Tel. YEllowstone 2-4600)
Mgr.-Purch.: Clifford Napolitano
V. P.: W. O. Boschen **MS, CT, RD, HSE**

AVION FOUNDRY CORP.
P. O. Box 395, Tarpon Springs, Fla. (Tel. VIctor 2-6633)
Pres.: E. R. Huneke

AVIONICS RESEARCH CORP.
111 E. Colonial Dr., Orlando, Fla. (Tel. GA 5-0547)
Div. Mgr.: Alan Drucker **PS, MS, G**

AVNET CORP.
5877 Rodeo Rd., Los Angeles 16, Calif. (Tel. UPton 0-6141)
Purch. Agent: Stanley Adler
V. P.-Sales: M. G. Newberger **MS, M, G, CT, RD**

AVO LTD.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Dir.-Sales: Si Bosworth

AVON TUBE DIV., HIGBIE MFG. CO.
Kinney St., Rochester, Mich. (Tel. OL 1-9671)
Purch. Agent: R. W. Robertson
Buyer: Jerry Andeson
V. P.-Sales: E. P. Robinson **M**

AVONDALE CO., THE
260 Happ Rd., Northfield, Ill. (Tel. AMB 2-0342)

Purch.: Paul Manning
Sales: H. N. Limback

AVONDALE MARINE WAYS, INC.
Box 1030, New Orleans 8, La. (Tel. UN 6-4561)
Purch. Agent: R. Perrin
V. P.-Engrg. & Sales: S. Stone
Gen. Sales Mgr.: R. Lamar Woodfin S

AVTRON MFG., INC.
10409 Meech Ave., Cleveland 5, Ohio (Tel. MI 1-8310)
Purch.: D. E. Conery
V. P.-Sales: A. F. Pelster MS, CT

AXEL ELECTRONICS, DIV.-AXEL BROS. INC.
134-20 Jamaica Ave., Jamaica 18, N. Y. (Tel. REpublic 9-1700)
Purch. Agent: Philip Rimland
Sales Mgr.: Joseph P. O'Donnell MS, CT, TT

B. & C. INSULATION PRODUCTS, INC.
490 Lincoln Hwy., Iselin, N. J. (Tel. LIberty 8-0815)
Gen. Mgr.: Bernard Sherman M

B & F INSTRUMENTS, INC.
3644 N. Lawrence St., Philadelphia 40, Pa. (Tel. GA 5-4175)
V. P.-Purch.: C. E. Stufflebeam
Sales Mgr.: Robert G. Ball MS, CT, RD

B G CORP., THE
321 Broad Ave., Ridgefield, N. J. (Tel. WHitney 5-8800)
Purch. Agent: Melville Miller
Asst. Purch. Agent: M. Barakat
Dir.-Sales & Engrg.: Robert W. Brattvet PS

B. H. AIRCRAFT CO., INC.
Eastern Parkway at Maplewood Ave., Farmingdale, L. I., N. Y. (Tel. CHapel 9-5000)
V. P.-Purch.: Donald F. Baum S, PS, MS, RD

B & H INSTRUMENT CO., INC.
3479 W. Vickery Blvd., Fort Worth 7, Tex. (Tel. ED 6-7411)
Dir.-Purch.: J. R. Pipes
Purch. Agent: Fred Knepper
Sr. Buyer: J. H. Siggins
Sales Mgr.: Leon H. Becker MS, CT

B & K INSTRUMENTS, INC.
3044 W. 106th St., Cleveland 11, Ohio (Tel. CLearwater 1-8430)
Office Mgr.: Robert E. Madden
Pres.: James W. Day CT

BTU ENGRG. CORP.
179 Bear Hill Rd., Waltham 54, Mass. (Tel. TW 4-6050)
Dir.-Purch. & Sales: J. H. Beck

BABCO MFG. INC.
3376 Motor Ave., Los Angeles 34, Calif. (Tel. UPton 0-8246)
Purch. Agent: R. A. Martinson
Gen. Mgr.: A. S. Martinson M

BABCOCK RADIO ENGRG., INC.
1640 Monrovia Ave., Costa Mesa, Calif. (Tel. LIberty 8-7705)
Dir.-Material: Richard Liggitt
Buyers: Charles E. Wilson & Karl Bewlah
Asst. V. P.-Mktg.: Norman E. Cima G, CT, RD

BABCOCK RELAYS, INC.
1640 Monrovia Ave., Costa Mesa, Calif. (Tel. LIberty 8-7705)
Dir.-Material: Richard Liggitt
Purch. Agent: Bob Charleton
V. P.-Sales: Carl L. Martin

BABCOCK & WILCOX CO., TUBULAR PRODUCTS DIV.
Beaver Falls, Pa. (Tel. Beaver Falls, TI 6-0100)
V. P.: J. S. Anderson
Gen. Sales Mgr.: L. B. Wohlgemuth

BACH AURICON, INC.
6994 Romaine St., Hollywood 38, Calif. (Tel. HO 2-0931)
Purch. Agent: Joseph Perolio
V. P.-Adm.: William G. Straube
V. P.-Sales: A. N. Brown CT

SEMON BACHE & CO.
636 Greenwich St., New York 14, N. Y. (Tel. WA 4-2121)
Purch.: Henry Del Tosto
Sales: B. Newton

BACON INDUSTRIES, INC.
192 Pleasant St., Watertown 72, Mass. (Tel. WAtertown 4-5000)
Purch. Agent: Kenneth H. Barton
Sales Mgr.: Eldon H. Fay M, RD

BADGER DIE CASTING CORP.
201 W. Oklahoma Ave., Milwaukee 7, Wis. (Tel. SH 4-6643)
V. P.: Lyle Tuchel M

N. S. BAER CO.
1-11 Montgomery St., Hillside, N. J. (Tel. MUrdock 8-2250)
Gen. Mgr.: P. J. Stec
Sales Mgr.: S. W. Nette

BAIRD-ATOMIC, INC.
33 University Rd., Cambridge 38, Mass. (Tel. UNiversity 4-7420)
Purch. Agent: John B. Milliken CT, TT, RD

J. T. BAKER CHEMICAL CO.
N. Broad St., Phillipsburg, N. J. (Tel. GLencourt 4-2151)
Dir.-Purch.: John L. Zapf
Buyers: John R. Herd, Thomas W. Mohr, R. H. M. Meir M

BAKER CO., INC., THE
106 Granite St., Biddeford, Me. (Tel. ATlantic 4-8441)
Purch. Agent: Joseph F. Feeley
Purch. Dept.: Keith Hastey
Exec. V. P.-Sales: John M. Eagleson, Jr.

BAKER INDUSTRIAL TRUCKS, DIV.-OTIS ELEVATOR CO.
8000 Baker Ave., Cleveland, Ohio (Tel. OLympic 1-3000)
Purch. Agent: K. W. Keyerleber
Asst. Purch. Agents: Joseph Petras & Len Hawkins
Gen. Sales Mgr.: J. Thos. Swift
Sales Prom. Mgr.: Russell A. Moore

BAKER PERKINS INC.
1000 Hess St., Saginaw, Mich. (Tel. PLeasant 2-4121)
Purch. Agent: R. F. Byrne
V. P.-Sales: K. A. Mack
Asst. Sales Mgr.: W. D. Chapman M

BALCRANK INC.
Disney St., Cincinnati 9, Ohio (Tel. RE 1-7200)
Purch. Agent: E. M. Flannery
Sales Admin.: J. A. Weiss M

BALDWIN MFG. CO. INC., THE
140 Homer St., Waterbury 20, Conn. (Tel. PLaza 6-5561)
Purch. Agent: Mrs. H. L. Hebert
Gen. Mgr.: Frank V. Gullo

BALDWIN-LIMA-HAMILTON CORP., ELECTRONICS & INSTRUMENTATION DIVS.
42 4th Ave., Waltham 54, Mass. (Tel. TW 4-6700)
Purch. Agent: R. A. Welch
Asst. Purch. Agent: R. Lepore
Mechanical Buyer: R. Lauranzano
Gen. Sales Mgr.: Richard A. Lowe MS, CT

BALL BROTHERS RESEARCH CORP.
Boulder Indsl. Park, Boulder, Colo. (Tel. HI 2-2965)
Field Engr.: K. S. Kilgore
Purch. Agent: C. P. Bennett RD

BALLASTRAN DIV., TELEX, INC.
1701 N. Calhoun St., Fort Wayne 7, Ind. (Tel. EAstbrook 9602)
Dir.-Purch.: H. L. Matthias
Buyer: H. D. Carr
Dir.-Sales: O. Kiltie MS

BALTEAU ELECTRIC CORP.
P. O. Box 385, 5 New St., Stamford, Conn. (Tel. DA 4-6118)
Div. Mgr., X-Ray Sales: Fred C. Sarchet
V. P.-Purch.: M. Marechal

BANNER INDUSTRIES
9501 Inkster Rd., Taylor, Mich. (Tel. WH 1-9800)
Purch. Agent: Richard Olesak
Sales Mgr.: Tom MacDonald

BANTHIN ENGRG. CO.
1849-57 Main St., Bridgeport 4, Conn. (Tel. ED 4-3143)
Purch. Agents: Monroe H. Sanford & William Krause

BARBER-COLMAN CO.
1411-3 Rock St., Rockford, Ill. (Tel. WOodland 8-6833)
Purch. Agent: D. R. Farquhar
Div. Mgr, Aircraft Controls Div.: R. A. Baird
Div. Mgr., Electrical Components Div.: W. F. Tice

BARCO CHEMICAL PRODUCTS CO.
701-3 S. LaSalle St., Chicago 5, Ill. (Tel. HA 7-2916)
Purch. Agent: S. P. Barewin
V. P. & Sales Mgr.: R. R. Barewin M

BARCO, INC.
Box 1222, Milwaukee 1, Wis. (Tel. BRoadway 6-8515)
Purch. Agent: L. E. Leichtfuss
Sales Mgr.: I. I. Aaron M

BARCO MFG. CO., INC.
566 N. Hough St., Barrington, Ill. (Tel. DUnkirk 1-1700)
Purch. Agent: W. F. Donaldson
V. P.'s: J. O. Heyworth, F. M. Moore PS, MS

BARDEN CORP., THE
200 Park Ave., Danbury, Conn. (Tel. Pioneer 3-9201)
Purch. Agent: W. R. Ferguson
Buyers: K. A. Taylor & F. H. Lee
V. P.-Sales: Alphe G. Jarreau M

BARIUM & CHEMICALS, INC.
Lake Co. Nat. Bank Bldg., Willoughby, O. (Tel. WI 2-5151)
V. P.-Chg. of Purch.: Douglas Naylor
V. P.-Sales & Adv.: Albert Pavlik, Jr. PS, M

BARKER SALES CO.
339 S. Broad Ave., Ridgefield, N. J. (Tel. WHitney 3-2477)
Purch.: J. Donovan
Sales Mgr.: T. R. Sheron
Pres.: T. R. Cox M

BARKER & WILLIAMSON INC.
Bristol, Pa. (Tel. STillwell 8-5581)
Purch. Agent: Joseph Fattorini
V. P.-Sales: J. C. Pearce M

BARKSDALE VALVES
5125 Alcoa Ave., Los Angeles 58, Calif. (Tel. LUdlow 9-6181)
Purch. Agent: H. Lembke
Gen. Mgr. & V. P.-Sales: M. C. Nelson
Sales Mgr.-Eastern Div.: J. D. Brown
Sales Mgr.-Western Div.: Frank Kramer PS, MS, G, CT, RD

BARNEBEY-CHENEY CO.
Eighth Ave. & North Cassady, Columbus 19, Ohio (Tel. CL 8-9501)
Buyer: H. Groce
V. P.-Sales: H. L. Barnebey HSE

W. O. BARNES CO., INC.
1297 Terminal Ave., Detroit 14, Mich. (Tel. VAlley 2-3422)
Treas.: E. G. Mosteller
Sales Mgr.: W. A. McCullough, Jr. M

WALLACE BARNES DIV., ASSOCIATED SPRING CORP.
18 Main St., Bristol, Conn. (Tel. LU 2-9581)
Purch. Agent: Arthur LeVasseur
Asst. Purch. Agent: John Reilly
Buyer: William Greer
Sales Mgr.: J. S. Gamble

BARNES DEVELOPMENT CO.
213 W. Baltimore Ave., Lansdowne, Pa. (Tel. MA 6-3294)
Purch. Agent & Sales Mgr.: J. W. Barnes
Purch., Engrg.: J. N. Natter
Purch., Prod.: R. S. Tittler CT, RD

BARNES ENGRG. CO.
30 Commerce Rd., Stamford, Conn. (Tel. FIreside 8-5381)
Purch. Agent: James D. Bennett

BARNSTEAD STILL & STERILIZER CO.
2 Lanesville Terr., Boston 31, Mass. (Tel. JAmaica 4-3100)
Purch. Agent: J. C. Mullan
Sales Mgr.: D. G. Miller PS, RD, HSE

BARNUM MACHINE WORKS, INC.
200 Wooster St., New Haven, Conn. (Tel. LOcust 2-2169)
Pres.: Henry G. Halbing

BAR-RAY PRODUCTS, INC.
211 25th St., Brooklyn 32, N. Y. (Tel. SOuth 8-1020)
Dir.-Purch.: G. Hollands

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Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

Purch. Agent: F. Carlopio
V. P.-Sales: R. Lapof M

LEON J. BARRETT CO., THE
1495 Grafton Rd., Worcester 1, Mass. (Tel. PLeasant 5-4306)
Dir.-Purch.: D. C. Page
Purch. Agent: L. E. Clark
Sales Mgr.: R. B. Ayres M

BARRETT-CRAVENS CO.
630 Dundee Rd., Northbrook, Ill. (Tel. CRestwood 2-2300)
Purch. Agent: R. Sonnen
Dir.-Sales: K. E. Forster MS

BARRY CONTROLS INC.
938 Pleasant St., Watertown 72, Mass. (Tel. WAtertown 3-1150)
Purch. Agent: Thomas Foster
Buyers: James Wise, James Writesel
V. P.-Mktg.: Edward A. Johnson S, CT, RD

BARRY ELECTRONICS CORP.
512 Broadway, New York 12, N. Y. (Tel. WAlker 5-7000)
Pres.: B. N. Gensler
Sales Mgr.: L. Chall

BART MFG. CORP.
135 Manchester Pl., Newark 4, N. J. (Tel. PLymouth 9-0200)
Purch. Agent: Larry Scheid
Pres.-Sales: S. G. Bart
Sales Mgr.: Arthur E. Hallander M, RD

BARTH ENGRG. & MFG. CO., INC.
48 Elm St., Meriden, Conn. (Tel. BE 7-7468)
Purch. Agent: Joseph Putala
Sales Mgr.: Edward Houston MS

BARTON INSTRUMENT CORP.
580 Monterey Pass Rd., Monterey Park, Calif. (Tel. CUmberland 3-6501)
Purch. Agent: Sylvia Clingerman
Gen. Sales Mgr.: Robert Yerxa MS, RD

L. J. BARWOOD MFG. CO. INC.
12 Williams St., Everett 49, Mass. (Tel. Boston, DUnkirk 7-0942)
V. P.: R. J. Greenleaf M

BARWOOD ELECTRONICS INC.
120 S. Maryland Ave., Glendale 5, Calif. (Tel. CHapman 5-4063)
Pres.: W. H. E. Barwood G

GEORGE BASCH CO., THE
19 Hanse Ave., Freeport, N. Y. (Tel. FReeport 8-8100)
Sales Mgr.: George Basch
Gen. Mgr.: Jerome D. Basch

BASIC & EXPERIMENTAL PHYSICS
Box 689, Falmouth, Mass. (Tel. KImball 8-2175)
Purch. Agent: L. Grafton
Sales Mgr.: J. A. Roberts
Gen. Mgr.: N. A. Denman MS, G, CT, TT, RD, HSE

BASIC TOOL INDUSTRIES, INC.
14439 S. Avalon Blvd., Gardena, Calif. (Tel. FAculty 1-2665); 440 Hester St., San Leandro, Calif. (Tel. LOckhaven 2-4634)
Purch. Agent: Robert F. Rigali
Exec. V. P.-Sales: Robert G. Lucas S, MS

BASO INC.
730 N. Jackson St., Milwaukee 1, Wisc. (Tel. BRoadway 3-5388)
Purch. Agent: G. C. Winters
Asst. Purch. Agent: F. J. Jens
Dist. Mgr.: D. Weidenfeller

REX BASSETT, INC.
1314 N. E. 17th Ct., Ft. Lauderdale, Fla. (Tel. LOgan 6-8416)
Purch.: William T. Jansen
Dir.-Sales: Rex Bassett, Jr. M

BASSICK CO., THE, DIV.-STEWART-WARNER
3045 Fairfield Ave., Bridgeport 5, Conn. (Tel. FOrest 6-3671)
Dir.-Purch.: George Raiselis
Purch. Agent (Parts): Henry Burr
Dir.-Sales: R. D. Mount MS

BASTIAN-BLESSING CO., THE
4201 W. Peterson Ave., Chicago 46, Ill. (Tel. MUlberry 5-1121)
Dir.-Purch.: H. A. Barnes
Asst. V. P.-Sales: R. H. Engstrom MS, G

CYRIL BATH CO., THE
32400 Aurora Rd., Solon 39, Ohio (Tel. CHurchill 8-6510)
Purch. Agent: J. E. Fagan
Sales Mgr.: J. J. Frank S, MS, RD

CHRISTIE BATLAS, INDUSTRIAL SCALE MODELS
17 Irving Pl., Summit, N. J. (Tel. CR 3-8364)

BATTELLE MEMORIAL INSTITUTE
505 King Ave., Columbus 1, Ohio (Tel. AX 9-3191)
Purch. Agent: M. Coate
Mgr.-Proj. Development: M. R. Nestor RD

BAUSCH & LOMB OPTICAL CO.
87060 Bausch St., Rochester, N. Y. (Tel. LOcust 2-3000)
Purch. Agent: C. Buss
Mgr.-Military Products Div.: William A. Kerr M, G, TT, RD

E. BAUCHES S. A., C/O FREEPORT ENGRG. CO.
350 Fifth Ave., New York 1, N. Y. (Tel. LO 5-2488)
Dir.-Sales: Charles Friedman CT, TT, RD

BEACH-RUSS CO.
420 Lexington Ave., New York 17, N. Y. (Tel. OR 9-7636)
Purch. Agent: S. Sukmanski, 544 Union Ave., Brooklyn 11, N. Y. (Tel. EV 8-4090)
V. P.-Sales: A. T. Beach M, RD

BEACON STEEL CORP.
11810 Center St., Hollydale, Calif. (Tel. NEvada 6-1142)
Purch. Agent: Art Mann
Dir.-Sales: C. Corodimas S, MS

BEAD CHAIN MFG. CO., THE
110 Mountain Grove St., Bridgeport 5, Conn. (Tel. EDison 4-4124)
Purch. Agent: M. H. Doolittle
Sales Mgr.: G. F. Bahr M

MORRIS BEAN & CO.
Yellow Springs, O. (Tel. ROckwell 7-7301)
Dir. Purch.: D. W. Waechter
Purch. Agent: T. E. Charlton
Asst. Purch. Agent: R. E. Pollock
V. P.-Sales: R. H. Hollister M

BEARING INSPECTION, INC.
3311 E. Gage Ave., Huntington Park, Calif. (Tel. LUdlow 2-6431)
Pres. & Sales Mgr.: Charles McKnight
Purch. Agent: J. O. Butler S, PS, MS, M, G, CT, TT, RD

BEARIUM METALS CORP.
Mill & Commercial Sts., Rochester 14, N. Y. (Tel. LOcust 2-7700)
Purch. Agent: A. E. Zielke
Sales Mgr.: B. M. Garek PS, MS, G

BEATON & CORBIN MFG. CO., THE
328 N. Main St., Southington, Conn. (Tel. MArket 8-4747)
V. P.: C. W. Rush, Jr.

BEATTIE-COLEMAN, INC.
1000 N. Olive St., Anaheim, Calif. (Tel. PRospect 4-4503)
Purch.: L. B. Blythe
Sales Mgr.: J. A. Wilcox MS, G, CT, TT

BEAVER GEAR WORKS, INC.
1025 Parmele St., Rockford, Ill. (Tel. WO 3-9691)
Dir.-Purch. Dept.: R. A. Zwicky
Dir.-Sales Dept.: Charles L. Kessler G, TT

***BEAVER PRECISION PRODUCTS INC.**
651 N. Rochester Rd., Clawson, Mich. (Tel. JOrdan 4-6547)
Purch. Agent: Edw. Smokoski
V. P.-Sales: John A. Hope
*(See advertisement this issue)

BEAVER-ADVANCE CORP.
P. O. Box 792, Ellwood City, Pa. (Tel. PL 8-7571)
Purch. Agent: J. T. Penman
Sales Mgr.: R. B. Cooper CT

BECCO CHEMICAL DIV.-FOOD MACHINERY & CHEMICAL CORP.
Station B, 34 Sawyer Ave., Buffalo, N. Y. (Tel. BEdford 8300)
Purch. Agent: Herbert J. Newman
Asst. Purch. Agent & Traffic Mgr.: Edward Wheeler
Dir.-Sales: A. P. Shutts PS

BECKER ELECTRONICS MFG. CORP.
1091 Rockaway Ave., Valley Stream, L. I., N. Y. (Tel. LOcust 1-2510)
V. P.-Purch.: Fred Becker, Jr.
Sales Mgr.: Manning Mintzer RD

BECKMAN INSTRUMENTS, INC., BERKELEY DIV.
220 Wright Ave., Richmond, Calif. (Tel. LA 6-7730)
Purch. Mgr.: Walter Day
Sales Mgr. (Test & Indsl. Instruments): John W. Scheck
Sales Mgr. (Analog Computers): Karl Sterne CT

BECKMAN/SCIENTIFIC & PROCESS INSTRUMENTS DIV.
2500 Harbor Blvd., Fullerton, Calif. (Tel. TRojan 1-4848)
Purch. Agent: K. A. Bruner
Mktg. Mgr.: Roy F. Brown RD

BECKMAN/SYSTEMS DIV.
325 N. Muller Ave., Anaheim, Calif. (Tel. PRospect 4-5430)
Purch. Agent: J. A. McKnight
Buyers: T. R. Novis & A. D. Pennington
Mktg. Mgr.: Frank J. Scheufele MS, CT, TT, RD

BECKMAN & WHITLEY, INC., INSTRUMENT DIV.
973 San Carlos Ave., San Carlos, Calif. (Tel. LYtell 3-7824)
Purch. Agent: R. Rader
Camera Prod.: R. Shoberg
Meteorological Instr.: H. V. Thompson PS, MS, G, CT, RD

BECKMAN & WHITLEY, INC., MISSILE PRODUCTS DIV.
985 E. San Carlos Ave., San Carlos, Calif. (Tel. LYtell 3-7824)
Purch. Agent: J. W. Booth
Mktg. Mgr.: F. Kerr PS, MS, G, CT, RD

BEECH AIRCRAFT CORP.
9709 E. Central, Wichita 1, Kans. (Tel. MUrray 3-4681)
Mgr.-Materials: L. E. Bowery
Asst. Mgr.-Proc.: W. R. Sullivan
Mgr., Outside Prod.: Seymour Coleman
V. P.-Contract Admin.: James N. Lew
V. P.-Commercial Sales: Leddy Greever
V. P.-Export Sales: Michael G. Neuburger S, MS, G, CT, RD

BEEMER ENGRG. CO.
401 N. Broad St., Philadelphia 8, Pa. (Tel. WAlnut 2-0900)
Purch. Mgr.: J. M. Brower
Sales Mgr.: H. G. Silcox, 3rd M

BEHLMAN ENGRG. CO.
2911 Winona Ave., Burbank, Calif. (Tel. VIctoria 9-5733)
Purch. Agent: L. J. Harvey
V. P.-Sales: J. M. Schroeder MS, CT, RD

BEHR-MANNING CO.
5860 Howe St., Troy, N. Y. (Tel. ARsenal 3-0100)
Purch. Agent: Mark B. Patten
V. P.-Sales: Henry R. Merrill M

BEKINS INDUSTRIAL PACKAGING
12512 Inglewood Ave., Hawthorne, Calif. (Tel. OR 8-7213)
Gen. Mgr.: R. A. Patton
Operations Mgr.: Norman L. Johnson
Dir.-Sales & Engrg.: Noble W. Jones

BEL FUSE INC.
198 Van Vorst St., Jersey City, N. J. (Tel. HE 2-0463)
Dir.-Purch.: G. Frannel
Dir.-Sales: H. V. Anderson M, RD

BELDEN MFG. CO.
415 S. Kilpatrick, Chicago 44, Ill. (Tel. ESterbrook 8-1000)
Dir.-Purch.: William A. Sandy
Gen. Sales Mgr.: Les A. Thayer

BELFAB CORP., THE
9 Hobson Ave., Hamden, Conn. (Tel. ATwater 8-3581)
Purch. Agent: Roger Pegolo, Municipal Airport, Daytona Beach, Fla. (Tel. CLinton 3-0628)
Sales Mgr.: R. F. Harrigan S

BELFORT INSTRUMENT CO.
Central Ave., Baltimore 2, Md. (Tel. DIckens 2-2626)
Purch. Agent: G. Wasmus
Sales Mgr.: A. E. Clark, Jr.

BELL AIRCRAFT CORP., NIAGARA FRONTIER DIV.
P. O. Box 1, Buffalo 5, N. Y. (Tel. Niagara Falls, BUtler 5-7851)
Dir.-Procurement: Maurice J. Coughlin
V. P. & Gen. Mgr.: W. G. Gisel
Dir.-Govt. Relations: S. B. Elggren
V. P. & Dir.-Engrg.: Dr. W. R. Dornberger
Dir.-Mfg.: T. M. Nolan S, PS, MS, M, RD, HSE

BELL & GOSSETT CO.
8200 N. Austin, Morton Grove, Ill. (Tel. OR 3-3700)
Purch. Agent: N. Van Parys
Buyers: C. Kirchoff & R. Hough
Sales Mgr.-Electronics Div.: D. F. Shea, Jr.
MS, CT, TT, RD

BELL & GOSSETT CO., MARLOW PUMPS DIV.
Box 200, Midland Park, N. J. (Tel. GIlbert 4-6900)
Purch. Agent: Miss R. K. Boyd
Govt. Sales: H. L. Kociencki
Gen. Sales Mgr.: A. F. Woods MS

BELL & HOWELL CO.
7100 McCormick Blvd., Chicago 45, Ill. (Tel. AMbassador 2-1600)
Dir. Purch.: S. W. Knabe
Dir. Govt. Sales: Carl J. Stauff RD

BELL OIL & GAS CO.
1310 National Bank of Tulsa Bldg., Tulsa, Okla. (Tel. LU 2-7191)
Mgr.-Purch.: M. W. Sullivan
Sales Mgr.: L. H. Deatherage M

BELL TELEPHONE LABORATORIES, INC.
Murray Hill, N. J. (Tel. CRestview 3-6000)
V. P. & Gen. Mgr.: R. L. Helmreich RD

BELLEVILLE-HEXEM CORP.
638 University Ave., Los Gatos, Calif. (Tel. EL 4-1379)
Dir.-Purch.: L. M. Belleville
Dir.-Sales: John Hexem

BELLOFRAM CORP.
Blanchard Rd., Burlington, Mass. (Tel. MIssion 3-9000)
Purch. Agent: Mrs. Ruth Clark
Sales Mgr.: John F. Taplin
Buyer: Harold Currier M

BELLOWES CO., THE
125 E. Nash St., Milwaukee 12, Wis. (Tel. CO 4-5090)
Plant Mgr.: Pat Casey
Purch. Dept.: John McCoy
Sales Mgr.: Clarence Martin M

BELLOWS-VALVAIR DIVS.
230 W. Market St., Akron 9, Ohio (Tel. FRanklin 6-2174)
Purch. Agents: D. E. Sterling & R. E. Stoll
Sales Mgr.: J. James Mudd M

BELMAR WHEEL & MACHINE CO., INC.
1707 F St., Belmar, N. J. (Tel. MUtual 1-1616)
B. M. Kelly S, M, CT, RD

BELMONT SMELTING & REFINING WORKS, INC.
330 Belmont Ave., Brooklyn 7, N. Y. (Tel. DIckens 2-4900)
V. P.-Purch.: Robert V. Henning

BELOCK INSTRUMENT CORP.
112-03 14th Ave., College Point 56, Queens, N. Y. (Tel. HIckory 5-4200)
Purch. Mgr.: Herbert Helmers
V. P.-Sales: John F. Donato S, MS, G, CT, RD

BEL-TRONICS CORP.
344 Interstate Rd., Addison, Ill. (Tel. KIngswood 3-7778)
Mgr.-Purch.: Lee Belowich
Purch. Agent: Mrs. E. Wanders
Pres. & Sales Mgr.: Thomas J. Wright

BEMIS BRO. BAG CO.
111 N. Fourth St., Box 72, St. Louis 2, Mo. (Tel. CHestnut 1-0900)
V. P.-Proc.: B. L. Willmore, 40 Central St., Boston 5, Mass. (Tel. LAfayette 3-3010)
V. P.-Sales: H. V. Howes

BENBOW MFG. CORP.
11920 W. Jefferson Blvd., Culver City, Calif. (Tel. EX 8-5766)
Purch. Agent: P. C. Badger
V. P.-Sales: Wayne S. Boals MS, CT, RD

BENDIX AVIATION CORP.
1104 Fisher Bldg., Detroit 2, Mich. (Tel TRinity 5-5000)
Pres.: M. P. Ferguson MS, G, CT, TT, RD

BENDIX AVIATION CORP., CINCINNATI DIV.
3130 Wasson Rd., Cincinnati 8, Ohio (Tel. ELmhurst 1-2323)
Purch. Agent: A. S. Cogswell
Buyer: J. Lancaster
Sales Mgr.: G. J. Rosenblit MS, CT, RD

***BENDIX AVIATION CORP., HAMILTON DIV.**
Fifth St. & Ford Blvd., Hamilton, Ohio (Tel. TWinbrook 3-6181)
Purch. Agent: D. J. MacGregor
Dir.-Sales & Service: S. R. Craig G
*(See advertisement this issue)

BENDIX AVIATION CORP., MONTROSE DIV.
South Montrose, Pa. (Tel. Montrose 570)
Purch. Agent: J. B. Wilson
Buyers: R. J. Pope, R. L. Kerr, J. E. Mahon & K. R. Flint
Dir.-Sales & Service: M. G. Douglas

BENDIX AVIATION CORP., PIONEER-CENTRAL DIV.
Hickory Grove Rd., Davenport, Iowa (Tel. DAvenport 7-9101)
Dir.-Purch.: George Thomas
Asst. Dir.-Purch.: Vernon Dick
Sr. Buyers: Donald Patrick & William Hiegel
Buyer: Robert Lindsay
Dir.-Sales & Serv.: I. H. MacMillon MS, CT, RD, HSE

BENDIX AVIATION CORP., RED BANK DIV.
Eatontown, N. J. (Tel. LIberty 2-2000)
Purch. Agent: L. Fyfe
Mktg. Mgr.-Electron Tubes: J. F. Bozzelli MS, M

BENDIX AVIATION CORP., SEMICONDUCTOR PRODUCTS, RED BANK DIV.
201 Westwood Ave., Long Branch, N. J. (Tel. CApital 2-6220)
Mktg. Mgr.: Robert R. Meijer
Dir.-Purch.: L. D. Fyfe, Eatontown, N. J. (Tel. LIberty 2-2000)
Purch. Agent: Thomas Hackett RD

BENDIX AVIATION CORP., YORK DIV.
York, Pa. (Tel. 47-1951)
Purch. Agent: R. H. Moore
Chief Buyer: P. B. Gross
Sales Mgr.: T. R. Bartlett MS, CT, RD

BENDIX COMPUTER, DIV.-BENDIX AVIATION CORP.
5630 Arbor Vitae St., Los Angeles 45, Calif. (Tel. Spring 6-2220)
Purch. Agent: R. J. Thelen
Dir.-Mktg.: O. P. Staderman MS, G, CT, TT, RD

BENDIX CORP., THE, ECLIPSE-PIONEER DIV.
Williams Ave., Teterboro, N. J. (Tel. ATlas 8-2000)
Dir.-Purch.: John P. Quinn
Purch. Agents: Robert Reade, Jr. & Robert E. Rosemund
Dir.-Sales & Service: James P. Buckley MS, G, CT, RD

BENDIX FILTER DIV., BENDIX AVIATION CORP.
434 W. Twelve Mile Rd., Madison Hgts., Mich. (Tel. JOrdan 6-2380)
Purch. Dept.: D. S. Kinsman
Buyers: Ivan Papin & Theodore C. Ling
Dir.-Sales: W. N. Caldwell, Jr.
Sales Mgr.: G. T. Grimstad PS, MS, G, CT, RD

BENDIX FOUNDRIES, BENDIX AVIATION CORP.
Teterboro, N. J. (Tel. ATlas 8-2000)
Foundry Mgr.: R. D. Ferguson
Foundry Purch. Agent: G. F. Cartier
Sales Mgr.: L. Eigenrauch

BENDIX MISHAWAKA, DIV.-BENDIX AVIATION CORP.
400 S. Beiger St., Mishawaka, Ind. (Tel. BL 5-2111)
Dir.-Proc.: D. J. Youngerman
Supvr.-Subcontracts: R. D. Weller
Asst. Purch. Agent: F. R. Glassman
Dir.-Contracts & Planning: M. R. Balis S, PS, G, CT, TT, RD

***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
401 Bendix Dr., South Bend, Ind. (Tel. CEntral 3-4141)
Dir.-Purch.: C. E. Budd
Dir.-Mktg.: R. W. Whitesell S, PS, MS, M, CT, RD
*(See advertisement this issue)

BENDIX RADIO DIV. BENDIX AVIATION CORP.
E. Joppa Rd., Baltimore 4, Md. (Tel. VAlley 3-2200)
Govt. Prods. Materials Mgr.: J. L. Winchester
Buyers: C. W. McGuire & E. A. White
Govt. Prods. Sales Mgr.: E. A. King MS, G, CT, TT

BENDIX SYSTEMS DIV.
3300 Plymouth Rd., Ann Arbor, Mich. (Tel. NOrmandy 5-7766)
Dir.-Long Range Planning: James A. Burns MS, G, CT, TT, RD, HSE

BENDIX UTICA DIV., BENDIX AVIATION CORP.
211 Seward Ave., Utica, N. Y. (Tel. SWift 7-2500)
Dir.-Purch.: Alan J. Dodd
Senior Buyers: P. B. Huested & G. R. Didio
Dir.-Sales & Service: W. S. Allison RD

BENDIX-PACIFIC DIV., BENDIX AVIATION CORP.
11600 Sherman Way, N. Hollywood, Calif. (Tel. POplar 5-1010)
Dir. Purch.: R. R. Zimmerman
Applications Engrg. Mgr.: S. F. Rice G, CT, TT, RD, HSE

BENNETT-FERAGEN
1408 Jerome St., Niles, Mich. (Tel. MUtual 3-8121)
Dir.-Purch.: J. B. Whitlow

BENSON MFG. CO., THE
1811 Agnes Ave., Kansas City, Mo. (Tel. BE 1-8300)
Dir.-Purch.: Ralph Bure
Buyers: Jim Mitchell & Earl Miller
Pres.: A. J. Benson S, MS, RD

BENSON-LEHNER CORP.
1860 Franklin St., Santa Monica, Calif. (Tel. EXbrook 3-9921)
Purch. Agent: Everett Case
Asst. Purch. Agent: Richardson Hill
Mgr., Applications Engrg.: Robert C. Saunders MS, CT, TT, RD

BENTLEY, HARRIS MFG. CO.
Hector & Lime Sts., Conshohocken, Pa. (Tel. TAylor 8-7600)
Purch. Agent: E. A. Ruth
Sales Mgr.: J. A. Webb M

BENTON HARBOR ENGRG. WORKS, INC.
622 Langley Ave., St. Joseph, Mich. (Tel. YUkon 3-5523)

BERGEN CARBIDE CO.
P. O. Box 531, Fair Lawn, N. J. (Tel. GRegory 1-3538)
Gen. Mgr.: Charles Openden PS, MS, M, G

BERGEN LABS., INC.
60 Spruce St., Paterson 1, N. J. (Tel. ARmory 8-3020)
Purch. Agent: D. Mierop
Sales Mgr.: M. Hoberman CT, RD

BERGEN WIRE ROPE CO.
11 Gregg St., Lodi, N. J. (Tel. HUbbard 7-3521)
Purch. Agent: Jack Harper
Mgr.-Mktg.: W. E. Herdman M, RD

BERKSHIRE ELECTRIC CABLE CO.
River Rd., Leeds, Mass. (Tel. Northampton-JUstice 4-3853)
Treas.: Garson R. Feinstein M

BERKSHIRE TRANSFORMER CORP.
Kent, Conn. (Tel. WAlker 7-3541)
Purch. Agent: Barbara Giddings
Pres.: B. B. Hordeski

BERMITE POWDER CO.
22116 W. Soledad Canyon Rd., Saugus, Calif. (Tel. NEwhall 241)
V. P.-Purch.: Hugo Lizza
Sales Dept., Prod.: Jack Arnold & Dave Auman
Sales Dept., Research & Development: Louis L. Fiego
Mgr., Eastern Office: Samuel P. Miller, Alexandria, Va. (Tel. FLeetwood 4-4118) PS, TT, RD

BERNCO ENGRG. CORP.
2320 S. Tibbs Ave., P. O. Box 41037, Indianapolis 41, Ind. (Tel. CHapel 1-2871)
Purch. Agent: Leland L. Reich
Sales Mgr.: William Zaring G, CT, RD

BERYLLIUM CORP., THE
P. O. Box 1462, Reading, Pa. (Tel. WAlker 9-0781)
Purch. Agent: T. Blessing
V. P.-Sales: L. F. Boland

CHARLES BESELER CO.
219 S. 18th St., East Orange, N. J. (Tel. OR 6-6500)
Purch. Agent: J. Prager
Sales Mgr.: M. F. Myers

BEST AIRCRAFT CORP.
711 Sip St., Union City, N. J. (Tel. UNion 5-1681)
Sales Mgr.: F. Gebhardt
Purch. Agent: William Decker S, PS, MS, M, G

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

BESTCRAFT PRODUCTS CO. INC.
626 Broadway, New York 12, N. Y. (Tel. AL 4-7920)
V. P.-Purch.: Kurt Levy
Dir.-Sales: Rost Smylie M

BETHLEHEM STEEL CO.
701 E. Third St., Allentown, Pa. (Tel. UN 7-2424)
V. P.-Purch.: P. S. Killian
V. P.-Sales: J. V. Honeycutt S, MS, M

BETTER FINISHES & COATINGS INC.
268 Doremus Ave., Newark 5, N. J. (Tel. MA 4-6700)
Pres.: Myron Bryant M

BETTINGER CORP.
Sumner St., Milford, Mass. (Tel. GReenleaf 3-7500)
Purch. Agent: Walter Gorenflo
Plant Supt.: J. Zariboni
V. P.-Sales: N. Cannistraro M

BEVA LAB., INC.
185 Fourth St., Trenton 8, N. J. (Tel. TUxedo 2-6847)
Dir.-Purch. & Sales: W. Hartig

JAMES G. BIDDLE CO.
1316 Arch St., Philadelphia 7, Pa. (Tel. LO 4-1620)
Purch. Agent: Lester Markham
Chief Engr.: E. B. Curdts
Sales Mgr.: P. E. Sellers CT, TT, RD

A. BIEDERMAN, INC.
1045 Air Way, Glendale 1, Calif. (Tel. CHapman 5-8621)
Purch. Agent: Lyle Teeple
Sales Engr.: Dale L. Porter
Dir.-Sales: Frank Herle MS, M, G, CT, RD

CARL H. BIGGS CO.
1547 14th St., Santa Monica, Calif. (Tel. GR 8-0461)
Purch. Agent: G. Hert
Dir.-Sales: D. N. Lott, Jr. M, RD

BIL-JAX INC.
P. O. Box 38, Archbold, Ohio (Tel. 2045)
Purch.: Olen L. Britsch
Dir.-Sales: Wilbur M. Wyse S

BILLINGS & SPENCER CO., THE
1 Laurel St., Hartford, Conn. (Tel. JAckson 7-5181)
Purch. Agent: Wm. V. Pilon
Sales Mgr.: E. A. Crocker M

J. F. BINGHAM MFG. CO.
69 Bay State Rd., Lawrence, Mass. (Tel. MUrdock 5-5188)
Purch. Agent: C. R. Yeaton
Asst. Purch. Agent: R. A. Arscott
V. P.-Sales: C. E. Callahan MS

BINKLEY CO., THE
Warrenton, Mo. (Tel. GLadstone 6-3455)
Purch. Agent: M. D. Coleman
V. P.-Sales: Frank A. Bornmann MS

BINKS MFG. CO.
3114 Carroll Ave., Chicago 12, Ill. (Tel. Van Buren 6-4200)
Purch. Agent: Richard Krisch
Purch.: James Shomenta & Doran Unschuld
Gen. Sales Mgr.: B. James Hedger

BIO-RAD LABS.
32nd & Griffin Ave., Richmond, Calif. (Tel. BEacon 4-4130)
Purch. Agent: James L. Donovan M, RD

BIOS LABS., INC.
17 W. 60th St., New York 23, N. Y. (Tel. PLaza 7-8171)
Asst. Dir.-Purch.: H. Brodie
Dir.-Sales: Fred Linsker

RICHARD H. BIRD & CO., INC.
1 Spruce St., Waltham 54, Mass. (Tel. TWinbrook 4-0160)
Purch. Agent: R. T. Cameron
Dir.-Sales: R. P. Cameron, Jr.
Supt.: C. F. Whittemore

BIRDAIR STRUCTURES, INC.
1800 Broadway, Buffalo 12, N. Y. (Tel. KEystone 5100)
Purch. Agent: Warren K. Horey
Sales Mgr.: Alvin C. Smith S, MS, RD

BIRMA MFG. CO. INC.
254 Rano St., Plant #1, Buffalo 13, N. Y. (Tel. Victoria 7000)
Purch. Agent: C. Hopkins
Sales Mgr.: George H. Nelson S, M

BIRNBACH RADIO CO., INC.
145 Hudson St., New York 13, N. Y. (Tel. WOrth 6-5611)
Sales Mgr.: Aaron D. Danziger
Pres.-Purch.: M. Birnbach M

BIRTCHER CORP., THE
4371 Valley Blvd., Los Angeles 32, Calif. (Tel. CApitol 2-9101)
Purch. Mgr.: Mrs. Jessie Matranga
Sales Mgr., Indsl. Div.: Charles F. Booher

J. BISHOP & CO., PLATINUM WORKS
E. King St., Malvern, Pa. (Tel. Niagara 4-3100)
Dir.-Purch.: J. Cortez
V. P.: J. J. Buckley
Mgr.-Mktg.: H. S. Roberts M, RD

BISHOP MFG. CORP.
10 Canfield Rd., Cedar Grove, N. J. (Tel. CEnter 9-2400)
Purch. Agent: P. W. Reed, Jr.
V. P.-Sales: F. X. McCormack M

BIWAX CORP.
3445 W. Howard St., Skokie, Ill. (Tel. ORchard 3-1050)
Pres.: H. J. Bystricky
V. P.: P. H. Scrutchfield M, RD

BJORKSTEN RESEARCH LABS. FOR INDUSTRY, INC.
P. O. Box 1175, Madison 1, Wis. (Tel. ALpine 6-5581)
Admin. Asst.: Irvin J. Leichtle
Exec. V. P.-Sales: Alan G. Richards RD

BLACK & DECKER MFG. CO., THE
E. Pa. Ave., Towson 4, Md. (Tel. VA 3-4400)
Purch. Mgr.: Alex Dahl
V. P.-Mktg.: R. G. Horner

BLACKMER PUMP CO.
1809 Century Ave., S. W., Grand Rapids 9, Mich. (Tel. CHerry 1-1611)
Purch. Agent: Darcey Mahon
Dir.-Sales: E. H. Lanthorn

BLACKSTONE CORP.
1111 Allen St., Jamestown, N. Y. (Tel. 5-1121)
Dir.-Purch.: D. E. Benson
Products Mgr.: G. A. Gustafson

BLACO MFG. CO.
6541 Euclid Ave., Cleveland 3, O. (Tel. EXpress 1-0497)
Purch.: S. J. Haretik
Mgr.-Sales: I. W. McCulley M

ERNEST E. BLANCHE & ASSOCIATES, INC.
10425 Fawcett St., Kensington, Md. (Tel. LOckwood 4-7527)
Chief-Purch.: Mrs. Irene Van Yuga TT, RD

BLAND BURNER CO., THE
83 Woodbine St., Hartford 6, Conn. (Tel. CHapel 9-8651)
Purch. Agent: Jerry Glassman
Sales Mgr.: Joel Livingston M

BLAW-KNOX EQUIPMENT, DIV.-BLAW-KNOX CO.
P. O. Box 1198, Pittsburgh 30, Pa. (Tel. STerling 1-2700)
Div. Purch. Agent: Phillip H. Rollings
Sales Mgr.: R. A. Troman S

S. BLICKMAN, INC.
35 Gregory Ave., Weehawken, N. J. (Tel. UNion 3-0800)
Dir.-Purch.: Frank Curran
Dir.-Sales: Newton Blickman M

E. W. BLISS CO.
1375 Raff Rd., S. W., Canton, Ohio (Tel. GReenwood 7-3421)
Purch. Mgr.: F. R. Mayer
Buyers: W. B. Boyd, G. W. Baker, J. M. Baylor
Sales Mgr.-Govt. Contracts: R. E. Reilly S, PS, MS

BLISS ELECTRONIC CORP.
Box 366, Sussex, N. J. (Tel. SUssex 2-3000)
Dir.-Purch.: Gilbert Coates
Dir.-Sales: Robert Kaiser

BLONDER-TONGUE LABS., INC.
9 Alling St., Newark 2, N. J. (Tel. MArket 2-8151)
Purch. Agent: David Rubin
Sales Mgr.: Joseph H. Kerner M, RD

BLONDER-TONGUE LABS. INC., SPECIAL PRODUCTS DIV.
49 Edison Place, Newark 2, N. J. (Tel. MA 2-0501)
Mgr.-Purch.: H. R. Walker
Contract Mgr.: I. A. Faye G, CT, TT, RD

BLOOMINGDALE RUBBER CO.
Roosevelt & Grant Aves., Aberdeen, Md. (Tel. Aberdeen 2050)
Prod. Mgr.-Purch. Dept.: LaVerne R. Britton, R. #40 & Plater St., (Tel. Aberdeen 2370)
Chief Engr.-Sales: R. B. Krieger, Jr. (Tel. Aberdeen 2050) S, M

BLOSSOM MFG. CO. INC.
2337 McDonald Ave., Brooklyn 23, N. Y. (Tel. DEwey 6-5555)
Dir.-Purch. & Sales: Jack I. Antokal
Prod. Mgr.: Howard Antokal M

BLOWERS INC.
12655 S. Western Ave., Blue Island, Ill. (Tel. FUlton 8-3060)
Purch. Agent: S. A. Witte

BLUE M ELECTRIC CO.
138th & Chatham St., Blue Island, Ill. (Tel. FUlton 5-9000)
Purch. Agent: W. F. Wilde
V. P.-Sales: Angelo Lazzara CT, RD

BLUE M ENGRG. CO.
2312 S. Main St., Los Angeles 7, Calif.

BOBRICK AERO MISSILE PRODUCTS
1839 Blake Ave., Los Angeles 39, Calif. (Tel. NOrmandy 2-3188)
Purch. Agent: J. A. Puleo
V. P.-Sales: Arnold A. Cowan MS, RD

BODINE ELECTRIC CO.
2500 W. Bradley Pl., Chicago 18, Ill. (Tel. IR 8-3515)
Exec. V. P.-Purch.: E. W. Larson
Asst. Purch. Mgr.: H. G. Anderson
Sales Mgr.: W. M. Yogerst

BOEING AIRPLANE CO., AERO-SPACE DIV.
Box 3707, Seattle, Wash. (Tel. JUniper 6-2121)
Mgr.-Materiel Dept.: M. W. McClung
Mgr.-Minuteman Proc.: E. G. Swanson
Mgr.-Bomarc Proc.: F. E. Akin S, MS, CT, RD, HSE

BOGART MFG. CORP.
315 Seigel St., Brooklyn 6, N. Y. (Tel. HY 7-4972)
Supvr.: H. Schoenfeld
Purch. Agents: W. Edgar & A. Levinson
Expeditor: R. Goldberg
Mgr.-Engrg. Sales: Lee N. Blatt RD

BOGUE ELECTRIC MFG. CO.
52 Iowa Ave., Paterson 3, N. J. (Tel. LAmbert 5-2200)
Purch. Agent: Miss A. Schinman
Purch. Dept.: J. Whitcomb
Sales Mgr.: Joseph Rambusek PS, MS, CT, TT, RD

BOHN ALUMINUM & BRASS CORP.
1400 Lafayette Bldg., Detroit 26, Mich. (Tel. WOodward 3-0655)
V. P.-Sales: R. C. Aylward

BO MYTE CO., INC., THE
Green St., Silverdale, Pa. (Tel. ALpine 7-2300)
Purch. Agent: A. Swann
Pres.: Richard P. Kahn M

BOND METAL SURPLUS CO.
321 Canal St., New York 13, N. Y. (Tel. CA 6-2928)
Sales Mgr.: Jack Cooper M

BONNY MFG. CORP.
146 Main St., Maynard, Mass. (Tel. TWin Oaks 7-9311)
V. P.-Sales: John A. Crowe M

BOOKER-COOPER, INC.
6940 Farmdale Ave., North Hollywood, Calif. (Tel. TRiange 7-7105)
Sales Dir.: Roy Smith

BOONTON ELECTRONICS CORP.
738 Speedwell Ave., Morris Plains, N. J. (Tel. JE 9-4210)
Purch. Agent & Sales Mgr.: J. Frucht
Buyer: N. A. Mangieri

BOONTON RADIO CORP.
50 Intervale Rd., Boonton, N. J. (Tel. DEerfield 4-3200)
Purch. Agent: R. S. Lesser
Sales Mgr.: H. J. Lang

ARTHUR E. BOOTH CO.
265 S. Alexandria Ave., Los Angeles 4, Calif. (Tel. DUnkirk 1-2161)
Purch. Agent: A. R. Booth
Sales Mgr.: Arthur E. Booth CT

BOOTS AIRCRAFT NUT CORP.
Newtown Turnpike, Norwalk, Conn. (Tel. VIctor 7-2446)

Dir.-Purch.: Charles A. Milton
Purch. Agent: Frank Lown
Sales Mgr.: Robert Riddle M

BORDEN CHEMICAL CO.
350 Madison Ave., New York 17, N. Y. (Tel. MUrray Hill 7-4100)
Chem. P. A.: Richard J. Magner
Exec. V. P.-Sales: E. J. Sullivan
Mgr.-Govt. Services: L. J. Jaworski M, RD

BORDEN CHEMICAL CO., THE RESINITE DEPT.
1 N. Clark St., North Andover, Mass. (Tel. MUrdock 7-7131)
Purch. Agent: H. R. Erickson, P. O. Box 430, Compton, Calif. (Tel. NEwmark 9-0423)
Works Mgr.: C. E. Drugge

BORG EQUIPMENT DIV., AMPHENOL-BORG ELECTRONICS CORP.
120 S. Main St., Janesville, Wisc. (Tel. PLeasant 4-6616)
Sales Mgr.: R. K. Johnson G, CT, TT

BORG-WARNER CONTROLS, BORG-WARNER CORP.
3300 Newport Blvd., Santa Ana, Calif. (Tel. Kimberly 5-5581)
Purch. Agent: H. E. Schuyler
Sales Mgr.: H. G. Ayers

BORG-WARNER CORP.
200 S. Michigan Ave., Chicago 4, Ill. (Tel. WA 2-7700)
Pres. & Chief Exec.: Robert S. Ingersoll

BORG-WARNER MECHANICAL SEALS, DIV.-BORG-WARNER CORP.
P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif. (Tel. LUdlow 7-6171)
Gen. Mgr.: H. E. Tracy PS, MS

BOSTON AUTO GAGE CO., THE
70 West St., Pittsfield, Mass. (Tel. HIllcrest 5-5691)
Dir.-Sales & Purch.: T. C. Nelson
Sales Engr.: J. H. Mattoon M

BOSTON GEAR WORKS
14 Hayward St., Quincy 71, Mass. (Tel. PResident 3-0400)
Purch. Agent: William MacRae
Mgr.-Field Sales: William J. Johnson
Mgr.-Inside Sales: Edward P. Williams

BOSTON INSULATED WIRE & CABLE CO.
64 Bay St., Boston, Mass. (Tel. COlumbia 5-2104)
Purch. Agents: Alden C. Davis, Hachig Aghjayan

BOSTROM CORP.
133 W. Oregon St., Milwaukee 4, Wis. (Tel. BRoadway 1-4122)
Purch. Agent: Ed Weiland
Dir.-Mktg.: R. D. Cory
Dir.-Chemical Div.: H. G. Kilb M

BOUND BROOK OIL-LESS BEARING CO.
Bound Brook, N. J. (Tel. ELliot 6-0441)
Dir.-Purch.: D. Brookes
Purch. Agent: S. Richardson
Sales Mgr.: W. F. Kiney
V. P.-Sales: S. S. Connor

BOURNS, INC.
6135 Magnolia Ave., P. O. Box 2112, Riverside, Calif. (Tel. OVerland 4-1700)
Purch. Agent (Trimpot Div.): M. McGuire
Purch. Agent (Instrument Div.): Brad Stevens
Dir.-Sales (Trimpot Div.): D. P. Vaughan
Dir.-Sales (Instrument Div.): E. J. Goeppinger MS, TT, RD

BOW SOLDER PRODUCTS CO., INC.
251 Freeman St., Brooklyn 22, N. Y. (Tel. EVergreen 9-4863)
Purch. Agent: S. Turkus, Jr.
Sales Mgr.: N. Zimmer M

BOWEN-McLAUGHLIN-YORK, INC.
955 Kings Mill Rd., York, Pa. (Tel. York 7814)
Dir.-Purch.: C. S. Bransom
Buyers: William Glassmeyer & William Ritter
V. P.-Sales: J. E. Forinash S, MS

BOWER ROLLER BEARING DIV.
3040 Hart, Detroit 14, Mich. (Tel. VA 2-7300)
Purch. Agent: Charles Heller
Mgr.-Sales: S. E. Davidson

BOWERS BATTERY & SPARK PLUG CO.
P. O. Box 1262, Reading, Pa. (Tel. WAlker 9-0771)
Purch. Agent: Harold L. Deprill
Sales: Paul E. Goodrich

BOWMAR INSTRUMENT, CORP.
8000 Bluffton Rd., Box 2835, Ft. Wayne, Ind. (Tel. Sherwood 3121)
Purch. Agent: Robert J. Stratman
Gen. Sales Mgr.: George F. McCarthy, Great Neck, N. Y. (Tel. HUnter 2-1750) PS, MS, G, RD

BOWSER, INC.
1302 E. Creighton Ave., Fort Wayne, Ind. (Tel. HArrison 2341)
Dir.-Purch.: E. A. Steinhauser
Purch. Agent: M. Coston
Sales Admin.: P. J. Peterink S, MS, RD

BOWSER, INC., DEFENSE DIV.
1302 E. Creighton Ave., Ft. Wayne, Ind. (Tel. HArrison 2341)
Dir.-Purch.: E. A. Steinhauser
Asst. Purch. Agent: Milton Coston
Sales Admin.: Paul J. Peterink MS, G, TT, RD

BOYT HARNESS CO.
303 New York Ave., Des Moines 5, Iowa (Tel. CH 3-4188)
Pres.: Robert F. Boyt
V. P.-Purch.: B. B. Quiner
V. P.-Sales: James O. Boyt MS

BRACH MFG. CORP.
200 Central Ave., Newark 3, N. J. (Tel. HUmboldt 2-1500)
Sr. Buyers: P. Marino, F. Werner, K. Gazo
Dir.-Sales: J. Berger MS, CT, TT

BRADLEY SEMICONDUCTOR CORP.
275 Welton St., New Haven, Conn. (Tel. State 7-7181)
Purch. Agent: Robert A. Brothers
Gen. Sales Mgr.: William J. Gagnon

W. H. BRADY CO.
727 W. Glendale Ave., Milwaukee 12, Wisc. (Tel. EDgewood 2-8100)
Purch. Agent: Eldon Meier
V. P.-Sales: T. W. Wise M

BRAM METALLURGICAL CHEMICAL CO.
820 65th Ave., Philadelphia 26, Pa. (Tel. WAverly 4-2121)
Metallurgical-Chemical Exec.: H. H. Bram
Asst.: T. G. Bram M

WILLIAM BRAND, REX DIV.-AMERICAN ENKA CORP.
31 Sudbury Rd., Concord, Mass. (Tel. EMerson 9-9630)
Mgr.-Planning & Purch.: J. R. Garey
Purch. Agent: C. J. Crawford
Dir.-Mktg.: G. E. Bell
Gen. Sales Mgr.: C. R. Riordan M

BRANSON CORP.
41 S. Jefferson Rd., Whippany, N. J. (Tel. TUcker 7-1100)
Purch. Agent: C. H. Tuttle
Sales Mgr.: C. G. Braun

BRANSON INSTRUMENTS, INC.
33 Brown House Rd., Stamford, Conn. (Tel. DAvis 4-6721)
Purch. Agent: Celso Biagini
Pres.: Peter K. Bloch
Sales Mgr.: John E. Bobbin CT

BRAUN-KNECKT-HEIMANN CO., INDUSTRIAL DIV.
601 O'Niell Ave., Belmont, Calif. (Tel. LYtell 3-8276)
Purch. Agent: H. M. Warden
Sales Mgr.: H. Hutchings RD

BREEZE CORPORATIONS, INC.
700 Liberty Ave., Union, N. J. (Tel. MUrdock 6-4000)
Purch. Agent: R. Fuller
Mgr.-Mktg.: Matthew Lyon
Sales Mgr.: Alban P. Mudd
Asst. Sales Mgr.: J. M. Hearn M

RICHARD D. BREW & CO., INC.
90 Airport Rd., Concord, N. H. (Tel. CApitol 5-6605)
Purch. Agent: Paul Fisher
Buyer: Merton Tolman
V. P.-Sales: Roy E. Lonnberg G, TT, RD

BRIDGEPORT BRASS CO.
30 Grand St., Bridgeport 2, Conn. (Tel. EDison 4-1182)
V. P.-Sales: R. L. Allen
Dir.-Purch.: A. Malisek M, RD

BRIDGEPORT THERMOSTAT DIV., ROBERTSHAW-FULTON CONTROLS CO.
155 Hill St., Milford, Conn. (Tel. TRinity 8-1721)
Purch. Agent: H. V. Boshea
Sales Mgr.: Carl F. Ahlheim

BRIGGS ASSOCIATES, INC.
10 De Kalb St., Norristown, Pa. (Tel. BRoadway 9-0400)
Buyer: Miss J. Wallman
Sales Mgr.: G. A. Hedden, Jr.
Sales Admin.: J. F. Baldino MS, CT

BRIGGS FILTRATION CO., THE
River Rd., Washington 16, D. C. (Tel. OLiver 4-7722)
Purch. Agent: D. H. Hardester
V. P.-Gen. Mgr.: J. H. Nash
Sales: John MacGuffin MS, RD

BRIGHT STAR INDUSTRIES
600 Getty Ave., Clifton, N. J. (Tel. GRegory 1-3200)
Dir.-Purch.: Arthur T. Levine
Gen. Sales Mgr.: Charles F. Bishop PS, M, CT

BRIGHTON CORP.
820 State Ave., Cincinnati 4, Ohio (Tel. GRandview 1-4110)
Purch. Agent: C. Johnson
Sales Mgr.: Richard G. Hext M

BRILHART PLASTICS CORP.
Old Country Rd., Mineola, L. I., N. Y. (Tel. Ploneer 6-0425)
Purch. Agent: William Shea

E. W. BRILMAYER LABS., INC.
86 Fulton St., New York 38, N. Y. (Tel. BEekman 3-7914)
Pres.: Eugene W. Brilmayer CT

BRISCOE MFG. CO.
1055 Gibbard Ave., Columbus 3, Ohio (Tel. AX 4-3376)
Purch. Agent: Mrs. Jeanne L. Hewitt
Pres.: E. H. Briscoe MS

BRISTOL BRASS CORP., THE
580 Broad St., Bristol, Conn. (Tel. LUdlow 2-3161)
Purch. Agent: Fred J. Greenleaf
Gen. Sales Mgr.: Donald Gay M

***BRISTOL CO., THE**
Waterbury 20, Conn. (Tel. PLaza 6-4451)
Purch. Agent: F. Frohn
Asst. Purch. Agents: E. J. Griffith & J. E. Coleman
V. P.-Sales: H. E. Beane
Sales Mgr., Aircraft Dept.: W. C. Calvert MS, G, CT
*(See advertisement this issue)

BRISTOL INSTRUMENT GEARS, INC.
11 Union St., Bristol, Conn. (Tel. LUdlow 3-1395)
Treas.: Alexander Carros RD

BRISTOL MOTORS DIV.-VOCALINE CO. OF AMERICA, INC.
Coulter St., Old Saybrook, Conn. (Tel. EVergreen 8-3414)
Purch. Agent: Robert B. Cooney
Sales: Charles M. Murphy

***BRISTOL SIDDELEY ENGINES LTD.**
Mercury House, 195, Knighsbridge, London, S.W. 7
Directors: Sir W. Reginald Verdon Smith, Chrm., Sir Roy H. Dobson, Vice Chrm., H. T. Chapman, Deputy Chrm.-Coventry
Chief Engr.: Dr. E. Warlow Davies
*(See advertisement this issue)

BRITTON ELECTRONICS CORP.
19 Warren Place, Mt. Vernon, N. Y. (Tel. OWens 9-3311)
V. P.-Purch.: F. M. Comins
Purch. Agent: Ray Rogers
Asst. Purch.: Paul Dengler
Dir.-Sales: Henry S. Ovrut

BROADVIEW RESEARCH CORP.
1811 Trousdale Dr., Burlingame, Calif. (Tel. Diamond 4-7625)
V. P.-Purch.: Warren R. Ketler
Dir.-Planning: Theodore R. Broida
Pres.: Richard De Lancie
Acting Dir.-Intelligence Systems Div.: Frederick J. Doyle, Washington, D. C. (Tel. FEderal 7-7300) RD

BROOK MOLDING CORP.
30 Industrial Way, Norwood, Mass. (Tel. NOrwood 7-4715)
Purch. Agent: F. K. Whiting
Sales Mgr.: C. M. Cunningham S, M

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

MILTON H. BROOKS & SON ENGRAVING & MFG. CO., INC.
2134 N. Upton St., Arlington 7, Va. (Tel. JAckson 2-4803)
V. P.-Purch. & Sales: Milton H. Brooks, Jr.
M, G, CT, RD

BROOKS & PERKINS, INC.
1950 W. Fort St., Detroit 16, Mich. (Tel. TA 5-5900)
Purch. Agent (Mgr.): H. L. Westerdale
Purch. Dept.: John Drypen & Neil McLean
Gen. Sales Mgr.: H. P. Dunne **S, MS, M**

BROOKS ROTAMETER CO.
407 W. Vine St., Hatfield, Pa. (Tel. ULysses 5-5174)
Purch. Agent: Frederick Roethemeier
Exec. V. P.-Sales: Seymour Blechman **MS, CT, RD**

DAYTON T. BROWN, INC.
1305 Strong Rd., Copiague, N. Y. (Tel. TUrner 4-2700)
Purch. Agent: Stephan Babinsky
Exec. V. P.: William P. McLean
V. P.-Sales: Ernest E. Tealey
S, PS, MS, M, G, CT, TT

S. G. BROWN
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Sales Mgr.: Ed Cornfeld

BROWN & SHARPE MFG. CO.
Promenade, Providence 1, R. I. (Tel. DExter 1-5000)
Purch. Agent: E. L. Anderson, Jr. **MS**

BROWN-LINE CORP.
111 Main St., El Segundo, Calif. (Tel. EA 2-2237)
Purch. Agent: A. C. Tlougan
V. P.-Sales: M. A. Miner **MS**

BRUCE ENGRG. CO.
1633 W. 134th St., Gardena, Calif. (Tel. FAculty 1-2220)
Sales Mgr.: Burr McDowell
Supt.: M. K. Redlin **S, PS, MS, M**

BRUNING CO., THE
601 S. 9th St., Lincoln, Neb. (Tel. HE 5-3511)
Purch. Agent: E. G. Moffitt
Sales Mgr.: J. D. Irvine
Pres.: E. F. Bruning

BRUNO-NEW YORK INDUSTRIES CORP.
460 W. 34th St., New York 1, N. Y. (Tel. LOngacre 4-5930)
Gen. Mgr. & Pres.: Irving Strauss
Purch. Agent: Ralph Wilson
Asst. to Pres.: Emauel Singer **G, CT, TT, RD**

BRUNSON INSTRUMENT CO.
8000 E. 23rd St., P. O. Box 7951, Kansas City 29, Mo. (Tel. HUmbolt 3-3187)
V. P.-Purch.: Gene E. Brunson
V. P.-Sales: M. C. Anderson **CT, RD**

BRUNSWICK BALKE COLLENDER CO., THE, DEFENSE PRODUCTS DIV.
1700 Messler St., Muskegon, Mich. (Tel. 2-6681)
Buyer: R. W. Jarman
Gen. Sales Mgr.: L. A. Niedfeldt
Buyer: E. Spitzer, Marion, Va. (Tel. STate 3-7111)
S, PS, RD

BRUNSWICK INSTRUMENTS
Box 813, New Brunswick, N. J. (Tel. CHarter 7-5919)
Chief Engr.-Purch.: L. A. Rosenthal
Sales Mgr.: E. J. Horodner **RD**

BRUSH BERYLLIUM CO., THE
5209 Euclid Ave., Cleveland, O. (Tel. ENdicott 1-5400)
Dir.-Purch.: Richard Anuskiewicz
Purch. Agent: R. A. Cobb
V. P.-Sales: N. W. Bass **M, RD**

BRUSH INSTRUMENTS, DIV.-CLEVITE CORP.
37th & Perkins, Cleveland 14, Ohio (Tel. ENdicott 1-3315)
Purch. Mgr.: W. J. David
Gen. Sales Mgr.: Norman R. Klivans

BRYANT COMPUTER PRODUCTS DIV.
123 Main St., Springfield, Vt. (Tel. TUrner 5-2141)
Purch. Agent: A. E. Belanger
Purch. Dept.: W. S. Pozner
Dir.-Sales: P. L. Smith **M**

BRYS INSTRUMENT CO.
7026 Sixth Ave., Brooklyn 9, N. Y. (Tel. BEachview 8-0305)
Purch. Agent: Theodore Brys
Sales Mgr.: Otto Lohkemper **M, G, CT, TT**

BUCHANAN ELECTRICAL PRODUCTS CORP.
523 U. S. 22, Hillside, N. J. (Tel. WAverly 3-7474)
Plt. Supt. & Purch. Agent: Albert Mittleman
V. P.-Chg. Sales: Paul E. Vance **M**

BUCHMANN SPARK-WHEEL CORP.
4-20 47th Ave., Long Island City 1, N. Y. (Tel. RAvenswood 9-2980)
Gen. Mgr.: E. Schmidt
V. P.-Purch.: R. Dismas
Dir.-Sales: P. Schmidt

BUCKEYE IRON & BRASS WORKS
324 E. 3rd St., Dayton 1, O. (Tel. BAldwin 4-8355)
Purch. Agent: R. L. Reel
Sales Mgr.: Ray O. Comp **MS**

BUCKEYE TOOLS CORP.
5005 Springboro Pike at U. S. 25, Dayton 39, Ohio (Tel. AXminster 8-5281)
Dir.-Purch.: E. E. Reeves
V. P.-Mktg.: E. B. Meynard

BUD RADIO, INC.
2118 E. 55th St., Cleveland 3, Ohio (Tel. HEnderson 1-7166)
V. P.-Purch.: E. J. Korey
Pres.: A. N. Haas **MS, M**

BUDD CO., THE
2450 Hunting Park Ave., Philadelphia 32, Pa. (Tel. BAldwin 5-9100)
Dir.-Purch.: W. A. Ehresman
Purch. Agent, Steel: R. F. Estes
Purch. Agent: W. G. Sutter
Gen. Sales Mgr.: W. H. Knowles, Jr. **S, M, CT**

BUDD LEWYT ELECTRONICS, INC.
43-22 Queens St., Long Island City 1, N. Y. (Tel. EXeter 2-5050)
Purch. Agent: Alter Hurwitz
V. P.-Sales: Jerome L. Strauss **MS, G, CT, TT, RD**

BUDELMAN ELECTRONICS CORP.
375 Fairfield Ave., Stamford, Conn. (Tel. Fireside 8-9231)
Purch. Agent: Edward Callum
Sales Mgr.: Robert L. Feistel **TT, RD**

BUFFALO METAL CONTAINER CORP.
35 Roetzer St., Buffalo 11, N. Y. (Tel. BA 3944)
Dir.-Purch.: Robert J. Schieder
Sales Mgr.: A. E. Bausenbach **RD**

BUFFALO WIRE WORKS CO., INC.
320 Terrace, Buffalo 2, N. Y. (Tel. CLeveland 4520)
Purch.: Charles F. Scheeler, Jr.
Sales Mgr.: Norman F. Grundner **M**

H. H. BUGGIE DIV., BURNDY CORP.
P. O. Box 817, Toledo 1, Ohio (Tel. OXford 1-2411)
Dir.-Purch.: Marty Koehl
Gen. Sales Mgr.: F. L. Cahill **MS, M, G, CT, TT, RD**

BULLARD CO., THE
286 Canfield Ave., Bridgeport 9, Conn. (Tel. EDison 6-2511)
Mgr.-Purch. & Traffic: T. H. Wilber
Gen. Sales Mgr.: H. E. Neale

BULOVA RESEARCH & DEVELOPMENT LABS., INC.
62-10 Woodside Ave., Woodside 77, N. Y. (Tel. NEwtown 9-5700)
Purch. Mgr.: Walter Rogers
V. P.-Engrg. Sales: Oscar B. Brockmeyer
CT, TT, RD

BULOVA WATCH CO., ELECTRONICS DIV.
40-06 62nd St., Woodside 77, N. Y. (Tel. NEwtown 9-5700)
Sales Mgr.: J. D. Harlin

BULOVA WATCH CO., INC., TURTLE MOUNTAIN DIV.
Rolla, N. D. (Tel. Rolla 408)
Plant Mgr.: Delbert E. Anderson
Dir.-Sales: Warren Young **M, G, CT**

BULOW ELECTRIC CO.
11000 Capital, Oak Park 37, Mich. (Tel. LI 7-1133)
Dir.-Purch.: C. J. Galea
Sales Mgr.: R. L. Bulow **RD**

BUNTING BRASS & BRONZE CO., THE
715 Spencer St., Toledo 9, Ohio (Tel. EVergreen 2-3451)
Dir.-Purch.: W. H. Roberts
Asst. Treasurers: R. G. Sevrence & R. L. Lingruen
Dir.-Sales: R. O. Oyler **M**

BURG TOOL MFG. CO., INC.
15001 S. Figueroa St., Gardena, Calif. (Tel. FA 1-3510)
Purch. Agent: M. Tavlin
V. P.-Sales: J. Burg

BURGESS BATTERY CO., DIV.-SERVEL, INC.
Foot of Exchange, Freeport, Ill. (Tel. ADams 2-2161)
Purch. Agent: Raymond Beldt
V. P.-Sales: C. E. Balz **G, CT, TT**

BURGMASTER CORP.
13226 S. Figueroa, Gardena, Calif. (Tel. FAculty 1-2931)
Sales Mgr.: Edward G. Merk
Purch. Agent: Marvin Tavlin, 15001 S. Figueroa St., Gardena, Calif. (Tel. FAculty 1-3510)

BURKLYN CO.
3429 Glendale Blvd., Los Angeles 39, Calif. (Tel. NOrmandie 2-3111)
Chief Clerk: A. Reed
Dir.-Sales & Purch.: Roland Stevens
Asst. Mgr.: A. L. Kissler **MS, CT, TT**

BURNDY CORP., OMATON DIV.
Richards Ave., Norwalk, Conn. (Tel. TEmple 8-4444)
Dir.-Purch.: L. Menzl
Dir.-Sales: S. D. Bergman
Buyers: W. Frey, J. Hartcorn **MS, G, CT, TT**

BURNELL & CO., INC.
10 Pelham Pkwy., Pelham Manor, N. Y. (Tel. PElham 8-5000)
Purch. Agent: V. Triwedi
Sales Mgr.: L. Schwartz **M, TT**

BURNER-HOLLOMON MFG. CORP.
4706 Rhode Island Ave., Hyattsville, Md. (Tel. UNion 4-5401)
Secy.-Treas.: Frank A. Hollomon
Pres.: C. Randolph Burner
Chief Engr.: Charles K. Ramsdell **S, MS**

BURNS & ROE INC., CONSULTING ENGINEERS
160 W. Broadway, New York 14, N. Y. (Tel. REctor 2-7000)
Purch. Agent: G. L. Ryan
Dir.-Defense & Aero Div.: J. E. Robbins
V. P.-Sales: L. F. A. Mitchell **S, MS, CT, TT, RD**

BURNLEY BATTERY & MFG. CO., THE
103 Clay St., North East, Pa. (Tel. SAratoga 5-3595)
Pres.: N. C. Swanson

BURR-BROWN RESEARCH CORP.
Box 6444, Tucson, Ariz. (Tel. AXtel 8-0772)
Dir.-Purch. & Sales: Thomas R. Brown, Jr. **RD**

BURROUGHS CORP.
6071 2nd Ave., Detroit 32, Mich. (Tel. TRinity 5-2260)
Dir.-Purch.: Russ T. Stark
Defense Sales Mgr.: Jack C. Lindley **MS, G, CT, RD**

BURROUGHS CORP., ELECTRODATA DIV.
460 Sierra Madre Villa, Pasadena, Calif. (Tel. MUrray 1-3251)
Mgr.-Purch.: W. B. Wight
Purch. Agent (Gen. Proc.): N. E. Ronkainen
Purch. Agent (Mech. Proc.): C. B. Mulhollend
Sales Mgr.: Robert G. Dee

BURROUGHS CORP., ELECTRONIC TUBE DIV.
Mt. Bethel Rd., Plainfield, N. J. (Tel. PL 7-5000)
Purch. Agent: Vincent Perrucci
Sales Dir.: Arthur B. Shesser **MS, CT**

BURTON-RODGERS, INC.
Blade & Helen Sts., Cincinnati 16, Ohio (Tel. UNiversity 1-2155)
Asst.-Pres.: O. A. Linse
Purch. Agent: Allen Loftspring **MS, CT, RD**

BURTON-ROGERS CO., SALES DIV.-HOYT ELECTRICAL INSTRUMENTS
42 Carleton St., Cambridge 42, Mass. (Tel. ELiot 4-1643)
Dir.-Sales: William Burton
Chairman-Board: C. W. Burton
Pres.: V. S. Church

E. W. BUSCHMAN CO., THE
Cincinnati 32, Ohio (Tel. MUlberry 1-1600)
Purch. Agent: A. E. Oehler
Asst. Purch. Agent: D. Scholl
Pres.: R. B. Vogt **S, M**

BUSHINGS, INC.
4358 Coolidge Hwy., Royal Oak, Mich. (Tel. LIberty 9-3320)
V. P.-Purch.: K. W. Maust
V. P.-Sales: H. G. Moore **M**

BUSSMANN MFG. DIV., McGRAW-EDISON CO.
University at Jefferson, St. Louis 7, Mo. (Tel. GArfield 1-1740)

Dir.-Purch.: Lee J. Bussmann
V. P.-Sales: J. C. Ingram M

BUTLER MFG. CO.
7400 E. 13th St., Kansas City, Mo. (Tel. BEnton 1-7400)
Dir.-Purch.: L. P. Melcher
V. P.-Mktg.: H. A. Edlund S, MS, M

A. M. BYERS CO.
1810 Clark Bldg., Pittsburgh 22, Pa. (Tel. ATlantic 1-8110)
Dir.-Purch.: F. Engelhardt M

BYRON JACKSON PUMPS, INC.
2300 E. Vernon Ave., Los Angeles, Calif. (Tel. LUdlow 7-6171)
Purch. Agent: Elmer C. Prairie
Mgr.-Sales: N. D. Jesse MS, RD

BYTREX CORP.
50 Hunt St., Newton 58, Mass. (Tel. WAlnut 6-0360)
Prod. Mgr.: Malcolm Green
Buyer: J. A. Simone
Chief Engr.: David J. First
Sales Mgr.: Stanley Charren MS, CT, RD

CBS ELECTRONICS, DIV.-COLUMBIA BROADCASTING SYSTEM, INC.
100 Endicott St., Danvers, Mass. (Tel. SPring 4-2360)
Dir.-Purch.: Edward R. Carroll
Purch. Agent: John F. Ryan
Asst. Purch. Agent: William E. Dennis
Buyers: R. A. Powers, J. W. Connery, F. W. Courage, W. W. Cook, E. F. Murphy, H. J. McLaughlin
V. P.-Mktg.: Reed V. Bontecou

CBS LABS., DIV.-THE COLUMBIA BROADCASTING SYSTEM
227 High Ridge Rd., Stamford, Conn. (Tel. DAvis 5-4321)
Dir.-Purch.: Ralph Danue
Mgr., Mil. Liaison: Howard A. Zeimer TT, RD

C. E. M. CO., INC.
24 School St., Danielson, Conn. (Tel. PRescott 4-8571)
V. P.-Purch.: Hans Koehl
Sales Mgr.: R. J. Harrington

CESCO
4025-37 Sebastopol Hwy., Santa Rosa, Calif.

CG ELECTRONICS CORP.
1500 Central East, Albuquerque, N. M. (Tel. AXtel 9-7601)
Purch. Agent: Ina Crampton
Mktg. Dept.: Ed Yrisarri, Jr. MS, G, CT, TT, RD

CGS LABS., INC.
59 Danbury Rd., Rte 7, Wilton, Conn. (Tel. POrter 2-5521)
Purch. Agent: George W. Korper
Asst. Purch. Agent: Lloyd Sturges
V. P.-Mktg.: Melvin L. Jackson RD

C & H SUPPLY CO.
415 E. Beach Ave., Inglewood 3, Calif. (Tel. ORegon 8-4181)
Purch. Agent: Clifford Stockdale
Chief Engr.: James Collins
Sales Mgr.: James C. Colfer M

C & K COMPONENTS, INC.
101-103 Morse St., Newton 58, Mass. (Tel. WAlnut 6-0800)
Purch. Agent: Charles Crothers
Buyer: L. Greenblatt
Sales Mgr.: Robert H. Sturdy MS, G

CABLE ELECTRIC PRODUCTS INC.
234 Daboll St., Providence, R. I. (Tel. STuart 1-5400)
Purch. Agent: W. Balutowski
Dir.-Sales: F. W. Schwartz M, RD

CADILLAC GAGE CO.
25760 Groesbeck Hwy., Warren, Mich. (Tel. PRescott 7-7100)
Dir.-Purch.: H. Goll
Sales Mgr., Aero Div.: Robert E. Kolp MS, CT, RD

CADILLAC PLASTIC & CHEMICAL CO.
15111 Second Ave., Detroit 3, Mich. (Tel. TOwnsend 9-9500)
Purch. Agent: Al Piper
Tech. Purch. Dir.: Frank Bomard
Dir.-Sales: Kenneth Glabach M

CADILLAC PLASTIC CO. OF CALIF.
2305 Beverly Blvd., Los Angeles, Calif. (Tel. DUnkirk 5-3001)
Mgr.: Eugene Quinn M

CAIG LABS.
46 Stanwood Rd., New Hyde Park, L. I., N. Y. (Tel. Ploneer 2-0278)
Purch.: A. Pagelson
Sales: O. Lohkemper M

CAL CONNECTOR CO.
7360 Varna Ave., North Hollywood, Calif. (Tel. TRiangle 7-2623)
Owner: Scott Glenn G, CT, TT

CAL PARTS CO.
14858 Aetna St., P. O. Box 134, Van Nuys, Calif. (Tel. TRiangle 3-2360)
Purch. Mgr.: H. J. Ceiley
Sales Dept.: R. Levison M

CALCON MFG. CO., INC.
100 Oakland Ave., Washington, Pa. (Tel. BAldwin 2-8190)
Purch. Agent: F. H. Haynor
Wks. Mgr.: A. W. Moore
Gen. Sales Mgr.: James C. Morosco MS, CT, RD

CALCOR CORP.
1010 W. Philadelphia St., Whittier, Calif. (Tel. RAymond 3-0211)
Gen. Mgr.: Robert Feltham
Pres.: Andrew A. Brown
Sales Mgr.: Edwin A. Trent S, MS, RD

CALEDONIA ELECTRONICS & TRANSFORMER CORP.
P. O. Box 98, Caledonia, N. Y. (Tel. KEystone 8-4423)
Dir.-Purch.: F. E. Gannon
Sales Mgr.: R. E. Hutchins

CALIDYNE CO., INC., THE, SUB.-LING-ALTEC ELECTRONICS, INC.
120 Cross St., Winchester, Mass. (Tel. PArkview 9-3810)
Purch. Agent: Gordon Worthen
Asst. Purch. Agent: Walter Meehan
V. P.-Prod.: Joseph Distefano
Dir.-Sales: Stanley H. Walters

CALIFORNIA AIRCRAFT PRODUCTS
790 Greenfield Dr., El Cajon, Calif. (Tel. HIckory 2-3451)
Purch. Agent: Gavin W. Coles
Sales Mgr.: Joseph S. Alan MS, RD

CALIFORNIA COMPUTER PRODUCTS, INC.
8714 Cleta St., Downey, Calif. (Tel. WAlnut 3-1913)
Dir.-Quality Control: F. K. Kelsay
Pres.: L. D. Kilpatrick G, TT

***CALIFORNIA GENERAL, INC.**
P. O. Box 565, Chula Vista, Calif.
*(See advertisement this issue)

CALIFORNIA PLASTECK INC.
219 E. 4th St., Los Angeles 13, Calif. (Tel. MA 4-4311)
Gen. Mgr.: Les Madansky
Sales Dept.: Harry Simmons G, CT, TT

CALIFORNIA SPRING CO., INC.
8401 E. Slauson Ave., Pico-Rivera, Calif. (Tel. RAymond 3-8581)
Purch. Agent: Robert Harris
V. P. & Sales Mgr.: Ray E. Coffield

CALIFORNIA STAMPING & MFG. CO.
909 E. 59th St., Los Angeles 1, Calif. (Tel. ADams 1-5141)
Gen. Mgr.: P. V. Eskew, Sr.
Sales Mgr.: Richard Wink S, MS

CALIFORNIA TECHNICAL INDUSTRIES, DIV.-TEXTRON INC.
1421 Old County Rd., Belmont, Calif. (Tel. LYtell 3-8466)
Dir.-Purch.: John Burk
Buyers: Carl Stigall & Betty Wellington
Sales Mgr.: H. C. May CT, RD

CALINOY DIV., ILLINOIS TOOL WORKS
3155 El Segundo Blvd., Hawthorne, Calif. (Tel. ORegon 8-3437)
Purch. Agent: Willard Long
Purch. Asst.: Jean Jones
Chief Engr.: Thomas R. Boyd
Sales Mgr.: H. O. Hansen S, MS

CALLAIR, INC.
Afton, Wyoming (Tel. 166)
Pres. & Gen. Mgr.: John J. Mangum, Jr.
Purch.: Barlow H. Call S

CALLERY CHEMICAL CO.
P. O. Box 11145, Pittsburgh 37, Pa. (Tel. Evans City, Pa. 3510)
Purch. Agent: R. L. Horstman
Mgr.-Mktg.: R. A. Mulholland
Purch. Agent: L. D. Henderson, P. O. Box 1452, Muskogee, Okla. (Tel. MUrray 7-4401) M, RD

CALTRON PRODUCTS CO.
3518 W. Pico Blvd., Los Angeles 19, Calif. (Tel. REpublic 4-2420)
Mgr.-Purch.: C. P. Swanson
Sales Mgr.: J. B. Sebrell M

CALVERT ELECTRONICS INC.
536 Broadway, New York 12, N. Y. (Tel. CAnal 6-7400)
Pres.: Murray Fudim
Purch.: Benjamin Fudim
V. P.-Sales: Bernard Fox M, CT

CAMBRIDGE FILTER CORP.
738 E. Erie Blvd., Syracuse 1, N. Y. (Tel. GRanite 5-1608)
Purch. Agent: Richard C. Linehan
Sales Mgr.: Donald E. Wendel MS, CT, RD

CAMBRIDGE THERMIONIC CORP.
445 Concord Ave., Cambridge 38, Mass. (Tel. TRowbridge 6-2800)
Purch. Agent: Frank C. Waterhouse
Sales Mgr.: Lowell Wilkes G, TT

CAMBRIDGE WIRE CLOTH CO., THE
Cambridge, Md. (Tel. ACademy 8-3000)
Purch. Agent: Fulton Moore
Exec. V. P.-Sales: F. L. Hooper M

CAMCAR SCREW & MFG. CO., DIV.-TEXTRON INDUSTRIES, INC.
600 Eighteenth Ave., Rockford, Ill. (Tel. WOodland 5-9451)
Purch. Agent: Iver Hawkinson
V. P.-Sales: James L. Holland

CAMDALE PRECISION, INC.
28300 Groesbeck Hwy., Roseville, Mich. (Tel. PRescott 1-0400)
Purch. Agent: H. L. Miller
V. P.-Sales: A. R. Schwesinger

CAMERAFLEX DIV., THE, FEDERAL MFG. & ENGRG. CORP.
1055 Stewart Ave., Garden City, L. I., N. Y. (Tel. Ploneer 2-7400)
Purch. Agent: Harry Levin
Chief Designer: Joseph Henkel
Mgr.-Special Proj. Sales: Henry J. Bopp, Jr. MS, G, CT, TT, RD

***CAMERON IRON WORKS, INC.**
P. O. Box 1212, Houston, Texas (Tel. OV 6-5511)
Purch. Agent: I. P. Dahl
Asst. Sales Mgr., Special Products Div.: R. D. Springer S
*(See advertisement this issue)

CAMLOC FASTENER CORP.
22 Spring Valley Rd., Paramus, N. J. (Tel. HUbbard 9-4900)
Gen. Supt.: T. A. Barkauskas
Purch. Agent: U. G. Grapengeter
Purch. Dept.: T. Skelly
Eastern Sales Mgr.: Bennet F. Becker
Western Sales Mgr.: James G. English, 5410 Wilshire Blvd., Los Angeles, Calif. (Tel. WEbster 1-1361)

CAMPBELL CHAIN CO.
York, Pa. (Tel. York 5456)
V. P.-Mfg.: Howard D. Campbell
Purch. Agent: George Laver
V. P.-Mktg.: A. A. Hally M

CAMPBELL INDUSTRIES, INC.
Grant St., North Aurora, Ill. (Tel. Aurora 6-8551) M

CANADIAN RADIUM & URANIUM CORP., MFG. DIV.
43 W. 16th St., New York 11, N. Y. (Tel. WAtkins 4-3760)
Purch.: Mrs. Rose Herman
Chief Engr.: B. Gorlin G, CT, RD

C. F. CANNON CO.
Springwater, N. Y. (Tel. 531)
Dir.-Sales: A. W. Shriner

CANNON ELECTRIC CO.
3208 Humboldt St., Los Angeles 31, Calif. (Tel. CApitol 5-1251)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch. Agent: Earl Bixler
Mgr.-Purch.: Leroy Whitney
Gen. Sales Mgr.: Floyd M. Cate
Purch. Agent (Salem Div.): L. J. McCarthy, Pingree & Leavitt Sts., Salem, Mass. (Tel. Pioneer 5-0700)
Purch. Agent (Phoenix Div.): Charles Latchem, Jr., 2801 Airline, Phoenix, Ariz. (Tel. BRidge 5-4792)
Purch. Agent (Santa Ana Div.): Monty Burns, 666 E. Dyer Rd., Santa Ana, Calif. (Tel. KImberly 5-7121) M

CANNON-MUSKEGON CORP.
2875 Lincoln St., Muskegon, Mich. (Tel. 5-1676)
Purch. Agent: George Gimakas
Sales Mgr.: F. Kenneth Iverson M

CANOGA DIV., UNDERWOOD CORP.
15330 Oxnard St., Van Nuys, Calif. (Tel. STate 6-9010); 736 N. Beale St., Ft. Walton Beach, Fla.
Dir.-Purch.: Louis E. Moore
Buyers: J. Caminiti & D. Tayrien
V. P.-Sales: M. P. Roebuck TT

CAPEWELL MFG. CO.
60 Governor St., Hartford 2, Conn. (Tel. JAckson 2-8191)
V. P.: Seery C. Gordon
Purch. Agent: Bernard Dunphy RD

CAPITAL CITY MFG. CO., INC.
857 King Ave., Columbus 12, O. (Tel. AX 9-2149)
Purch. Agent: C. E. Bailey
Sales Engr.: L. E. Alspach S, PS, MS, RD

CAPITOL MACHINE CO., THE
36 Balmforth Ave., Danbury, Conn. (Tel. Pioneer 3-2758)
Purch. Agent & Sales Mgr.: Arthur E. Wilson MS, CT, TT, RD

CAPTIVE SEAL CORP.
30 Henry, Teterboro, N. J. (Tel. AT 8-0205)
Purch. Agent: R. Dodd
Purch.: R. T. Scott
Dir.-Sales: P. H. Palen PS, MS, CT, RD

CARBOLINE CO.
32 Hanley Ind. Ct., St. Louis 17, Mo. (Tel. MI 7-5795)
Purch. Agent: R. Meder
Sales Mgr.: R. R. Rosenthal M

CARBONE CORP., THE
400 Myrtle Ave., Boonton, N. J. (Tel. DE 4-0700)
Purch. Agent: E. Wizeman
Sales Mgr.: E. Dixon M

CARBORUNDUM CO., THE
Niagara Falls, N. Y. (Tel. BUtler 5-6631)
Purch. Mgr.: W. F. Burk, Jr.
Dir.-Mktg.: F. T. Keeler M, RD

CARBORUNDUM CO., LATROBE PLANT, REFRACTORIES DIV.
Latrobe, Pa. (Tel. KEystone 7-3331)
Purch. Agent: J. W. Bell, Jr.
Mgr.-Electronic Sales: D. S. Bowman M, RD

CARBORUNDUM CO., REFRACTORIES DIV.
Perth Amboy, N. J. (Tel. HIllcrest 2-3380)
Buyer: F. Richter
Mgr.-Refractories Sales Branch: A. A. Turner
Mgr.-Mktg.: J. M. Smith M

CARBORUNDUM METALS CO., THE
P. O. Box 32, Akron, N. Y. (Tel. LH 2-5454)
Buyer: William F. Pritchard
Mgr., Sales Branch: H. A. Andersen M

CARDELL MFRS.
1225 Harshman Rd., Dayton 31, Ohio (Tel. CLearwater 6-2311)
Dir.-Purch.: C. J. Snider
Dir.-Sales: T. K. Snider CT

CARDOX DIV., CHEMETRON CORP.
840 N. Michigan Ave., Chicago 11, Ill. (Tel. WHitehall 4-7450)
Purch. Agent: M. Hemman
V. P.-Sales: F. C. Rodgers MS

CARLETON AVIATION CO., INC.
Jamison Rd., East Aurora, N. Y. (Tel. CYpress 4838)
Dir.-Purch.: John H. Shirmer
George Ord PS, MS, HSE

CARLING ELECTRIC, INC.
504 New Park Ave., West Hartford 7, Conn. (Tel. ADams 2-4461)
Purch. Agent: William Fleming
Asst. Sales Mgr.: Francis Hanselman
V. P.-Sales: Wesley T. Sorenson M

G. O. CARLSON, INC.
200 Marshalton Rd., Thorndale, Pa. (Tel. DUdley 4-2800)
Purch. Agent: G. B. Hubbard
V. P.-Sales: W. D. Gerstell M

CARMER INDUSTRIES INC.
22 N. 26th St., Kenilworth, N. J. (Tel. CH 5-1495)
Purch. Agent: F. Sanborn
Pres.: Carl Redmer
V. P.-Sales: Thomas J. Corbett M

CAROL CABLE DIV.
Box 260, Pawtucket, R. I. (Tel. PA 2-3100)
Purch. Agent: F. Sisson
Gen. Sales Mgr.: K. R. MacLean M

CAROL ELECTRONICS CORP.
315 W. Stephen St., Martinsburg, W. Va. (Tel. AMherst 7-8911)
Gen. Mgr.: Eric Ruckbrod M

CARPENTER MFG. CO., INC.
Highbridge Rd., P. O. Box 217, DeWitt 14, N. Y. (Tel. GIbson 6-0670)
Gen. Mgr.: Hubert J. Carpenter

CARPENTER STEEL CO., THE
153 W. Bern St., Reading, Pa. (Tel. Reading, FRanklin 4-8211)
Purch. Agent: R. P. Freehafer
Asst. Purch. Agent: G. D. Nahn
V. P.-Sales: H. S. Potter M

CARPENTER STEEL CO., THE, ALLOY TUBE DIV.
Springfield Rd., Union, N. J. (Tel. MUrdock 6-7230)
Purch. Agent: V. T. Nolan
Asst. Purch. Agent: R. A. Southard
Sales Mgr.: P. E. Kelly M

CARR FASTENER CO., DIV.-UNITED-CARR FASTENER CORP.
31 Ames St., Cambridge 42, Mass. (Tel. KIrkland 7-4900)
Purch. Agent: F. J. Ross
Asst. Purch. Agent: David Erb
Gen. Sales: Arthur W. Rice, Jr.

CARRIER CORP.
Carrier Pkwy., Syracuse, N. Y. (Tel. HOward 3-8411)
Dir.-Purch.: Adolph Ruediger

CARSON MACH. & SUPPLY CO.
200 S. E. 29th St., Box 4547, Oklahoma City 9, Okla. (Tel. ME 4-0511)
V. P.: Henry R. Mills S, M

J. C. CARTER CO., THE
671 W. 17th St., Costa Mesa, Calif. (Tel. LIberty 8-3421)
Purch. Agent: William C. Melo
V. P.-Mfg.: C. J. Allan
V. P.-Engrg. & Sales: M. D. Kilmer
Sales Mgr.: W. W. Saxton PS, MS, M, RD

CARTER MFG. CORP.
23 Washington St., Hudson, Mass. (Tel. JOrdan 2-2206)
Pres.: W. Graustein

CARTER MOTOR CO.
2711 W. George St., Chicago 18, Ill. (Tel. JUniper 8-7700)
V. P.-Purch.: A. J. Carter
Dir.-Sales: E. J. Mitchell TT, RD

CARTRISEAL CORP.
3515 W. Touhy Ave., Lincolnwood, Ill. (Tel. BR 4-6140)
Buyer: Stanley Pyzik
Sales Mgr.: B. M. Foster PS, MS

A. W. CASH VALVE MFG. CORP.
666 E. Wabash Ave., Decatur, Ill. (Tel. 2-8574)
Dir.-Purch.: Donald M. Perry
V. P.-Sales: G. William Madden MS

CASTING ENGINEERS DIV., CONSOLIDATED FOUNDRIES & MFG. CORP.
2323 N. Bosworth Ave., Chicago 14, Ill. (Tel. BUckingham 1-5940)
Purch. Agent: Arthur Matulis
Sales Mgr.: F. H. Meeder S

CATALIN CORP. OF AMERICA
1 Park Ave., New York 16, N. Y. (Tel. MUrray Hill 3-2100)
Adv. Mgr.: R. A. Woodard M

CATALYTIC CONSTRUCTION CO.
1528 Walnut St., Philadelphia 2, Pa. (Tel. KIngsley 5-7500)
V. P.-Purch.: Gerald J. Smith
Buyers: Francis H. Hoffbauer & Edwin B. Stebbins
Mgr., Govt. Sales: Alan McCone

CATERPILLAR TRACTOR CO., DEFENSE PRODUCTS DEPT.
Peoria, Ill. (Tel. 6-3311)
Mgr.: E. B. English
Mgr., Contracts Div.: T. A. Glass
Mgr., Sales Div.: C. B. Leber MS, CT, RD

CATERPILLAR TRACTOR CO., ENGINE DIV.
Peoria, Ill. (Tel. 6-3311)
Purch. Agent: R. D. Norris
Asst. Sales Mgrs.: Hugh Rose & R. A. Cumming
Sales Mgr.: F. V. Jacobs MS

CATERPILLAR TRACTOR CO., INDUSTRIAL ENGINE PLANT
Peoria, Ill. (Tel. 6-3311)
Purch. Agent: R. D. Norris
Buyer: R. V. Pearson
Sales Mgr.: F. V. Jacobs MS

ALBERT H. CAYNE EQUIPMENT CORP.
71 Spring St., New York 12, N. Y. (Tel. CAnal 6-3317)
Purch. Agent: J. C. Lynn
Dir.-Sales: Albert H. Cayne S, M

CAYWOOD-SCHILLER, ASSOCIATES
203 N. Wabash Ave., Chicago 1, Ill. (Tel. ANdover 3-3340)
Purch.: T. E. Caywood
Purch. & Sales: D. H. Schiller RD

CEDAR ENGRG. DIV.-CONTROL DATA CORP.
5806 W. 36th St., Minneapolis 16, Minn. (Tel. WEst 9-1681)
Purch. Agent: L. G. Bernier
Buyer: C. W. Engleman
Gen. Mgr.: Thomas G. Kamp MS, M, G, RD

CENTRAL ELECTRONIC MFRS., DIV.-NUCLEAR CORP. OF AMERICA
2 Richwood Place, Denville, N. J. (Tel. OAkwood 7-4200)
Purch. Agent: Mike Buff
Gen. Sales Mgr.: Gene G. Perry G, TT, RD

CENTRAL RESEARCH LABS., INC.
Red Wing, Minn. (Tel. DUnkirk 8-3566)
Pres.: Frank G. Chesley
V. P.: Demetrius G. Jelatis MS

CENTRAL SAFETY EQUIP. CO.
6601 Marsden St., Philadelphia 35, Pa. (Tel. DEvonshire 3-4788)
Pres.: Henry D. Gordon
Purch. Agent: E. Moss
Sales Mgr.: M. F. Gordon M

CENTRAL SCIENTIFIC CO.
1700 Irving Park Rd., Chicago 13, Ill. (Tel. WE 5-8600)
G. C. Godejahn

CENTRAL SCREW CO.
3501 Shields Ave., Chicago 9, Ill. (Tel. BO 8-6000)
Purch. Agent: M. A. Mueller
Gen. Sales Mgr.: R. E. Munson M

CENTRAL TRANSFORMER CO.
900 W. Jackson Blvd., Chicago 7, Ill. (Tel. TAylor 9-1936)
Purch. Agent: Miss Katharine Bednar
Sales Mgr.: Frank J. Gallagher M

CENTRALAB, DIV.-GLOBE-UNION INC.
900 E. Keefe Ave., Milwaukee 1, Wisc. (Tel. WO 2-9200)
Dir.-Purch.: Frank A. Messor
Gen. Sales Mgr.: W. E. Peek M

CENTURY ELECTRONICS & INSTRUMENTS, INC.
1333 N. Utica, Tulsa 10, Okla. (Tel. LUther 4-7111)
Purch. Agent: C. R. Campbell
V. P.-Sales: C. H. Brunell MS, CT, RD

CENTURY FASTENERS CORP.
88 Sandford St., Brooklyn 5, N. Y. (Tel. ULster 2-6440)
Mgr., Aircraft Div.-Purch.: Pierre Tord
Sales Mgr.: George Stieglitz

CERAMASEAL, INC.
P. O. Box 25, New Lebanon Ctr., N. Y. (Tel. West Lebanon 3-5851)
Purch. Agent: Everett Fransazon
Mgr.-Sales Engrg.: Gene D. Sawin M, RD

CERIUM METALS & ALLOYS DIV., RONSON METALS CORP.
45-65 Manufacturers Pl., Newark 5, N. J. (Tel. MArket 4-1380)
V. P. & Gen. Mgr.: I. S. Hirschhorn
Sales Mgr.: W. A. Otis
V. P.-Sales: J. A. Livingston M

CHADWICK-HELMUTH CO.
472 E. Duarte Rd., Monrovia, Calif. (Tel. EL 8-4567)
Purch. Agent: R. R. Runnels
Sales Mgr.: William F. Cox **CT, RD**

CHAIN BELT CO.
4701 W. Greenfield Ave., Milwaukee, Wisc. (Tel. EVergreen 4-3000)
Purch. Agent: F. A. Coenen
Asst. Purch. Agent: M. O. Menzel
V. P.-Mktg.: G. H. Woodland

CHAIN BELT CO., SHAFER BEARING DIV.
Belmont Rd. at Curtiss St., Downers Grove, Ill. (Tel. WOodland 9-1770)
Div. Purch. Mgr.: R. L. Kaiser
Asst. Sales Mgr.: R. F. Hunter

CHALCO ENGRG. CORP.
15126 S. Broadway, Gardena, Calif. (Tel. FAculty 1-0121)
Dir.-Materiel: Irving Kierman
Purch. Agent: Ronald Ferdman
Dir.-Sales: William L. Rose **MS**

CHAMBERSBURG ENGRG. CO.
Chambersburg, Pa. (Tel. COlony 4-7151)
Purch. Agent: W. H. Derbyshire
Sales Mgr.: S. C. Clarke

CHAMPION CO., THE
400 Harrison St., Springfield, O. (Tel. FAirfax 3-7545)
Purch. Agent: W. E. Cooksey
Asst. Purch. Agent: Samuel Patch
Mgr., Contracts Spec. Prod.: Thomas J. Martin
Mgr., Military Special Prod.: Norman L. Dickey

CHAMPION SPARK PLUG CO.
900 Upton Ave., Toledo 1, O. (Tel. JEfferson 6-3711)
Dir.-Purch.: Keith Wilson
Asst. Dir.-Purch.: C. W. Sweet
V. P.-Sales: Duane Stranahan **PS**

CHANCE VOUGHT AERONAUTICS DIV.
P. O. Box 5907, Dallas, Texas (Tel. AN 2-3211)
Gen. Purch. Agent: W. H. Haugh
Purch. Agent, Gen. Purchases: J. R. Bruno
Purch. Agent, Subcontracts & Subsystems: W. H. Andrews
Dir.-Mktg.: J. B. Allyn
Mgr., Materials: W. R. Kiefer **S, MS, G, CT, RD**

CHANCE VOUGHT AIRCRAFT, INC.
P. O. Box 5907, Dallas, Tex. (Tel. AN 2-3211)
Dir.-Sales & Service: Forbes Mann

CHANCE VOUGHT ASTRONAUTICS DIV.
P. O. Box 5907, Dallas, Texas (Tel. AN 2-3211)
Mgr.-Mkt. Development: H. W. Thomas
Purch. Agent: A. J. Patton **S, MS, CT, RD, HSE**

CHANCE VOUGHT ELECTRONICS DIV.
P. O. Box 5907, Dallas, Texas (Tel. AN 2-3211)
Mgr.-Mktg. Dept.: A. E. Wasserman
Materials Mgr.: B. A. Carlson
Purch. Agent: G. Fumas **G, CT, RD**

CHANCE VOUGHT RANGE SYSTEMS DIV.
P. O. Box 5907, Dallas, Texas (Tel. AN 2-3211)
Mgr.-Bus. Branch: M. E. Wilkes
Materials Mgr.: B. A. Carlson
Asst. Purch. Agent: B. A. Barker **MS, CT, TT**

CHANDLER EVANS CORP.
Charter Oak Blvd., West Hartford 1, Conn. (Tel. ADams 6-0651)
Dir.-Purch.: F. Donald Dildine
Purch. Agent: G. Kenneth Metcalfe
V. P.: Louis G. Burns **PS, M, G, RD**

CHANDLER PRODUCTS CORP.
1491 Chardon Rd., Cleveland 17, O. (Tel. IVanhoe 1-4400)
Purch. Agent: R. H. Akers
Buyer: W. Semian
V. P.-Sales: Fred C. Chandler **PS, MS**

CHASE BRASS & COPPER CO., INC.
236 Grand St., Waterbury 20, Conn. (Tel. PLaza 6-9444)
Gen. Purch. Agent: C. D. Patterson
V. P.-Sales: G. B. Moseley
Gen. Sales Mgr.: W. E. Evans

CHASE ELECTRONICS MOTOR DIV., INC.
82-31 51st Ave., Elmhurst 73, N. Y. (Tel. OLympia 1-0330)
Purch. Agent: Nicholas J. Mangino

CHASSIS-TRAK, INC.
525 S. Webster Ave., Indianapolis 19, Ind. (Tel. FLeetwood 9-5407)
Purch. Agent: J. Maurice Harrell
Sales Mgr.: Lawrence M. Vaughn **MS, RD**

CHATHAM ELECTRONICS DIV., TUNG-SOL ELECTRIC INC.
630 W. Mt. Pleasant Ave., Livingston, N. J. (Tel. WYman 2-1100)
Purch. Agent: Peter Giannuzzi
Buyer: Ernie Bard
Sales Mgr.: Charles Reeves **MS**

JOHN CHATILLON & SONS
85-93 Cliff St., New York 38, N. Y. (Tel. BEekman 3-2552)
Dir.-Purch.: V. D. McCoy
Exec. V. P.-Sales: George C. Reiley **CT**

CHEMALLOY ELECTRONICS CORP.
Gillespie Airport, Santee, Calif. (Tel. San Diego—HIckory 4-7661)
Gen. Mgr.: Samuel Freedman **M, CT**

CHEMICAL MICRO MILLING CO.
105 S. 7th St., Philadelphia 6, Pa. (Tel. WAlnut 2-4542)
Purch. Agent: A. Bellangi
M. E.: R. De Palma
Chief Engr.: J. Del Elia **G, CT, TT**

CHEMICAL PRODUCTS CORP.
King Phillip Rd., East Providence, R. I. (Tel. GE 4-1770)
V. P.-Purch.: J. Ross Mainland
V. P.-Chem-o-sol Sales: Hugh B. Allison
V. P.-Lacquer Sales: Joseph S. Hawes **M**

CHEMPLAST, INC.
3 Central Ave., East Newark, N. J. (Tel. HUmboldt 2-2622)
Dir.-Purch.: Harry M. Truska
Dir.-Sales: Stephen S. Dorn **M**

CHEMPUMP DIV., FOSTORIA CORP.
Rock & County Line Rds., Huntingdon Valley, Pa. (Tel. HObart 4-2000)
Purch. Agent: R. Ashenfelter
Mktg. Dir.: W. W. Drake
Prod. Mgr.: W. T. Korzuch
Sales Mgr.: A. D. Fell

CHERRY RIVET DIV., TOWNSEND CO.
1224 E. Delhi Rd., Santa Ana, Calif. (Tel. KImberly 5-5511)
Purch. Agent: Ralph Herndon
Buyer: Leroy Levers
Sales Mgr., Aircraft: John H. Roy **S, MS**

CHESTER CABLE CORP., SUB.-MIAMI COPPER CO.
2000 Hill St., Chester, N. Y. (Tel. HOmestead 9-2141)
Purch. Agent: Anthony Knipp, Jr.
Asst. Gen. Mgr.: R. W. Kerney **M**

CHICAGO AERIAL INDUSTRIES, INC.
1980 Hawthorne Ave., Melrose Park, Ill. (Tel. FIllmore 5-1840)
Purch. Agent: Robert Rundle
Dir.-Customer Rel.: Arthur R. Fichter

CHICAGO BRIDGE & IRON CO.
332 S. Michigan Ave., Chicago, Ill. (Tel. HA 7-6708)
Purch. Agent: R. E. Hallenbeck
V. P.-Sales: S. C. Hamilton **S, MS, RD, HSE**

CHICAGO DEVELOPMENT CORP.
5810 47th Ave., Riverdale, Md. (Tel. APpleton 7-2821)
V. P.-Purch.: William W. Gullett
Sales Mgr.: C. S. Goodloe **M, RD**

CHICAGO ELECTRONIC ENGRG. CO., INC.
3223 W. Armitage Ave., Chicago 47, Ill. (Tel. CApitol 7-3130)
Gen. Mgr.: B. F. Vivacque **M**

CHICAGO EXPANSION BOLT CO.
1338 W. Concord Pl., Chicago 22, Ill. (Tel. EVerglade 4-1700)
Pres.: L. L. Peirce
Sales Mgr.: Richard S. Ralph **S**

CHICAGO GASKET CO.
1271 W. North Ave., Chicago 22, Ill. (Tel. HUmbolt 6-3060)
Mgr., Purch. Dept.: Paul H. Dittmer
Sales Mgr.: R. H. Martin **M**

CHICAGO MINIATURE LAMP WORKS
1500 N. Ogden Ave., Chicago 10, Ill. (Tel. MOhawk 4-1741)
Controller: Earl E. Erickson
V. P.-Sales: Ernest E. Freeman, Jr. **M**

CHICAGO PNEUMATIC TOOL CO.
6 E. 44th St., New York 17, N. Y. (Tel. MUrray Hill 7-1700)
Purch. Agent: K. T. Dolson
Sales Mgr., Pneumatic Tools: R. T. Beers
Sales Mgr., Electric Tools: L. J. Walker

CHICAGO RAWHIDE MFG. CO.
1301 N. Elston Ave., Chicago 22, Ill. (Tel. BRunswick 8-2100)
V. P. & Dir.-Purch.: Norman R. Hanson
Asst. Dir.-Purch.: B. J. Yunker
V. P. & Dir.-Sales: Phelps Wilder **M**

CHICAGO RIVET & MACHINE CO.
950 S. 25th Ave., Bellwood, Ill. (Tel. LInden 4-5100)
Purch. Agent: W. A. Bautz
Asst. Purch. Agent: J. A. Campbell
Sales Mgr.: Wm. O. Shineflug

CHICAGO SCREW CO., THE, DIV.-STANDARD SCREW CO.
2501 Washington Blvd., Bellwood, Ill. (Tel. LInden 4-3500)
Dir.-Purch.: W. J. McCoy
Asst. Purch. Agents: P. W. McKenna & John James
V. P.-Standard Prod. Sales: E. L. Claussen **PS, MS, M**

CHICAGO STANDARD TRANSFORMER CORP.
3501 W. Addison St., Chicago 18, Ill. (Tel. INdependence 3-7400)
Purch.: E. Donnellan
Buyer: C. Dubas
Dir.-Sales: P. N. Cook

CHIKSAN CO., SUB.-FOOD MACHINERY & CHEMICAL CORP.
330 N. Pomona Ave., Brea, Calif. (Tel. JAsper 9-2121)
Mgr.-Purch.: E. H. Nelson
Supvr.-Purch.: W. G. Keen
V. P. & Sales Mgr.: J. F. Powers, Jr. **MS**

CHISHOLM-MOORE HOIST DIV., COLUMBUS McKINNON CHAIN CORP.
Fremont Ave., Tonawanda, N. Y. (Tel. JAckson 2230)
Purch. Agent: W. J. Wolf
Sales Mgr.: E. J. Byrne
Sales Prom. Mgr.: R. N. Warnke

CHLOR-ALKALI DIV., FOOD MACHINERY & CHEMICAL CORP.
161 E. 42nd St., New York 17, N. Y. (Tel. MU 7-7400)
Dir.-Purch.: J. A. Mooney
Sales Mgr.: J. R. Harris
Mgr., Dimazine Sales: B. L. Rose **M**

CHRISTIE MACHINE WORKS
201 Harrison St., San Francisco 5, Calif. (Tel. EXbrook 2-2187)
V. P.-Purch. & Sales: Lloyd F. Christie **PS, MS, G, TT, RD**

CHROMIUM CORP. OF AMERICA
P. O. Box 1229, Waterbury 20, Conn. (Tel. PLaza 4-3141)
Purch. Agent: M. J. Melchionna
Plant Mgr.: E. C. Knill
Gen. Sales Mgr.: John B. Allen **M**

CHRYSLER CORP., DEFENSE OPERATIONS DIV.
7000 E. Eleven Mile Rd., Center Line, Mich. (Tel. JEfferson 9-3000) Mailing Address: P. O. Box 757, Detroit 31, Mich.
Dir.-Proc.: O. G. White
Purch. Supvr.: A. M. Thom
Dir.-Govt. Relations: C. W. Snider

CHRYSLER CORP., MISSILE DIV.
P. O. Box 2628, Detroit 31, Mich. (Tel. JEfferson 9-2000)
Purch. Agent: S. J. Roach
Purch. Admin.: J. M. Orr
Mgr.-Buying & Follow-up: J. P. Forbes
Mgr.-Purch. Analysis: C. R. McMacken
Mgr.-Sub-Contracts: H. L. Sinclair **S, PS, MS, M, G, CT, TT, RD, HSE**

CIBA PRODUCTS CORP.
P. O. Box 415, Fair Lawn, N. J. (Tel. SWarthmore 1-1122)
Sales Mgr.: M. M. Gruber **M**

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

CINCINNATI CLEANING & FINISHING MACHINERY
1100 Hageman St., Cincinnati 41, O. (Tel. PRinceton 1-5100)
Purch. Agent: C. Tyahur
Dir.-Sales: H. Nonneman

CINCINNATI MILLING MACHINE CO., THE
Marburg Ave., Cincinnati 9, Ohio (Tel. REdwood 1-2121)
Purch. Agent: Herman Decatur
Sales Mgr.: R. Bevis M

CINCINNATI SHAPER CO., THE
P. O. Box 111, Cincinnati 11, Ohio
Adv. Mgr.: J. A. Warren

CINCINNATI SUB ZERO PRODUCTS
3932 Reading Rd., Cincinnati 29, O. (Tel. PLaza 1-8810)
Purch. Agent: H. Kaupp
Proj. Engr.: R. E. Schroeder
Chief Engr.: T. J. Frederick
Dir.-Sales Prom.: Mrs. L. M. Doherty CT, RD

CINEMA ENGRG.
1100 Chestnut St., Burbank, Calif.
Gen. Mgr.: E. H. Miller

CINE-VIDEO PRODUCTIONS, INC.
Boston Post Rd., Milford, Conn. (Tel. TRinity 4-6590)
Pres.: G. W. Ray

CIRCO EQUIPMENT CO.
51 Terminal Ave., Clark, N. J. (Tel. FUlton 8-8600)
V. P.-Purch.: Norman Fischell
Purch. Agent: Paul F. Andersen
Sales Mgr.: Severn S. Carlson CT

CIRCO ULTRASONIC CORP.
51 Terminal Ave., Clark, N. J. (Tel. FUlton 8-8600)
Tech. Dir.: Benson Carlin
Purch. Agent: Paul F. Andersen
Sales Mgr.: Severn S. Carlson CT

CIRCON COMPONENT CORP.
Santa Barbara Municipal Airport, Goleta, Calif. (Tel. WOodland 7-1113)
Sales Mgr.: M. J. Ainsworth

CITY CHEMICAL CORP.
132 W. 22nd St., New York 11, N. Y. (Tel. WA 9-2723)
Secy.: T. R. Keller
Treas.: H. L. Baer RD

CLAIREX CORP.
19 W. 26th St., New York 10, N. Y. (Tel. MUrray Hill 4-0940)
Dir.-Purch.: V. M. Schell
Sales: A. F. Deuth M

DAVID CLARK CO., INC.
360 Park Ave., Worcester, Mass. (Tel. PLeasant 6-6216)
Purch. Agent: Ralph Miller, Jr.
Sales Mgr.: Charles W. Kaufman RD, HSE

CLARK BROS. CO., DIV.-DRESSER OPERATIONS, INC.
N. Fifth St., Olean, N. Y. (Tel. Olean 2-2101)
Gen. Purch. Agent: Edward E. Bonsper
Purch. Agent, Recip. Prod. Div.: Michael L. Hadbavny
Purch. Agent, Turbo Prod. Div.: John J. Sheehan
V. P.-Sales: George W. Probst MS

CLARK CONTROLLER CO., THE
1146 E. 152nd St., Cleveland 10, Ohio (Tel. ULster 1-2000)
Purch. Agent: N. E. Schall
Asst. Purch. Agent: W. E. Anderson
Sales Mgr.: R. Whitehill

CLARK CRYSTAL CO.
2 Farm Rd., Marlboro, Mass. (Tel. MArlboro 1411)
Mgr.: F. O. Nobles

CLARK ELECTRONIC LABORATORIES
Box 165, Palm Springs, Calif. (Tel. FAirview 8-2210)
Sales Mgr.: D. B. Clark G, CT, RD

CLARK EQUIPMENT CO.
324 E. Dewey Ave., Buchanan, Mich. (Tel. OXbow 5-3811)
V. P.-Purch.: J. G. Mack
Dir.-Purch.: L. E. Stevens
Asst. Dir.-Purch.: J. G. Swanson, Battle Creek, Mich. (Tel. WOodward 2-6561) MS, M

CLARK EQUIPMENT CO., INDUSTRIAL TRUCK DIV.
Battle Creek, Mich. (Tel. WO 2-6561)
Dir.-Purch.: Jim Swanson
Asst. to Dir.: Lee Hiatt
Gen. Sales Mgr.: J. E. Mitchell M

CLARK-AIKEN CO., THE
Water St., Lee, Mass. (Tel. 1261)
Purch. Agent: T. E. Locke
Prod. Engr.: J. P. Stoeke S

CLARKE FLOOR MACHINE CO.
30 E. Clay Ave., Muskegon, Mich. (Tel. PArkway 2-3701)
Purch. Agent: G. Hentshel

CLARKSON LABS., INC., THE
920-30 N. Darien St., Philadelphia 23, Pa. (MArket 7-6764)
Treas.: Morris Coppersmith
Pres.: E. W. Heller
Chem. Engr.: Thomas Morris M

CLAROSTAT MFG. CO., INC.
Dover, N. H. (Tel. SHerwood 2-1120)
Purch. Dir.: E. O. Schramm
Gen. Sales Mgr.: Fran J. Chamberlain

CLARY DYNAMICS
408 Junipero St., San Gabriel, Calif. (Tel. CUmberland 3-2724)
Gen. Mgr.: P. Meeks
Gen. Sales Mgr.: A. L. Colella

CLAUSING DIV.-ATLAS PRESS CO.
1915 N. Pitcher St., Kalamazoo, Mich. (Tel. FIreside 5-7157)
Dir.-Purch.: S. L. Shaw
V. P.-Sales: G. C. Nancarrow

CLAYTON MFG. CO.
401 N. Temple City Blvd., El Monte, Calif. (Tel. CUmberland 3-4131)
Mgr., Purch.: Roland Mackey
Mgr., Special Products Div.: Glenn Marshall
Asst. to V. P.-Sales: E. N. Moon
V. P.-Sales: J. A. Cortright CT

CLECO AIR TOOLS, DIV.-REED ROLLER BIT CO.
5125 Clinton Dr., P. O. Box 2119, Houston 1, Texas (Tel. ORchard 2-1761)
Purch. Agent: R. G. Stockton
V. P.-Purch.: C. H. Elliott
Sales Mgr.: E. W. Clayton

CLEGG LABS., DIV.-CLEGG, INC.
Ridgedale Ave., Morristown, N. J. (Tel. JEfferson 8-7214)
Purch. Agent: Ann Gillingham
Sales Mgr.: Edward T. Clegg MS, CT, RD

CLEVELAND AUTOMATIC MACHINE CO., THE
4932 Beech St., Cincinnati 12, O. (Tel. REdwood 1-5300)
Purch. Agent: A. W. Niederhelman
V. P.-Sales Mgr.: John Prohaska

CLEVELAND GRAPHITE BRONZE DIV.-CLEVITE CORP.
17000 St., Clair Ave., Cleveland 10, O. (Tel. IVanhoe 1-7221)
Dir.-Purch.: J. G. Mehring
Purch. Agent: J. C. Hall
Asst. Purch. Agent: R. Ovens
Purch. Analyst: J. McCauley
Gen. Sales Mgr.: W. D. Cowgill
Staff Asst.-Sales: R. C. Webster

CLEVELAND INSTRUMENT CO.
6220 East Schaaf Rd., Cleveland 31, O. (Tel. LA 4-4821)
Purch. Agent: W. Young
Mgr.-Sales: F. W. Witzke G, CT

CLEVELAND METAL SPECIALTIES CO., ELECTRONICS DIV.
1783 E. 21st St., Cleveland 14, O. (Tel. PRospect 1-4186)
Sales Mgr.: Al Gross
V. P.-Purch.: Joe Japel MS, G, TT, RD

CLEVELAND PNEUMATIC INDUSTRIES, INC.
3781 E. 77th St., Cleveland 5, Ohio (Tel. Diamond 1-1700)
Materiel Mgr.: John Chapman
V. P.-Sales: Elmer Krueger

CLEVITE ELECTRONIC COMPONENTS DIV., CLEVITE CORP.
3405 Perkins Ave., Cleveland 14, Ohio (Tel. ENdicott 1-1730)
Purch. Agent: L. N. Dadante
Gen. Sales Mgr.: M. R. Eastin MS

CLEVITE ORDNANCE, DIV.-CLEVITE CORP.
540 E. 105th St., Cleveland 8, Ohio (Tel. ULster 1-5500)
Mgr., Prod. Control: R. E. Hines
Buyers: Steve Szabo & D. C. Orr
Gen. Mgr.: T. E. Lynch PS, MS, G, RD

CLEVITE TRANSISTOR PRODUCTS, DIV.-CLEVITE CORP.
241-257 Crescent St., Waltham 54, Mass. (Tel. TWinbrook 4-9330)
Dir.-Material: B. D. Pendergast
Purch. Agent: G. Herd
Sr. Buyer: T. Kenney
Gen. Sales Mgr.: A. J. Dusault MS, RD

CLIFTON PRECISION PRODUCTS CO., INC.
Marple at Broadway, Clifton Heights, Pa. (Tel. MAdison 6-2101)
Purch. Agent: Tyson Parker
V. P. & Sales Mgr.: Thomas W. Shoop MS, G, RD

CLIMAX MOLYDBENUM CO. OF MICHIGAN
1270 Avenue of the Americas, New York 20, N. Y. (Tel. PLaza 7-9700)
Mgr., Refractory Metal Sales: Joseph P. McGuire
Sales Mgr.: Lars E. Ekholm M

CLOVER INDUSTRIES, INC.
578-588 Young St., Tonawanda, N. Y. (Tel. LUdlow 1331)
V. P.-Purch.: H. Paul Henderson
V. P.-Sales: L. N. Friol S, PS, MS, G, CT, TT, RD, HSE

COAST MFG. & SUPPLY CO.
Box 71, Livermore, Calif. (Tel. HIlltop 7-1000)
Purch. Agent: A. J. Andersen
Sales Mgr., Textile Div.: Carter Schriber M, RD

COAST PRO-SEAL & MFG. CO.
2235 Beverly Blvd., Los Angeles 57, Calif. (Tel. DU 7-5141)
Buyer: Mrs. Jean McLaughlin
V. P.-Sales: John W. Winkler M

COAXIAL CONNECTOR CO. INC.
37 N. 2nd Ave., Mt. Vernon, N. Y. (Tel. MOunt Vernon 8-6416)
Purch. Agent: William R. Clayton
Dir.-Sales: Don Reade

COBEHN, INC.
226 Passaic Ave., Caldwell, N. J. (Tel. CApital 6-6675)
Purch. Agent: William E. Bellars
V. P.-Sales: David F. Cook G

COBRA METAL HOSE DIV., DK MFG. CO.
5059 S. Kedzie Ave., Chicago 32, Ill. (Tel. REpublic 7-3311)
Purch. Agent: T. Kwasnik
Asst. Purch. Agent: Rudy Machuda
Buyer: Darrel Harter
Sales Mgr.: Clyde D. Greeno

COFFING HOIST DIV., DUFF-NORTON CO.
800 Walter St., Danville, Ill. (Tel. HI 6-3800)

COHAN EPNER CO. INC.
142 W. 14th St., New York 11, N. Y. (Tel. CHelsea 3-3411)
Purch. Agent: William Epner
Dir.-Sales: Gerald Epner

SIGMUND COHN CORP.
121 S. Columbus Ave., Mt. Vernon, N. Y. (Tel. MO 4-5300)
V. P.-Sales: Richard Cohn M

COIL CO. OF AMERICA
215 Washington St., Northvale, N. J. (Tel. CLoster 5-3434)
Treas.: H. Gay M

COIL WINDING EQUIPMENT CO.
19 Maxwell Ave., Oyster Bay, N. Y. (Tel. OYster Bay 6-1285)
Purch. Agent: Blanche A. George
Sales Engr.: James H. George
Sales: Howard A. George G, RD

COLE ELECTRIC CO.
8439 Steller Dr., Culver City, Calif. (Tel. UPton 0-4701)
Purch.: M. Armant & J. Tomasic
Sales Mgr.: H. P. Sparkes MS, CT, RD

COLEMAN ELECTRONICS, INC.
133 E. 162nd St., Gardena, Calif. (Tel. FAculty 1-4775)
Purch. Agent: Burt Ganoe
V. P. & Gen. Mgr.: Tom Coalson
Asst. to Gen. Mgr.: Loren Hill
Sales Mgr.: Rich Winkler CT

COLEMAN INSTRUMENTS, INC.
42 Madison St., Maywood, Ill. (Tel. FIllmore 5-9400) CT

COLLECTRON CORP.
304 E. 45th St., New York, N. Y. (Tel. MU 9-7120)
Purch. Agent & Sales Mgr.: R. B. Coombs M

G. L. COLLINS CORP.
2820 E. Hullett St., Long Beach 5, Calif. (Tel. MEtcalf 0-3121)
V. P.-Purch.: G. D. Collins
V. P.-Sales: L. A. Bondy MS, G, RD

COLLINS MFG. CORP.
9041 Lindblade St., Culver City, Calif. (Tel. UPton 0-4811)
Gen. Mgr.: Joe Collins
Purch. Agent: Ada Kadinger
Asst. Purch. Agent: Dolores Meyer
Sales Mgr.: John J. Collins PS, MS

COLLINS MICROFLAT CO.
3249 W. El Segundo Blvd., Hawthorne, Calif. (Tel. ORegon 8-7694)
V. P.-Purch.: E. Mike Bruhwiler
Pres.: Lee Collins

COLLINS RADIO CO.
855 35th St., N. E., Cedar Rapids, Iowa (Tel. EMpire 5-8481)
Dir.-Purch.: John H. Wagner, 411 First Ave., S. E., Cedar Rapids, Iowa (Tel. EMpire 5-8481)
Purch. Agent: Wendell Paxton
V. P.-Sales: J. G. Flynn, Jr., Dallas, Tex. (Tel. ADams 5-4511) CT, TT, RD

COLLYER INSULATED WIRE CO.
249 Roosevelt Ave., Pawtucket, R. I. (Tel. PA 3-7800)
Dir.-Purch.: R. D. Moeller
Dir.-Sales: J. Marshall Taylor MS

COLONIAL AIRCRAFT CORP.
Box 250 Sanford, Me. (Tel. SAnford 80)
Purch. Agent: Richard Dotter
Pres.: David B. Thurston S, MS, CT

COLONIAL ALLOYS CO.
Ridge Ave. & Crawford Sts., Philadelphia 29, Pa. (Tel. GE 8-2272)
Purch. Agent: C. Fay
Dir.-Sales: S. L. Cohn

COLONIAL RUBBER CO.
706 Oakwood St., Ravenna, O. (Tel. AXminister 6-9611)
Sales Mgr.: D. E. Mason M

COLORADO FUEL & IRON CORP., THE
575 Madison Ave., New York 22, N. Y. (Tel. MU 8-5400)

COLORADO RESEARCH CORP.
Broomfield, Colo. (Tel. INgersol 6-2331)
Purch. Agent: A. R. Holden, Jr., Denver, (Tel. HArrison 9-3501) TT, RD

COLSON CORP., THE
440 Somerville Ave., Somerville 43, Mass.
Purch. Agent: C. Lockwood
Sales Mgr.: L. B. Blum M

COLUMBIA ELECTRIC MFG. CO.
4519 Hamilton Ave., Cleveland 14, O. (Tel. ENdicott 1-8060)
Purch. Agent: John Sygielski
Sales Mgr.: H. W. Sussman

COLUMBIA NUT & BOLT CO., INC.
945 Main St., Bridgeport 3, Conn. (Tel. EDison 3-4956)
Pres.: Howard P. Cook

COLUMBIA PRODUCTS CO.
R.F.D. #3, Columbia, South Carolina (Tel. SUnset 7-8710)
Asst. Purch. Agent: Frank Cox
Sales Mgr.: S. W. Trewhella M, TT

COLUMBIA RESEARCH & DEVELOPMENT CORP.
4608 Indianola Ave., Columbus 14, O. (Tel. AMherst 7-1277)
Purch. Agent: D. E. Lehman
Gen. Mgr.: H. O. Kempton RD

COLUMBIA TECHNICAL CORP.
61-02 31st Ave., Woodside 77, N. Y. (Tel. AStoria 8-7401)
Dir.-Purch.: Victor Leibmann
Sales Mgr.: D. R. Stein M

COLUMBIAN CARBON CO., MAPICO IRON OXIDES UNIT
380 Madison Ave., New York 17, N. Y. (Tel. MUrray Hill 7-2300)
Sales Mgr.: C. O. Davidson M

COLUMBIAN ROPE CO.
309 Genesee St., Auburn, N. Y. (Tel. 3-3221)
Purch. Agent: C. A. Fowler
V. P.-Sales: L. R. Hole M

COLUMBUS ELECTRONICS CORP.
1010 Saw Mill River Rd., Yonkers, N. Y. (Tel. YOnkers 8-1221)
Purch. Agent: Saul Peck
Sales Mgr.: Gustav Bard MS, G, CT, TT

COLUMBUS McKINNON CHAIN CORP.
Fremont St., Tonawanda, N. Y. (Tel. JA 2230)
Dir.-Purch.: Walter Wolf
Sales Mgr.: G. L. Grace
V. P.-Sales: D. S. Brisbin

COLVIN LABS., INC.
364 Glenwood Ave., East Orange, N. J. (Tel. ORange 7-1221)
Purch. Agent: R. Post
Sales Mgr.: Earl Hall CT, TT

COMAR ELECTRIC CO.
3349 Addison St., Chicago 18, Ill. (Tel. JUniper 8-2410)
Purch. Agent: Chas. Kirchenbauer
Asst. Purch. Agent: R. Podlesak
Sales Mgr.: L. E. Noelck MS, M, G

COMBINED ELECTRONICS INC.
6045 W. Ogden, Chicago, Ill. (Tel. OL 6-3450)
V. P.-Purch.: George F. Johnson
V. P.-Sales: R. G. Dailey M

COMCO PLASTICS INC.
98-34 Jamaica Ave., Richmond Hill 18, N. Y. (Tel. VIrginia 9-9000)
Purch. Agent: A. Schutzman
Sales Mgr.: J. C. Steel

***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
100 River St., Waltham, Mass. (Tel. TWinbrook 9-8400)
Mktg. Mgr.: F. H. O'Kelley
Purch. Agent: Swift Gibson (Tel. Bigelow 4-7500)
*(See advertisement this issue)

COMMERCIAL FILTERS CORP.
2 Main St., Melrose 76, Mass. (Tel. DAvenport 4-7000)
Purch. Agent: Alan F. Riley
Sales Mgr.: J. R. Chisholm

COMMERCIAL SERVICES CO., INC.
1217 First St., P. O. Box 234, Alexandria, Va. (Tel. OVerlook 3-5700)
Pres.: R. M. Jackson, Jr.
V. P.-Sales: J. A. Jackson

COMMERCIAL SHEARING & STAMPING CO.
1775 Logan Ave., Youngstown 1, Ohio (Tel. RIverside 6-8011)
Purch. Agent: D. A. Boop
Gen. Mgr.-Sales: H. B. Wollison

COMMONWEALTH FELT CO.
76 Summer St., Boston 10, Mass. (Tel. LIberty 2-6590)
Treas.: I. Goldberg
Mgr.-Cut Parts Div.: N. M. Benson
Sales: J. S. Patterson

***COMMONWEALTH OF PENNSYLVANIA, DEPT. OF COMMERCE**
South Office Bldg., State St., Harrisburg, Pa.
*(See advertisement this issue)

COMMUNICATION ACCESSORIES CO.
Lee's Summit, Mo. (Tel. Kansas City, Mo., BRoadway 1-1700)
Purch. Agent: Cliff Black
Asst. Purch. Agent: Earl Kopke
Chief Engr.: Walter Kunde
Sales Mgr.: Carl Rollert G, TT

COMMUNICATION MEASUREMENTS LAB., INC.
350 Leland Ave., Plainfield, N. J. (Tel. PL 4-5502)
Purch. Agent: E. Talisse
Chief Engr.: C. J. Bonini

COMMUNICATIONS CO.
300 Greco Ave., Coral Gables 34, Fla. (Tel. HI 6-0846)
Purch. Agent: W. K. Whitmire
Asst. Gen. Mgr.-Sales: Frederick R. Macklin

COMMUNICATIONS RESEARCH CO.
P. O. Box 778, Richmond 6, Va. (Tel. Milton 4-3255)
Pres.: Paul K. Heim
Dir.-Research & Dev.: A. H. Child
Purch. Agent & Bus. Mgr.: George Harris RD

COMMUNITY ENGRG. CORP.
Box 824, State College, Pa. (Tel. ADams 8-2461)
Pres.: James R. Palmer
Prod. Supvr.: W. Clair King
Sales Mgr.: John E. Hines, Jr. MS, TT, RD

COMPONENTS CORP.
35 N. Arroyo Pkwy., Pasadena, Calif. (MUrray 1-7448)
Dir.-Sales: Robert L. Henry MS, CT

COMPUDYNE CORP.
400 S. Warminster Rd., Hatboro, Pa.
Dir.-Purch.: Al Kreig
Dir.-Sales: Nat Wilson MS, CT

COMPUTER CONTROL CO., INC., EASTERN DIV.
983 Concord St., Framingham, Mass. (Tel. Boston, CEdar 5-6220)
Purch. Agent: Bradford P. Daniels
V. P.-Mktg.: William Wolfson
Mktg.-Mgr.: James I. Leabman G, CT, RD

COMPUTER CONTROL CO., INC., WESTERN DIV.
2251 Barry Ave., Los Angeles 64, Calif. (Tel. GRanite 8-0481)
Purch. Agent: Peter Prouty
V. P. & Gen. Mgr.: Alfred L. Fenaughty
Mgr., Mktg.: R. D. Chamorro G, CT, RD

COMPUTER ENGRG. ASSOCIATES, INC.
350 N. Halstead St., Pasadena 8, Calif. (Tel. ELgin 5-7121)
Dir.-Purch.: Al Ispas, Jr.
Customer Service Mgr.: Richard T. Campbell MS, CT, TT, RD

COMPUTER INSTRUMENTS CORP.
92 Madison Ave., Hempstead, L. I., N. Y. (Tel. IVanhoe 3-8200)
Dir.-Purch.: H. Adise
Purch. Agent: I. Clinton
Sales Mgr.: J. Herman PS, MS, M, G, CT, TT, RD

COMPUTER SYSTEMS, INC.
611 Broadway, New York 12, N. Y. (Tel. SPring 7-4016)
Purch. Agent: E. Nawrocki
V. P.: Charles B. Husick
Indsl. Sales Mgr.: Jack M. Andrews MS, G, CT, TT, RD

CONANT LABS.
Box 3997, Bethany Station, Lincoln 5, Nebr. (Tel. IVanhoe 8-0432)
Gen. Mgr.: G. Conant M

CONAX CORP.
2300 Walden Ave., Buffalo 25, N. Y. (Tel. REgent 0600)
Purch. Agent: Edgar Kowalski
Sales Mgr., Indsl. Prod.: Warren L. Jones
Asst. Sales Mgr., Expl. Prod.: Raymond Rohlman M

CONCO ENGRG. WORKS, INC.
Mendota, Ill. (Tel. 2121)
Purch. Agent: P. J. Donohue
V. P.-Sales: R. A. Hossinger

CONMAR PRODUCTS CORP.
140 Thomas St., Newark 1, N. J. (Tel. Bigelow 8-2211)
Asst. Gen. Sales Mgr.: A. L. Moss

CONNECTICUT HARD RUBBER CO., THE
407 East St., New Haven 9, Conn. (Tel. SPruce 7-3631)
Purch. Agent: T. E. Grandshaw
Sales Mgr.: J. A. Moffitt, Jr. PS, M, RD

CONNECTICUT INSTRUMENT CORP.
80 Danbury Rd., Wilton, Conn. (Tel. POrter 2-5545)
V. P.-Purch. & Sales: P. A. Wilks, Jr. M

CONNECTICUT PLASTIC PRODUCTS CO., INC., THE
70 W. Liberty St., Waterbury 20, Conn. (Tel. PL 4-4134)
V. P.-Purch.: C. J. Sullivan
Pres.: M. F. Sullivan S

CONNECTOR CORP. OF AMERICA
12959 Sherman Way, N. Hollywood, Calif. (Tel. TRiangle 7-9653)
Pres.-Sales: Ralph R. Thomas

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

CONOFLOW CORP.
2100 Arch St., Philadelphia 3, Pa. (Tel. LOcust 7-7560)
Purch. Agent: H. Bonekat
Sales Mgr.: J. Robert Simpson **PS, MS, RD**

CONRAD, INC.
Conrad Sq., Holland, Mich. (Tel. EXport 2-3161)
Purch. Agent: Merle Pointer, 141 Jefferson St., Holland, Mich.
V. P.-Sales: Charles Conrad, 141 Jefferson St., Holland, Mich. **CT, RD**

CONRAD & MOSER
2-23 Borden Ave., Long Island City 1, N. Y. (Tel. STillwell 4-3616)
Dir.-Purch.: Leo Rovere
Dir.-Sales: Fred R. Conrad **S**

CONSOLIDATED AIRBORNE SYSTEMS, INC.
321 Willis Ave., Mineola, N. Y. (Tel. Pioneer 6-7224)
V. P.-Gen. Mgr.: John I. Nestel
V. P.-Chief Engr.: Leo Stamler
Proj. Engr.: Hugo Daffara
Sales Mgr.: John Nestel

CONSOLIDATED CONTROLS CORP.
13 Durant Ave., Bethel, Conn. (Tel. Pioneer 3-6721)
Purch. Agent: C. S. Joyce
Sales Mgr.: C. M. Colt **PS, MS, G, RD**

CONSOLIDATED DIESEL ELECTRIC CORP.
880 Canal St., Stamford, Conn. (Tel. DAvis 5-2261)
Purch. Agent: John Adams
Sales Mgr., Power Equipment Div.: Frank Cesario
Gen. Sales Mgr., Aircraft Equip. Div.: John Ryman **MS, CT, RD**

CONSOLIDATED DIESEL ELECTRIC CORP., TEST EQUIP. DIV.
1 John St., Stamford, Conn. (Tel. DAvis 5-2261)
Purch. Agent: John Budnik
Sales Mgr.: Kenneth C. Gerhardt

CONSOLIDATED DIESEL ELECTRIC CORP., WESTERN DIV.
15519 Lanark St., Van Nuys, Calif. (Tel. STate 2-4060)
Purch. Agent: T. C. McKinney

***CONSOLIDATED ELECTRODYNAMICS CORP.**
360 Sierra Madre Villa, Pasadena, Calif. (Tel. MUrray 1-8421)
Dir.-Purch.: Mario Gardner
V. P.-Mktg.: R. L. Smallman **CT, TT, RD**
*(See advertisement this issue)

CONSOLIDATED FILM INDUSTRIES
959 N. Seward St., Hollywood 38, Calif. (Tel. HOllywood 2-0881)
Dir.-Public Relations: Jack M. Goetz
Sales Mgr.: Richard S. Rodgers
Sales Mgr.: Burton Stone, 521 W. 57th St., New York 19, N. Y. (Tel. CI 6-0210)

CONSOLIDATED INDUSTRIES, INC.
Mixville Rd., West Cheshire, Conn. (Tel. Cheshire—BRowning 2-5371)
Sales Engr.: E. A. Fentzlaff **M**

CONSOLIDATED VACUUM CORP.
1775 Mt. Read Blvd., Rochester 3, N. Y. (Tel. GL 3-7972)
Purch. Agent: Warren Barton
Asst. Purch. Agents: Ward Kelley & Charles Baldwin
Dir.-Mktg.: Max Garber **M**

CONSOLIDATED WIRE & ASSOCIATED COMPANIES
1635 S. Clinton St., Chicago 16, Ill. (Tel. HA 1-4441)
Sales Mgr.: J. J. Mann **M**

L. L. CONSTANTIN & CO.
Rt. 46, Lodi, N. J. (Tel. GRegory 1-0100)
Purch. Agent: C. Brandt
Asst. Purch. Agent: J. Vierczhalek
Sales Mgr.: S. C. Taber **M**

CONTAINER LABS., INC.
6210 Kansas Ave., Washington, D. C. (Tel. RAndolph 6-7501)
Purch. Mgr.: William E. Hughes
Sr. Engineers: Jackson B. Weaver & Paul J. Zerr **RD**

CONTINENTAL AVIATION & ENGRG. CORP.
12700 Kercheval, Detroit, Mich. (Tel. VAlley 2-1500)
Dir.-Purch.: Carl L. Schiller
Purch. Agent, Toledo Div.: John Watson (Tel. GR 5-4641)
Mgr.-Sales & Service: Kenneth C. Smith **PS, MS, RD**

CONTINENTAL CONNECTOR CORP.
34-63 56th St., Woodside 77, N. Y. (Tel. TWining 9-4422)
Purch. Agent: A. Jacob
Exec. V. P.: Leon Gilbert
Chief Engr.: Martin Lesser
Dir.-Sales: N. J. Goldman **M**

CONTINENTAL DIAMOND FIBRE CORP.
Newark, Del. (Tel. ENdicott 8-8531)
Dir.-Purch.: W. H. Walker
Asst. Purch. Mgr.: F. A. Cain
V. P.-Sales: A. J. Briggs **S, PS, MS, M, G, RD**

CONTINENTAL ELECTRIC CO.
715 Hamilton St., Geneva, Ill. (Tel. CEnter 2-4140)
Purch. Agent: E. A. DeVel
Sales Asst.: T. Pantelleria **M**

CONTINENTAL ELECTRONICS MFG. CO., SUB.-LING-ALTEC ELECTRONICS, INC.
4212 S. Buckner Blvd., Dallas 27, Tex. (Tel. EVergreen 1-1137)
Dir.-Procurement Dept.: A. W. Schmidt, Jr.
Asst.-Procurement Dept.: Robert Keith
Dir.-Sales & Contract Negotiations: Thomas B. Moseley
Washington Rep., V. P.: G. Emerson Pray, 1511 K St., N. W., Washington, D. C. **RD**

CONTINENTAL ENGRG. CORP.
Farmington, Conn. (Tel. OR 7-2387)
Dir.-Purch. & Sales: Leland D. Cobb **RD**

CONTINENTAL FELT CO.
22 W. 15th St., New York 11, N. Y. (Tel. WAtkins 9-5262)
Treas.: W. J. Newbold **M**

CONTINENTAL MOTORS CORP.
205 Market St., Muskegon Mich. (Tel. 2-7631)
Dir.-Purch.: M. R. Ramsey
V. P.-Sales & Service: D. H. Hollowell **MS**

CONTINENTAL RUBBER WORKS
1963 Liberty St., Erie 6, Pa. (Tel. 2-5261)
Purch. Agent: Robert A. Bailey
Asst. Purch. Agent: R. C. Metz
Sales Mgr.: Charles C. Shenk **M**

CONTINENTAL SCREW CO.
459 Mt. Pleasant St., New Bedford, Mass. (Tel. WYman 3-2621)
Purch. Agent: Edward Pettengill
Gen. Sales Mgr.: Victor Ladetto

CONTINETAL SENSING, INC.
1950 N. Ruby St., Melrose Park, Ill. (Tel. COlumbus 1-0295)
Purch. Agent: Gene Ostrom
Sales Mgr.: Ray Ellefson **M, CT, RD**

CONTINENTAL TECHNICAL SERVICE, INC.
19 W. 4th St., Dayton 2, O. (Tel. BA 2-8626)
Purch. Agent: John R. Folkerth
Sales Coordinator: George Thomas

CONTINENTAL WIRE SALES CORP.
322 N. Cherry St., Ext. P. O. Box 366 Wallingford, Conn. (Tel. COlony 9-1421)
Purch. Agent: C. C. Christiansen
Sales Mgr.: E. T. Harrigan

CONTINENTAL-EMSCO CO., DIV.-THE YOUNGSTOWN SHEET & TUBE CO.
P. O. Box 359, Dallas 21, Texas (Tel. RI 7-9261)
Dir.-Purch.: C. N. Swanson
Assistants to V. P.: J. R. Bechtold & Lee A. Drake
V. P.-Sales: Craig Smyser **S, MS**

CONTINENTAL-WIRT ELECTRONICS CORP.
5221 Greene St., Philadelphia 44, Pa. (Tel. Germantown 8-9334)
Treas.: Kalman B. Lifson
V. P.-Sales: Burton S. Lifson **M**

CONTROL CIRCUITS INC.
66 Marlborough St., Portland, Conn. (Tel. DI 7-4634)
Purch. Agent: H. L. Voelker
V. P.-Sales: C. G. Banks

CONTROL DATA CORP.
501 Park Ave., Minneapolis 15, Minn. (Tel. FEderal 9-0947)
Pres.: William C. Norris
V. P.-Research & Engrg.: William R. Keye
V. P.-Mktg.: James G. Miles **G, CT, TT, RD**

CONTROL DATA CORP., COMPUTER DIV.
501 Park Ave., Minneapolis 15, Minn. (Tel. FEderal 9-0411)
Purch. Mgr.: Robert E. Anderson
Dir.-Sales & Contracts: George S. Hanson
Mgr.-Sales Prom.: Gordon V. Wise **RD**

CONTROL ELECTRONICS CO., INC.
Ten Stepar Pla., Huntington Sta., L. I., N. Y. (Tel. HAmilton 7-7961)
Dir.-Purch.: John Hackett
V. P.-Sales: Eugene S. Wendolowski **MS, CT, TT, RD**

CONTROL ENGRG. CO., DIV.-JERVIS B. WEBB CO.
8900 Roselawn, Detroit 4, Mich. (Tel. WE 3-9311)
Purch. Agent: John K. Gage
Asst. Sales Mgr.: Thomas J. Lindsay
Gen. Mgr.: Marvin S. Blemly **MS, CT**

CONTROL PRODUCTS, INC.
306 Sussex St., Harrison, N. J. (Tel. HUmbolt 2-0213)
Purch. Agent: H. R. Brewster
Sales Mgr.: J. R. Nile

CONTROL SW. DIV., CONTROLS CO. OF AMERICA
4218 W. Lake St., Chicago 24, Ill. (Tel. VA 6-3100)
Purch. Agent: Edw. Hall
Dir.-Sales: Harold F. Ames **MS**

CONTROL TECHNOLOGY CO.
1186 Broadway, New York 1, N. Y. (Tel. OR 9-2770)
Mgr., Purch. & Sales: Frank Phillips **MS, G, CT, RD**

CONTROLS CO. OF AMERICA
9555 Soreng Ave., Schiller Park, Ill. (Tel. NAtional 5-9000)
Purch. Agents: L. Manfre & H. Keller
V. P.-Sales: D. Strathearn & A. Topp

CONVAIR-ASTRONAUTICS DIV.-GENERAL DYNAMICS CORP.
5001 Kearny Villa Rd., San Diego 12, Calif. (Tel. BRowning 7-8900)
Mgr.-Material: C. F. Uhden
Gen. Purch. Agents: E. Fellows, Jr. & C. G. Keach
Purch. Agents: W. S. Tucker, Const. Res. & Outside Prod.; W. J. Hill, Launch Control & Ground Support Equip.; B. W. Gruber, Space Projects, (Buying Supvr.); C. C. Farnsworth, Raw Materials, Hardware, Supplies & Equip.; C. T. Talbott, Electronics & Electrical Components; D. D. Knapp, Propulsion Pneumatics & Hydraulics **S, MS, G, CT, TT, RD, HSE**

CONVAIR INSTRUMENTS, CONVAIR DIV.-GENERAL DYNAMICS CORP.
3595 Frontier St., San Diego 10, Calif. (Tel. AC 3-1614)
Prod. Supvr.: George Shaheen
Chief Proj. Engr.: Dr. Egon Muehlner

CONVAIR-POMONA, CONVAIR DIV.-GENERAL DYNAMICS CORP.
1675 W. Fifth St., P. O. Box 1011, Pomona, Calif. (Tel. NAtional 9-5111)
Mgr.-Material: R. D. Webster
Purch. Agent-Standard Parts, Raw Materials, Facilities & Commercial: R. J. Hartmayer
Purch. Agent-Subcontracts, Special Components, Castings & Forgings: J. D. Currier **S, MS, G, CT, TT, RD**

CONVAIR-SAN DIEGO DIV.-GENERAL DYNAMICS CORP.
3165 Pacific Hwy., San Diego 12, Calif. (Tel. CYpress 6-6611)
Mgr.-Materials: W. R. Bruce
Gen. Purch. Agents: W. G. Evans & R. L. Donoghue
Subcontracting Chief: L. A. Wood
Purch. Agents: E. F. Monsses, Electronics & Advance Systems; V. M. Burns, Raw Materials & Purchased Parts; L. F. Tubbs, Systems; R. C. Fildes, Facilities & Supplies; H. L. Henry, Machining, Tool Control & Furnishings; M. Formanek, Sheet Metal, Ducts & Assemblies; M. F. Moseley, Power Packages & Major Assemblies **G, CT, TT, RD, HSE**

COOK BATTERIES, SUB.-TELECOMPUTING CORP.
3850 Olive St., Denver 7, Colo. (Tel. DUdley 8-4836)
Purch. Agent: Eugene Martine
Field Engrg. Mgr.: W. Burch Winder

C. LEE COOK CO., AIRTOMIC PRODUCTS DIV.
916 S. Eighth St., Louisville 18, Ky. (Tel. JUniper 7-6783)
Asst. to Pres.: R. W. Hoyt
Proj. Engr.: B. L. Curran
Sales Engr.: W. E. Gossage **PS, RD**

COOK ELECTRIC CO.
2700 N. Southport Ave., Chicago 14, Ill. (Tel. DIversey 8-6700)
Dir.-Purch.: Henry Bolger **S, MS, CT, TT, RD, HSE**

COOPER ALLOY CORP.
Hillside, N. J. (Tel. MU 8-4120)
Mgr.-Adv. & Sales Prom.: Stuart F. Cooper

COOPER DEVELOPMENT CORP., DIV.-THE MARQUARDT CORP.
2626 South Peck Rd. Monrovia, Calif. (Tel. HIllcrest 6-3138)
Purch. Agent: Eugene Binford
Mgr., Indsl. Relations: B. D. Hedding

CO-OPERATIVE INDUSTRIES, INC.
100 Oakdale Rd., Chester, N. J. (Tel. 255)
Purch. Agent: Ed Youngquist
V. P.-Sales: V. C. Bonardel
Materials Planning Dir.: Peter Hogeboom

COORS PORCELAIN CO.
600 9th St., Golden, Colo. (Tel. CRestview 9-4533)
Purch. Agent: John Hilf
Buyer: P. J. O'Brien
Gen. Sales Mgr.: Ben Landes **M, RD**

COPPERWELD STEEL CO., WIRE & CABLE DIV.
Glassport, Pa. (Tel. NOrth 4-7131)
Purch. Agent: M. M. Siegel
Sales Mgr.: George Hamburger **S, M**

COPPUS ENGRG. CORP.
344 Park Ave., Worcester 10, Mass. (Tel. PLeasant 2-5638)
Purch. Agent: H. C. Hult
Sales Mgr.: E. Kundig **PS, CT**

COPYMATION, INC.
5650 N. Western Ave., Chicago 45, Ill. (Tel. EDgewater 4-2200)
Purch. Agent: Ray Thierry
Dir.-Sales: Warren E. Frandsen **RD**

CORD PRODUCTS CO.
1 W. Main St., South Hadley Falls, Mass. (Tel. JE 4-3577)
Pres.: Francis J. Renkowicz
Treas.: Edwin R. Podgorski **M**

CORDO CHEMICAL CORP.
34 Smith St., Norwalk, Conn. (Tel. VOlunteer 6-4438)
Buyer: Richard Gilbert
Exec. V. P. & Gen. Mgr.: George H. Sherrard
Sales Mgr.: F. M. Hall **M**

CORNELIUS CO., THE, AERO DIV.
550 39th Ave., N. E., Minneapolis 21, Minn. (Tel. SUnset 8-8613)
Purch. Agent: Fred A. Anderson
Mgr.-Sales: J. W. Mahanay **MS, G, CT, RD**

CORNELL AERONAUTICAL LAB.
Buffalo, N. Y.

CORNELL DEEP DRAWING CO., DIV.-LANES INDUSTRIES CORP.
612-620 Colorado Ave., Santa Monica, Calif. (Tel. EXbrook 3-1810)
Purch. Agent: Norman Jae
Dir.-Sales: Jim Azbill **MS**

CORNELL-DUBILIER ELECTRIC CORP.
Hamilton Blvd., South Plainfield, N. J. (Tel. PLainfield 6-9000)
Dir.-Purch.: Paul H. Burbage
Sales Mgr. Com'l. Products Div.: Arthur Williams
Dir.-Sales: Raymond T. Leary **M**

CORNING GLASS WORKS
Corning, N. Y. (Tel. 2-5011)
Dir.-Purch.: T. S. Wood
Purch. Agent: Ralph Baker
Sales Mgr., Aircraft, Missiles: Raymond A. Wasson
Sales Mgr., Optical Sales: C. F. Henkel, Jr.
Sales Mgr., Electronic Components: C. C. Harwood **M, G**

CORNISH WIRE CO. INC.
50 Church St., New York 7, N. Y. (Tel. BArclay 7-5140)
Purch. Agent: N. A. Brennan, 101 Water St., Williamstown, Mass. (Tel. GLenview 8-4111) **M**

CORRUGATED PAPER PRODUCTS, INC.
2233 Utica Ave., Brooklyn, N. Y. (Tel. ESplamade 7-6112)
Pres.: J. Kapor

CORSON ELECTRIC MFG. CORP.
540 39th St., Union City, N. J. (Tel. UNion 6-4227)
Purch. Agent: R. Buss
Sales: D. Corson

COSA CORP.
Chrysler Bldg., 405 Lexington Ave., New York 17, N. Y. (Tel. YUkon 6-9696)
Mgr., Order Dept.: F. Warthmann
Sales Mgr.: S. Von Wattenwyl **S, CT**

COSMIC INSTRUMENTS INC.
10-28 Connecticut Ave., Washington 6, D. C. (Tel. ME 8-2620)
Pres.: Pomine Gignoux
V. P.: Alain Varon **PS, RD**

COUCH ORDNANCE, INC.
3 Arlington St., North Quincy 71, Mass. (Tel. Boston, BL 8-4147)
Purch. Agent: S. D. Bellis
Sales Mgr.: B. W. Gray **G**

COURTER PRODUCTS, DIV.-MODEL ENGRG. & MFG., INC.
375 N. Lake St., Boyne City, Mich. (Tel. JUnction 2-6526)
Dir.-Purch.: Lyle Duncan
Purch. Dept.: Joseph Kobus & William Ryder
Dir.-Sales: D. G. Russ **MS, G, RD**

COVEL MFG. CO.
P. O. Box 116, Graham Ave. at North Shore Dr., Benton Harbor, Mich. (Tel. WAlnut 6-6157)
Purch. Agent: J. E. Schadler
Sales Mgr.: Elmer A. Hopf **M**

COWLES CHEMICAL CO.
7016 Euclid Ave., Cleveland 3, Ohio (Tel. HE 1-3400)
Purch. Mgr.: M. A. Small
V. P.-Sales: C. C. Bassett **M**

COX & CO., INC.
115 E. 23rd St., New York 10, N. Y. (Tel. OREgon 4-4727)
Purch. & Prod. Mgr.: Edward Kraft
Dir.-Sales: Herbert M. Brusman **M**

COX INSTRUMENTS DIV., GEORGE L. NANKERVIS CO.
15300 Fullerton, Detroit 27, Mich. (Tel. VErmont 8-5780)
Purch. Agent: D. Lindh
Sales Mgr.: Robert Yung

CRAIG SYSTEMS, INC.
360 Merrimack St., Lawrence, Mass. (Tel. MUrdock 8-6961)
Dir.-Purch.: Joseph L. Frost
Buyers: Miss Mildred Kaczor & Barry Barker
Dir.-Sales Engrg.: Michael J. MacDonald **MS**

CRAMER CONTROLS CORP.
Centerbrook, Conn. (Tel. SOuth 7-8255)
Purch. Agent: R. W. Williams
V. P. & Dir.-Sales: W. H. Armstrong

CRANE CARRIER CORP.
1150 N. Peoria, Tulsa, Okla. (Tel. LUther 3-5133)
Purch. Agents: Al Vogel, Robert Armstrong, William Riley
V. P.-Sales: W. T. Barber **S**

CRANE CO.
836 S. Michigan Ave., Chicago 5, Ill. (Tel. WA 2-3123)
Mgr., Chem. Sales: R. E. Catlett **MS**

CRANE CO., INDUSTRIAL PRODUCTS GROUP
4100 S. Kedzie Ave., Chicago 32, Ill. (Tel. LA 3-9200) **MS**

CRANE CO., SPECIAL PRODUCTS DIV.
221 Central Ave., Johnstown, Pa. (Tel. 7-4491)
Purch. Agent: Robert A. Hoy
Dir.-Sales: C. M. Baumgardner **S, MS**

CRANE PACKING CO.
6400 Oakton St., Morton Grove, Ill. (Tel. ORchard 4-0100)
Purch.: Victor Gorgleth
Buyers: William Parlette & Harry Schnur
V. P.-Sales: V. E. Vorhees

CRATEX MFG. CO., INC.
1600 Rollins Rd., Burlingame, Calif. (Tel. OXford 7-1600) **M**

CRAWFORD FITTING CO.
884 E. 140th St., Cleveland 10, Ohio (Tel. LIberty 1-5533)
Purch. Agent: Bill Larkman
Sales Mgr.: Durell P. Haag **RD**

CRESCENT ENGRG. & RESEARCH CO.
5440 N. Peck Rd., El Monte, Calif. (Tel. GIlbert 4-0528)
Purch. Agent: J. Wackerman
V. P.-Mktg.: Scott B. Linn
Sales Mgr.: L. L. Noble **MS, G, CT, TT, RD**

CREST TRANSFORMER CORP.
1834 W. North Ave., Chicago 22, Ill. (Tel. EVerglade 4-1600)
Purch. Agent: A. W. Swanson
Sales Mgr.: R. Rinehart **RD**

CROMER MFG. & ENGRG., INC.
2138 E. 88th St., Los Angeles 2, Calif. (Tel. LUdlow 2-5383)
Purch. Agent: Joseph E. Haverfield
Plt. Supt.: Darrel L. Sewart
Sales Mgr.: W. O. Dockendorf **S, PS, MS, M**

CROMPTON & KNOWLES CORP.
93 Grand, Worcester, Mass. (Tel. PL 3-5431)
Purch. Agent: Joseph J. Benoit
Mgr.-Special Mfg. Dept.: R. J. McGivney

CRONAME INC.
6281 Howard, Chicago 48 (Niles), Ill. (Tel. SPring 4-2100)
Dir.-Purch.: Arthur J. Dahlgren
V. P.-Sales: Anthony F. Nosek **M**

CROSBY-TELETRONICS CORP.
54 Kinkel St., Westbury, N. Y. (Tel. EDgewood 3-1027)
Purch. Agent: Arthur H. Zink
Buyer: Pete Maragos
Exec. V. P.-Sales: Robert S. Marston **MS, TT, RD**

CROUSE-HINDS CO.
Wolf & 7th North Sts., Syracuse, N. Y. (Tel. GR 4-8411)
Purch. Agents: John Link, Paul Billy
Asst. Purch. Agents: Robert Gardner, Floyd Spaulding
Mgr.-Proc.: M. D. Low
Asst. Purch. Mgr.: Frank M. Egan
V. P.-Sales: E. R. Monesmith

CROWN INTERNATIONAL DIV., INTERNATIONAL RADIO & ELECTRONICS CORP.
Box 261, Elkhart, Ind. (Tel. JAckson 2-8583)
Purch. Mgr.: Jason Bemis
Sales Mgr.: Edwin C. Moore **G, CT, TT**

CROWN MFG. CORP.
33 Pequot Ave., New London, Conn. (GI 2-4325)
Office Mgr.: Harry Ali
Treas.: T. Kelly Parker

CROWNOVER AIRCRAFT CO.
P. O. Box 48-1263, Miami 48, Fla. (Tel. TU 5-1741)
Pres.: John A. Crownover **S**

CRUCIBLE STEEL CO. OF AMERICA
P. O. Box 2518, Oliver Bldg., Pittsburgh 30, Pa. (Tel. ATlantic 1-3800)
Dir. Purch.: R. O. Bridge
V. P.-Comm. Sales: M. J. Day **MS, M**

CRYOGENERATORS, INC.
750 S. Fulton Ave., Mount Vernon, N. Y. (Tel. MO 4-4500)
Dir.-Purch.: Allen Johnson
Dir.-Sales: James Hourilian, Jr. **MS, RD, HSE**

CRYOGENIC ENGRG. CO.
200 W. 48th Ave., Denver 16, Colo. (Tel. CH 4-8691)
Purch. Agent: E. M. Geigle
Pres.: G. E. McIntosh **PS, MS, RD**

CRYSTALONICS INC.
249 Fifth St., Cambridge 42, Mass. (Tel. KIrkland 7-2750)
V. P.-Purch. & Sales: B. B. Frusztaver **MS, G, CT**

CRYSTAL-X CORP.
112 W. Lenni Rd., Lenni Mills, Pa. (Tel. GLobe 9-1000)
Sales Mgr.: W. H. Seiler

CUBIC CORP.
5575 Kearny Villa Rd., San Diego 11, Calif. (Tel. BRowning 7-6780)
Dir.-Purch.: John C. Buchan
Buyers: E. A. Manfredi, A. C. Seeley, William Freres
Sales Mgr.: William Boyd **CT, TT, RD**

CUMMINS ENGINE CO., INC.
1000 Fifth St., Columbus, Ind. (Tel. DR 2-7211)
Dir.-Purch.: R. A. Sebastian
Purch. Mgrs.: J. A. Beaman & L. J. Miller
V. P.-Sales: C. R. Boll **PS, MS, CT**

JAMES CUNNINGHAM SON & CO., INC.
33 Litchfield, Rochester 8, N. Y. (Tel. BAker 5-7240)
Purch. Agent: James Elliott
Sales: Peter F. Cunningham
Chief Engr.: A. W. Vincent **MS, CT, TT**

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

CUNO ENGRG. CORP., THE
S. Vine St., Meriden, Conn. (Tel. BEverly 7-5541)
Purch. Agent: Fred Gagnier
V. P.-Mktg.: Carlton H. Winslow **PS, MS, G**

CURTIS AUTOMOTIVE DEVICES, INC.
P. O. Box 297, Westfield, Ind. (Tel. 3-2415)
Purch.: Dale Stevens
V. P.-Sales: E. H. Hostettler

CURTIS COMPANIES INC.
New London, Wis. (Tel. 38)
Purch. Agent: R. C. Mattka
Mgr.: Alex Luft
Quality Control Dept.: H. H. Heinrich **M**

CURTIS UNIVERSAL JOINT CO., INC.
5A Birnie Ave., Springfield 7, Mass. (Tel. RE 7-0281)
Sales: T. B. Cavanaugh
Purch.: R. E. Curtis **PS**

CURTISS-WRIGHT CORP.
Valley Blvd., Wood-Ridge, N. J. (Tel. WEbster 3-0800)
Chrm. & Pres.: Roy T. Hurley

CURTISS-WRIGHT CORP., ELECTRONICS DIV.
631 Central Ave., Carlstadt, N. J. (Tel. GEneva 8-4000)
Purch. Mgr.: F. L. Nicholls
Dir.-Sales: Charles O. Cary
Mgr., Air Force Sales: J. P. Phelps
Mgr., Army & Navy Sales: P. A. Ferrandino
Mgr., IMI Instruments Br.: V. V. Myers, (Tel. AMherst 8-8791)
Mgr., Elec. Instr. Sales: J. H. Ruiter, (Tel. CApital 6-9500) **MS, CT, TT, RD, HSE**

CURTISS-WRIGHT CORP., ELECTRONICS DIV., IMI BRANCH
5400 Acoma Rd., S. E., Box 8324, Albuquerque, N. M. (Tel. AMherst 8-2474)
Purch. Agent: F. L. Johnson
Br. Mgr.: J. F. Quirk
Br. Sales Mgr.: V. V. Myers **M, RD**

CURTISS-WRIGHT CORP., MARQUETTE DIV.
1145 Galewood Dr., Cleveland 10, O. (Tel. GLenville 1-4800)

CURTISS-WRIGHT CORP., METALS PROCESSING DIV.
P. O. Box 13, 760 Northland Ave., Buffalo 15, N. Y. (Tel. BAiley 7770)
Purch. Agent: Walter Greapentrog
Chief Buyer: Joseph Schwalbach
Gen. Sales Mgr.: Paul J. Chaney **S, M**

CURTISS-WRIGHT CORP., PRINCETON DIV.
P. O. Box 110, Princeton, N. J. (Tel. SWinburne 9-0500)
Purch. Agent: Victor Croal
Mgr., Nondestructive Testing: Bruce Smith
Mgr., Electronic Instrumentation: Gerald Schoenwald
Mgr., Ultrasonic Cleaning: Irving S. Geer
Mgr., Indsl. Controls: J. F. Orr
Gen. Mgr.: W. H. Happe, Jr.
Gen. Sales Mgr.: Robert E. Johnson **M, G, CT, RD**

CURTISS-WRIGHT CORP., PROPELLER DIV.
Caldwell, N. J. (Tel. CApital 6-2540)
Mgr.-Purch.: W. B. Thompson
Purch. Agent: C. V. Cross
Sales Mgr.: H. S. Robbins **PS**

CURTISS-WRIGHT CORP., SANTA BARBARA DIV.
6767 Hollister Ave., Goleta, Calif. (Tel. WO 7-3411)
Mgr.-Purch.: R. W. Daumiller
Dir.-Sales: D. E. Trumbull **S, MS, M, CT, TT, RD**

CURTISS-WRIGHT CORP., SOUTH BEND DIV.
701 W. Chippewa Ave., South Bend, Ind. (Tel. ATlantic 9-7192)
Mgr.-Purch.: G. R. Quilhot
Chief Buyer: J. L. LaVine
Gen. Sales Mgr.: Robert Campello

CURTISS-WRIGHT CORP., UTICA DIV.
50500 Mound Rd., Utica, Mich. (Tel. REpublic 2-2111)
Purch. Mgr.: A. T. Holland
Asst. Sales Dir.: G. S. Moule

CURTISS-WRIGHT CORP., WRIGHT AERONAUTICAL DIV.
Wood-Ridge, N. J. (Tel. PRescott 7-2900)
Dir.-Purch.: James R. Donahue
V. P. & Gen. Mgr.: J. V. Miccio
Dir.-Sales: H. Hanink

CUSHING & NEVELL
101 Park Ave., New York 17, N. Y. (Tel. OR 9-3810)
Dir.-Engrg. Writing: Frank Petro
Acct. Exec.: Donald A. Stearns
Acct. Exec. Dir.: Gordon Hale

CUSHMAN PRECISION INDUSTRIES
262 Alexander St., Princeton, N. J. (Tel. WAlnut 1-7008)
Dir.-Purch.: Thomas Le Prevost
Pres.: Robert H. Cushman **MS, G, CT, TT, RD**

CUSTOM COMPONENT SWITCHES INC.
3137 Kenwood St., Burbank, Calif. (Tel. VI 9-5951)
Purch. Agent: Warren Davis
Traffic Dept.: John Perry
Pres.: R. P. Ketelseninc **PS, MS, M, RD**

CUSTOM MAGNETICS INC.
2901 Winona Ave., Burbank, Calif. (Tel. VIctoria 9-1981)
Dir.-Sales: J. M. Schroeder **M**

CUSTOM PRODUCTS CORP.
606 Lindley St., Bridgeport 6, Conn. (Tel. ED 4-7329)
Purch. Agent: J. M. Dockendorff
Sales Mgr.: W. H. Bacon **G**

CUSTOM TOOL & MFG. CO.
2201 N. Second St., Minneapolis 11, Minn. (Tel. JAckson 1-3591)
Plant Supt.: Raymond C. Williams
Purch. Agent: R. W. Senn
Dir.-Sales: R. L. Satterlee **M**

CUTLER METAL PRODUCTS CO.
1025 Line St., Camden 3, N. J. (Tel. WOodlawn 3-1060)
V. P.-Purch.: Irving Shipkin
Pres.: Harry H. Cutler **MS**

CUTLER-HAMMER INC.
212 N. 12th St., Milwaukee 1, Wisc. (Tel. BRoadway 1-7800)
Dir.-Purch.: B. M. Horter, Sr.
Purch. Analyst: C. N. Harwood
Buyers: J. A. Twet, J. R. Leedom
V. P.-Mktg.: J. M. Cook **M, CT, RD**

CYCLE TRANSFORMER CORP.
356 Glenwood Ave., East Orange, N. J. (Tel. ORange 4-0731)
Purch. Agent: J. U. Dion
Chief Engr.: H. Edgar Snow
Sales Engr.: Paul M. Brubaker **M**

DBM RESEARCH CORP.
Stoddard Bldg., Atlantic Ave., Cocoa Beach, Fla. (Tel. SUnset 3-2438)
Purch. Agent: A. J. Mattox
Sales Mgr.: Cliff E. Mattox **M, RD**

D K MFG. CO.
5059 S. Kedzie, Chicago 32, Ill. (Tel. RE 7-3311)
Purch. Agent: Ted Kwasnik
Sales Mgr.: John Ferdinandsen

D & R PILOT PLANTS INC.
Water St., Hazardville, Conn. (Tel. RIverview 9-8301)
Dir.-Purch.: G. Patterson
Dir.-Sales: M. Mead **M**

D. S. D. MFG. CO., THE
2964 Whitney Ave., Hamden, Conn. (Tel. ATwater 8-1678)
Wks. Mgr. & Secy.: William J. Devin
Dir.-Sales: Douglas Smith

DAGE ELECTRIC CO., INC.
67 N. 2nd St., Beach Grove, Ind. (Tel. STate 6-0458)
Purch. Agent: Edgar Zehr
Sales Mgr.: Albert N. Strickland
Gen. Mgr.: Calvin J. Zehr **M**

DAGE TELEVISION DIV., THOMPSON RAMO WOOLDRIDGE, INC.
West 10th St., Michigan City, Ind. (Tel. TR 4-3251)
Purch. Agent: W. E. Dillon
Buyers: J. L. Fisk & Miss Jean Meeks **MS, CT, RD**

GEORGE W. DAHL CO., INC.
86 Tupelo St., Bristol, R. I.
Asst. to Pres.: T. F. Matheson

DAHLSTROM METALLIC DOOR CO.
443 Buffalo St., Jamestown, N. Y. (Tel. 7991)
Dir.-Purch.: Henry N. Ericson
V. P.-Sales: R. Quintus Anderson

DALE PRODUCTS, INC.
P. O. Box 136, Columbus, Nebr. (Tel. LOcust 4-3131)
Purch. Agent: Wallace Brunken
V. P.-Sales: Dan Geeding **RD**

DALLONS SEMICONDUCTORS, DIV.-DALLONS LABS.
5066 Santa Monica Blvd., Los Angeles 29, Calif. (Tel. NO 4-1951)
Purch. Agent: Chas. E. Woolhouse
Sales Mgr.: Tom E. Ciochetti

DALMO VICTOR CO., DIV.-TEXTRON, INC.
1515 Industrial Way, Belmont, Calif. (Tel. LYtell 1-1414)
Purch. Agent: R. M. Brown
Gen. Mgr.: J. A. Chartz **MS, TT, RD**

DALTON FOUNDRIES INC., THE
Lincoln and Jefferson St., Warsaw, Ind. (Tel. AM 7-8111)
Dir.-Purch.: A. L. Witmer
Dir.-Sales: J. V. Shellabarger **M**

DALWELD CO., INC.
15 Bertel Ave., Mt. Vernon, N. Y. (Tel. MOunt Vernon 4-8698)
Pres.: Jerry Robinson

DAMASCUS TUBE CO.
P. O. Box 71, Greenville, Pa. (Tel. Transfer, Pa., Mitchell 6-1500)
Purch. Agent: J. M. Thompson
Sales Mgr.: F. A. Guba

DAMPP-CHASER, INC.
1440 Ridgewood Blvd., Hendersonville, N. C. (Tel. OXford 3-8271)
Purch.: B. Dalton
Sales Mgr.: O. Jack Buckley **M**

DANA CORP.
4100 Bennett Rd., Toledo 1, Ohio (Tel. GReenwood 9-8241)
Purch. Agent: A. Diana
Buyers: H. Foster & C. Carlson
V. P.: C. C. Dybvig **MS**

DANBURY CENTERLESS GRINDING CO.
Rt. 7, Sugar Hollow Rd., Danbury, Conn. (Tel. PI 3-5525)
Gen. Mgr.: George P. Valluzzo
Office Mgr.: Anthony F. Asmar **M**

C. R. DANIELS, INC.
Daniels, Md. (Tel. ELlicott City 1200)
Purch. Agent: D. H. Kelley
Buyers: W. L. Young, F. J. Trumpbour & J. Russell
V. P.-Sales: W. E. Carson

DANLY MACHINE SPECIALTIES, INC.
2100 S. Laramie Ave., Chicago 50, Ill. (Tel. BIshop 2-1800)
Purch. Agent: Paul R. Fields
Buyer: William Gardner
V. P.-Press Sales: D. R. Danly
V. P.-Sales, Die Makers Supp.: R. E. Danly

DANTE ELECTRIC MFG. CO.
Marne Park, Bantam, Conn. (Tel. Litchfield, JOrdan 7-5307)
Gen. Mgr.: Joseph J. Dante

DARCOID CO. INC., THE
145 6th Ave., New York 13, N. Y. (Tel. ALgonquin 5-1393)
Gen. Mgr.: Peter J. Digilio

R. E. DARLING CO., INC.
4858 Cordell Ave., Bethesda 14, Md. (Tel. OLiver 4-6900)
Purch. Agent: George M. Burge, Jr.
Prod. Control: Charles F. Fairfax
V. P.-Sales: R. E. Darling, Jr. **M, HSE**

DARLING VALVE & MFG. CO.
Foot of Walnut, Williamsport, Pa. (Tel. 3-6121)
Purch. Agent: S. Reese
Dir.-Sales: D. F. Sable **S, M**

DARNELL CORP. LTD.
37-28 61st St., Woodside 77, N. Y. (Tel. HAvemeyer 4-3717)
Sales Mgr.: A. L. Foster
Div. Sales Mgr.: R. J. Geberth **S, MS, M, RD**

DATA INSTRUMENTS DIV.-TELECOMPUTING CORP.
12838 Saticoy St., North Hollywood, Calif. (Tel. TRiangle 7-8181)
Purch. Agent: Jim Newton
Dir.-Sales: Robert E. Poole, Jr. **CT**

DATA-CONTROL SYSTEMS, INC.
39 Rose St., Danbury, Conn. (Tel. Pioneer 3-9241)
Mgr., Materiel Dept.: David Forshaw
V. P.-Operations: Weems E. Estelle
V. P.-Research & Development: R. A. Runyan
Mgr., Mktg.: Rosel H. Hyde **TT**

DATASCAN INC.
324 Colfax Ave., Clifton, N. J. (Tel. PRescott 3-8803)

Purch. Dept.: William Rothman
Sales Engr.: Morton S. Levin **CT, RD**

DATEX CORP.
1307 S. Myrtle Ave., Monrovia, Calif. (Tel. ELliot 9-5381)
Chief Buyer: Richard V. Ireland
Gen. Sales Mgr.: Michael J. Joncich **MS, CT, TT, RD**

DAUBERT CHEMICAL CO.
4700 S. Central Ave., Chicago 38, Ill. (Tel. LUdlow 2-1000)
Purch. Agent: J. W. Taylor
Sales Mgr., Sealants Div.: E. B. Jared
Sales Mgr., Packaging Div.: W. A. Spencer **M**

DAVEN CO., THE
Rt. 10, Livingston, N. J. (Tel. WYman 2-4300)
Dir.-Purch.: John Harbidge
Buyers: A. M. Watkins, I. Valentine
Sales Mgr.: E. L. Grayson **G, CT, TT, RD**

DAVENPORT MFG. CO.
2530-32 N. Elston Ave., Chicago 47, Ill. (Tel. DIckens 2-5620)
Treas.: A. W. Davenport **CT, RD**

JOE DAVIDSON & ASSOCIATES
2803 Los Flores Blvd., Lynwood, Calif. (Tel. NEvada 6-2245)
Sales Mgr.: Fred Simpson **MS, M, CT, RD**

DAVIDSON OPTRONICS, INC.
2223 Ramona Blvd., West Covina, Calif. (Tel. EDgewood 7-7281)
Purch. Agent: O. A. Kidwell
Asst. Purch. Agent: Eva Jeffries
Sales Mgr.: James McBride **MS**

DAVIS INSTRUMENTS
47 Halleck St., Newark 4, N. J. (Tel. HUmboldt 2-3660)
Purch. Agent: C. Freeman

J. H. DAY CO., THE, DIV.-THE CLEVELAND AUTOMATIC MACHINE CO.
4932 Beech St., Cincinnati 12, Ohio (Tel. REdwood 1-5300)
Purch. Agent: A. W. Niederhelman
Asst. Purch. Agent: Bert Bien
Sales Mgr.: Robert A. Miller **M**

DAYSTROM, INC., CONTROL SYSTEMS DIV.
4455 Miramar Rd., La Jolla, Calif. (Tel. GL 4-0421)
Purch. Agent: Conrad Stipp
Asst. Buyer/Expediter: Elizabeth Horn
Purch. Clerk: Alice Hill
Mktg. Mgr.: John A. Palmer **CT, RD**

DAYSTROM, INC., MILITARY ELECTRONICS DIV.
Archbald, Pa. (Tel. JErmyn 1100)
Materials Mgr.: Fred M. Seitz
Supvr., Proc.: David G. Brady
Prod. Control: G. B. Carroll
Sales Prom. Mgr.: Leslie Daniels
S, PS, MS, M, G, CT, RD

DAYSTROM INC., PACIFIC DIV.
9320 Lincoln Blvd., Los Angeles 45, Calif. (Tel. ORchard 4-7100)
Purch. Agent: Bernard A. Thompson
Asst. Sales Mgr., Instruments & Systems Sales: Joseph W. O'Callaghan
Sales Mgr., Potentiometer Sales: Robert Wolin
G, HSE

DAYSTROM INC., TRANSICOIL DIV.
Worcester, Montgomery County, Pa. (Tel. JUno 4-2421)
Purch. Agent: Pete Toscano
Dir.-Sales: John J. Gattoline **MS, RD**

DAYSTROM INC., WESTON INSTRUMENTS DIV.
614 Frelinghuysen Ave., Newark 12, N. J. (Tel. FUlton 1-4446)
Purch. Agent: N. A. Dinnsen
Gen. Sales Mgr.: K. C. Moulton

DAYTON AIRCRAFT PRODUCTS, INC.
P. O. Box 8007, 812 N. W. First St., Ft. Lauderdale, Fla. (Tel. JAckson 3-5451)
Dir.-Purch.: H. A. Cline
Dir.-Engrg.: A. J. Benkoczy
Dir.-Operations: F. C. Betcher **S, MS, G, RD**

DAYTON RUBBER CO., THE
2345 Riverview Ave., Dayton 1, Ohio (Tel. CRestview 8-2666)
V. P.-Purch.: L. J. Keyes
Buyers: R. P. Heist, R. A. Greenwald, J. B. Cochenour & B. Rhines
Dir.-Sales, Urethane: Allan W. Cox **S, RD**

DAYTRONIC CORP.
223-227 S. Jefferson St., Dayton 2, Ohio (Tel. BAldwin 4-1621)
Prod. Mgr.: W. R. Winger
Chief Engr.-Purch.: R. M. Kinkead
Dir.-Sales: M. M. Moorhead, Jr. **CT, RD**

DEAN & BENSON RESEARCH, DIV.-BENSON MFG. CO.
1811 Agnes Ave., Kansas City 27, Mo. (Tel. BEnton 1-8300)
Purch. Agent: Ralph Bure
Buyers: James Mitchell & Earl Miller
Mgr.-Sales: George A. Dean **M, RD**

DEAN PRODUCTS, INC.
616 Franklin Ave., Brooklyn 38, N. Y. (Tel. ST 9-5400)
V. P.-Sales: Rubin Raskin **MS, CT**

DEARBORN ELECTRONIC LABS., INC.
1421 N. Wells St., Chicago 10, Ill. (Tel. WH 3-2412)
Purch. Agent: George Economos
Gen. Mgr.: Ray Simpson
Sales Mgr.: Bill Cox **M**

DeBELL & RICHARDSON INC.
Water St., Hazardville, Conn. (Tel. RIverview 9-8301)
Pres.: John M. DeBell
Sr. Group Leader: Fred E. Wiley **M, CT, RD**

DECATUR CASTING CO., THE
822 Dayton Ave., Decatur, Ind. (Tel. 3-2700)
Resident Mgr.: Clarence E. Fishbaugh
Supt.: Glenn A. Mauller
Asst. Resident Mgr.: Lynn D. McDougall **M**

DECISION/INC.
4602 Red Bank Rd., Cincinnati 27, O. (Tel. BRamble 1-3200)
Pres.: Oliver P. Bardes **G, RD**

DECKER CORP., THE
45 Monument Rd., Bala-Cynwyd, Pa. (Tel. MOhawk 4-6700)
Dir.-Purch.: A. Richard Newhouse, Jr.
Asst. Dir.-Purch.: Peter Burn
Dir.-Sales: Robert L. Gross **M, G, CT, TT, RD, HSE**

DEE ELECTRIC CO.
1101 N. Paulina St., Chicago 22, Ill. (Tel. BElmont 5-5151)
Pres.: W. DeVerter
Purch. Agent: J. Lamberty

De HAVILLAND AIRCRAFT OF CANADA, LTD., SPECIAL PRODUCTS DIV.
Downsview, Ontario, Canada (Tel. MElrose 3-5230)
Purch. Agent: S. M. Gilbert
Contracts Admin.: L. D. Clarke
Sales Mgr.: E. Wall **MS, G, CT, RD**

DeJUR-AMSCO CORP., ELECTRONIC SALES DIV.
45-01 Northern Blvd., Long Island City 1, N. Y. (Tel. RAvenswood 1-4009)
Purch. Dir.: Peter Heaney
Buyer: Sol Frankel
Dir.-Sales, Electronics Div.: N. J. Geldman
M, CT, RD

DEL ELECTRONICS CORP.
521 Homestead Ave., Mt. Vernon, N. Y. (Tel. OWens 9-3232)
V. P.-Engrg.: H. J. DiGiovanni
V. P.-Research: R. Kaufman **M, RD**

***DEL MAR ENGRG. LABS.**
6901 Imperial Hwy., Los Angeles 45, Calif. (Tel. ORegon 8-4371)
Purch. Agent: David Hume
V. P.-Sales, Service, & Contracts: Neil Lamont
S, MS, RD
*(See advertisement this issue)

DELAVAN ELECTRONICS CORP.
77 Olean Rd., East Aurora, N. Y. (Tel. CYpress 3600)
Pres.: K. L. Richard
Sales Engr.: F. E. Riehle
Plant Mgr.: E. T. Drake **RD**

DELAVAN MFG. CO.
811 4th St., West Des Moines, Iowa (Tel. CR 4-1561)
Purch. Agent: W. E. Stroeber
Buyers: Robert Heles & Charles O'Brien
Sales Mgr.: Ray J. Slezak
Gen. Sales Mgr.: J. D. Hopkins **PS**

DELCO PRODUCTS DIV., GENERAL MOTORS CORP.
329 E. 1st St., Dayton 1, Ohio (Tel. BAldwin 2-0411)
Mgr.: G. J. Lowe
Defense Sales Mgr.: W. K. West **MS**

DELCO RADIO DIV.-GENERAL MOTORS CORP.
700 E. Firmin, Kokomo, Ind. (Tel. GLadstone 2-8211)
Purch. Agent: R. Hill, Jr.
Dir.-Sales & Engrg.: H. M. Stelzl
Gen. Sales Mgr.: D. A. Sandberg
Mil. Sales Mgr.: J. C. Crawford **MS, G, CT, RD**

DELCO-REMY DIV., GENERAL MOTORS CORP.
2401 Columbus Ave., Anderson, Ind. (Tel. 5581)
Gen. Mgr.: D. L. Boyes
Dir.-Purch.: F. E. Boze
Dir.-Sales & Engrg.: H. G. Riggs

DELL OPTICS CO., LIMITED
327 55th St., West New York, N. J. (Tel. UNion 7-1599)
Dir.-Purch. & Sales: Peter F. Tralongo
Sales Dept.: Frank J. Gervolino **M, RD**

DELRON CO., INC., THE
5224 Southern Ave., South Gate, Calif. (Tel. Lorain 7-2477)
V. P.: Bruce M. Wadsworth
Treas.: Iona Mouron
Sales Mgr.: Ray J. Schwab

DEL'S TUMBLING SERVICE
232 N. Rosemary St., Dearborn 6, Mich. (Tel. LOgan 2-5537)
Pres.: D. W. Dyer

DELSEN CORP.
719 W. Broadway, Glendale 4, Calif. (Tel. CHapman 5-8517)
Purch. Agent: Herbert A. Hansen
Gen. Mgr.: Leland E. McCrory **RD**

DELTA CHEMICAL WORKS, INC.
23 W. 60th St., New York 23, N. Y. (Tel. PLaza 7-6317)
Asst. Dir.-Purch.: P. K. Massey
Comptroller: Max Lendner

DELTA CORP.
1249 Main St., Hartford 5, Conn. (Tel. JA 7-8205)
Dir. Purch.: Joseph J. Morrone
Buyers: N. Barber & J. Hiesel
Purch. Agent: A. Mazzerferro **S, PS, MS**

DELTA-DESCO COMPANIES
539 Aero Dr., Box 1403, Shreveport, La. (Tel. 5-2416-17-18)
Sales Mgr.-Buyer: T. D. Chantler
Chief Clerk, Sales Dept.: Mrs. Helen Dudley **M**

DELTA DESIGN, INC.
3163 Adams Ave., San Diego 16, Calif. (Tel. AT 3-3193)
Pres.: Trigg Stewart
V. P.: David P. Comey
Sales Mgr.: D. H. Evans, Jr. **CT**

DELTRON INC.
4th & Cambria St., Philadelphia 33, Pa. (Tel. Regent 9-1101)
Purch. Agent: R. McGarvey
Purch. Clerk: C. Hohner
Dir.-Sales: A. Anton **MS, CT**

DELUXE COILS INC.
P. O. Box 454, Wabash, Ind. (Tel. 1720); Luxolene Div., Huntington, Ind. (Tel. 3600)
Purch. Agent: Arnold Yentes
Sales Mgr.: R. W. Keipper
Buyer, Luxolene Div.: R. Fickle
Material Mgr., Luxolene Div.: Herman Stegen **MS, G**

DELUXE METAL PRODUCTS CO.
Warren, Pa. (Tel. RAndolph 3-3900)
Purch. Agent: L. Hutchins
Gen. Sales Mgr.: R. H. Hauser

DEMING CO., THE
South Broadway, Salem, Ohio (Tel. ED 7-8741)
V. P.-Sales: R. F. Webber
Dir.-Purch.: Fred J. Limestahl
Sales Mgr.: R. L. Davis

DEMORNAY-BONARDI
780 S. Arroyo Pkwy., Pasadena, Calif. (Tel. SYcamore 2-4142)
Dir.-Purch.: Herbert J. McCann, Jr.
Sales: M. G. Ekstrom **MS, G, CT, TT, RD**

DEMPSTER BROTHERS INC.
Springdale Ave., Knoxville 17, Tenn. (Tel. 4-1671)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch. Agent: John L. McFall
Asst. Purch. Agent: Floyd Nichols
Sales Mgr.: Joseph M. Smallman M

DENISON ENGRG. DIV., AMERICAN BRAKE SHOE CO.
1160 Dublin Rd., Columbus 16, O. (Tel. HUdson 8-1191)
Dir.-Purch.: G. T. Hays
Gen. Sales Mgr.: W. J. Pelich
Dir.-Sales: Denison Neale

DENNIS CHEMICAL CO.
2701 Papin St., St. Louis 3, Mo. (Tel. PRospect 6-1868)
Purch. Agent: L. R. Pope
Sales Mgr.: Milton Carlie M, RD

DENVER RESEARCH INSTITUTE
University of Denver, Denver 10, Colo. (Tel. SH 4-1811)
Dir.: Shirley A. Johnson, Jr.
Assoc. Dir.: James P. Blackledge
Business Mgr.: George M. Canetta RD

DEPENDABLE PRINTED CIRCUIT CORP.
827 Black Oak Ridge Rd., Wayne, N. J. (Tel. TE 5-2765)
Dir.-Sales: George Ogens
Pres.: R. K. Hansen M

DERBY CASTINGS CO., THE
591 N. Main St., P. O. Box 111, Seymour, Conn. (Tel. TUxedo 8-2581)
Pres.: C. H. Stokesbury, Jr. M

F. W. DERBYSHIRE, INC.
157 High St., Waltham 54, Mass. (Tel. TWinbrook 4-2900)
V. P.: Shaw B. Smith M

DERINGER METALLURGICAL CORP.
8131 Monticello Ave., Skokie, Ill. (Tel. ORchard 5-1030)
Pres.: Edwin F. Allison
Exec. V. P.: J. Porter Duell, Jr.
Purch. Agent: Quintin E. Wiersum
V. P.-Sales: Paul H. Loeffler M

DESIGNERS FOR INDUSTRY, INC.
4241 Fulton Pkwy., Cleveland 9, Ohio (Tel. SH 9-0700)
Purch. Agent: W. F. Morgan
V. P.-Sales: J. C. Standish MS, G, CT, RD

DESOMATIC PRODUCTS, INC.-ANDERS-DRILINE
1109 W. Broad St., Falls Church, Va. (Tel. JEfferson 3-9600)
Purch. Agent: M. W. Reed
Gen. Sales Mgr.: Gunnar C. F. Asker
Sales Mgr., Anders-Driline: Edwin W. Anders MS

DESPATCH OVEN CO.
619 S. E. 8th St., Minneapolis 14, Minn. (Tel. FEderal 1-1873)
Purch. Agent: C. J. Flinn
Sales Mgr., Merch. Div.: E. M. Burud S, M, G, CT, RD

DESTRON CO.
25914 Chalmette, Rolling Hills, Calif. (Tel. FRontier 8-3450)
Owner: D. E. St. John MS, CT, TT

DETECTO SCALES, INC.
540 Park Ave., Brooklyn 5, N. Y.
Dir.-Purch.: Maxwell Klein
V. P.: Mack Rapp M, CT

DETREX CHEMICAL INDUSTRIES, INC.
Box 501, Detroit 32, Mich. (Tel. TOwnsend 8-8600)
V. P.-Sales: W. F. Newbery MS, M

DETROIT DIESEL ENGINE DIV.-GENERAL MOTORS CORP.
13400 W. Outer Dr., Detroit 28, Mich. (Tel. KE 1-7100)
Purch. Agent: W. T. Fogarty
Mgr.-Purch. & Prod.: John E. McKenna
Gen. Sales Mgr.: Robert E. Hunter MS

DETROIT HOIST & MACHINE CO.
8201 Morrow St., Detroit 11, Mich. (Tel. TR 5-8344)
Sales Engr.: V. A. Fulton

DETROIT STAMPING CO.
350 Midland Ave., Detroit 3, Mich. (Tel. TO 8-5080)
Purch. Agent: John Thullen
V. P.-Sales: H. C. Robeson M

DETROIT TESTING LAB. INC., THE
554 Bagley Ave., Detroit 26, Mich. (Tel. WO 1-4870)
Pres.: Douglas Dow CT, RD

DEUTSCH CO., ELECTRONIC COMPONENTS DIV., THE
Municipal Airport, Banning, Calif. (Tel. VI 9-6701)
Purch. Agent: M. Brown
Sales Mgr.: H. E. Schwank M

DEUTSCH FASTENER CORP.
14504 S. Figueroa St., P. O. Box 61072, Los Angeles 61, Calif. (Tel. DAvis 3-6640)
Purch. Agent: G. M. Hays
V. P. & Sales Mgr.: B. S. Sauter

DEVCO ENGRG. INC.
Pier Lane West, Caldwell, N. J. (Tel. CA 6-0610)
Purch. Agent: G. Schmidt
Sales: C. Allen

DEVELOPMENT ENGRG. CO., INC.
9 Cross St., Norwalk, Conn. (Tel. VOlunteer 6-7720)
Chief Engr.: Richard L. Seidman CT, RD

DEVICE DEVELOPMENT CORP.
428 Boston Post Rd., Weston 93, Mass. (Tel. TW 3-0300)
Dir.-Purch.: H. Stacey
Dir.-Sales: R. B. Holt MS, RD

DeVILBISS CO., THE
300 Phillips Ave., Toledo, O. (Tel. GReenwood 4-5411)
V. P.-Purch.: E. J. Etzel
Mgr.-Adv. & Sales Prom.: H. A. Lange

DeWALT DIV., AMERICAN MACHINE & FOUNDRY CO.
Fountain Ave., Lancaster, Pa. (Tel. EXpress 3-5831)
Gen. Sales Mgr.: A. E. Richardson, Jr.
Purch. Agent: Frank Zecher

DeWITT DEVELOPMENT CO.
3008 W. 127th St., Blue Island, Ill. (Tel. FUlton 8-2480)
Pres.: B. G. DeWitt G

DEZURIK CORP.
Sartell, Minn. (Tel. BL 1-0221)
Purch. Agent: L. Dezurik
Sales Mgr.: David Dezurik M

DIAL PRODUCTS CO.
19 Cottage St., Bayonne, N. J. (Tel. HEmlock 7-0720)
Exec. V. P.-Purch.: H. Samo
Purch. Agent: Mrs. L. Starkey
Buyer: E. Kay
Works Mgr.: J. Wolfkind PS, G

DIALIGHT CORP.
60 Stewart Ave., Brooklyn 37, N. Y. (Tel. HYacinth 7-7600)
Purch. Agent: E. S. Forman
V. P.-Sales: R. E. Greene M

DIAMOND ANTENNA & MICROWAVE CORP.
35 River St., Winchester, Mass. (Tel. PArkview 9-5500)
Purch. Agent: William L. Page
Sales Engr.: William Rand MS, G, TT, RD

DIAMOND CHAIN CO., INC.
402 Kentucky Ave., Indianapolis 7, Ind. (Tel. Melrose 8-6431)
Dir. Purch.: E. W. Allen
Sales Mgr.: J. E. Cooper M

DIAMOND DRILL CARBON CO., THE
244 Madison Ave., New York 16, N. Y. (Tel. LExington 2-3006)
Sales: Bernard Rhodes M

DIAMOND POWER SPECIALTY CORP.
Lancaster, Ohio (Tel. OLive 3-6540)
Purch. Agent: W. W. Black
V. P.-Sales: W. H. Jackson PS, MS

DIAMONITE PRODUCTS MFG. CO.
Shreve, Ohio (Tel. JO 7-4211)
Dir.-Purch.: B. Steimel
Sales Engr.: R. C. Mulligan M

J. W. DICE CO.
16 Highwood Ave., Englewood, N. J. (Tel. LOwell 9-0471)
Chief Engr.: M. Strain
Purch. Agent: E. Franz
Sales: E. Van Ressel CT

DIEHL MFG. CO.
1224 Finderne Ave., Somerville, N. J. (Tel. RAndolph 5-2200)
Purch. Agent: F. Boyne
Purch. Dept.: J. Rizzo & H. A. Conrad
V. P.-Sales: A. R. Booth M, G

HENRY G. DIETZ CO., INC.
12-16 Astoria Blvd., Long Island City 2, N. Y. (Tel. RAvenswood 6-3347)
Dir.-Purch.: M. Pheasey
Dir.-Sales: H. Dietz MS, CT, TT

EUGENE DIETZGEN CO.
2425 N. Sheffield Ave., Chicago 14, Ill. (Tel. Lincoln 9-3300)
Purch. Agent: G. Graefenstein
Chief Engr.: L. R. Halstead
V. P.: H. S. Sandler RD

DIGITAL SENSORS INC.
6443 N. Figueroa St., Los Angeles 42, Calif. (Tel. CLinton 5-1529)
Dir.-Sales: Lee Griswold RD

DIGITRAN CO., THE
660 S. Arroyo Pkwy., Pasadena, Calif. (Tel. MU 1-9667)
Purch. Agent: Don Lange CT, TT

DIGITRONICS CORP.
Albertson Ave., Albertson, N. Y. (Tel. PI 7-5090)
Purch. Agent: Angelo Targia
V. P.-Sales: Eugene Leonard G

DILECTRIX CORP.
Allen Blvd., Farmingdale, L. I., N. Y. (Tel. CHapel 9-7999)
Purch. Agent: M. Petriello
Sales Mgr.: M. Zangrillo PS, M

DILL MFG. CO., THE
700 E. 82nd St., Cleveland 3, Ohio (Tel. UTah 1-3200)
Dir.-Purch.: C. W. Bonifield
Asst. Purch. Agent: Ernest Spacone
Sales Mgr.: B. S. Byall M

W. C. DILLON & CO., INC.
14620 Keswick St., Van Nuys, Calif. (Tel. STate 5-3168)
Purch. Agent: Earl D. Roberts
Sales Mgr.: George A. Dillon CT

DIMCO-GRAY CO.
207 E. 6th St., Dayton 2, O. (Tel. BAldwin 2-6703)
Purch.: J. D. Gray
Sales Mgr.: C. F. Dearth M

DINION COIL CO., INC.
North St., Caledonia, N. Y. (Tel. KEystone 8-4412)
Purch. Agent: R. S. Eldridge
V. P. & Sales Mgr.: E. J. Holland M

DIT-MCO, INC.
911 Broadway, Kansas City 5, Mo. (Tel. HArrison 1-0011)
Purch. Agent: F. J. Peterschmidt
Natl. Sales Mgr.: W. C. Comer CT, RD

DIVCO-WAYNE ELECTRONICS DIV., DIVCO-WAYNE CORP.
9701 Reading Rd., Cincinnati 15, Ohio (Tel. POplar 1-0010)
Purch. Agent: T. C. Grate
Dir.-Sales: Gene Rove

DIVERSEY CORP., THE
1820 W. Roscoe St., Chicago 13, Ill. (Tel. Graceland 7-3000)
Purch. Agent: D. V. Hannibal
V. P.-Sales: B. B. Button

DIVISION LEAD CO.
7742 W. 61st Place, Summit, Ill. (Tel. Chicago—REliance 5-8600)
Purch. Agent: Mary J. Spacek
Pres.: Joe A. Stone M

DIXON CORP.
19-21 Burnside St., Bristol, R. I. (Tel. CLifford 3-7500)
Purch. Agent: Gerald Almeida
V. P.-Sales: John M. Feeley

DJECO, DIV.—DJORDJEVIC ENGRG. CO.
1933 N. Damen, Chicago 47, Ill. (Tel. ARmitage 6-7308)
Purch. Agent: O. D. Petrovic
Sales Mgr.: O. M. Djordjevic
Gen. Mgr.: G. Z. Djordjevic MS, RD

DMETER MFG. CO.
68 N. Broadway, P. O. Box 88, Yonkers, N. Y. (Tel. Yonkers 9-1770)
Dir.—Purch.: Frank D. Yablonsky
Dir.—Sales: William R. Foley
Pres.: D. Yablonsky M

DOAK AIRCRAFT CO. INC.
22309 South Western Ave., Torrance, Calif. (Tel. Spruce 5-2596)
Purch. Agent: F. R. Miller

V. P.: E. E. Rosier -S. MS

DODCO, INC.
Blawenburg, N. J. (Tel. Tuxedo 2-1838)
Pres.: Daniel O. Dommasch G. RD

DODGE MFG. CORP.
S. Union St., Mishawaka, Ind. (Tel. BLackburn 9-2421)
V.P.-Prod. & Purch.: Earl Wedlake
Dir.-Prod. & Purch.: Donald Saunter
Purch. Agent: Edwin Rhodes
Asst. Purch. Agent: Clifford Miller
Steel Buyer: Clifford Mechling
V.P.-Sales: Harry A. Torson

DOEHLER-JARVIS DIV., NATIONAL LEAD CO.
1945 Smead Ave., Toledo 1, Ohio (Tel. CHerry 4-9521)
Purch. Agent: Miss N. DiPersia
Mgr.-Sales: F. W. Burgie M

DOLGORUKOV MFG. CO.
407 Fisher Bldg., Detroit 2, Mich. (Tel. TR 1-6383)
Dir.-Sales: Gregory S. Dolgorukov

DOLIN METAL PRODUCTS, INC.
315 Lexington Ave., Brooklyn 16, N. Y. (Tel. NE 8-9472)
Purch. Agent: George Dolson
Asst. Purch. Agent: Ted Picon
Dir.-Sales: Albert Gorlin M

DOLINKO & WILKENS, INC.
1907 Summit AVe., Union City, N. J. (Tel. UNion 7-6630)
V. P.: Louis Dolinko M, CT, RD

DOLLIN CORP.
600 S. 21st St., Irvington, N. J. (Tel. ESsex 4-3000)
V. P.-Sales: Gordon C. Curry

DON-LAN ELECTRONICS INC.
1101 Olympic Blvd., Santa Monica, Calif. (Tel. EX 3-0758)
Gen. Mgr.: Harold W. Arlidge
Prod. Mgr.: Edward B. Butler
Buyer: Jack R. Yost MS, G, RD

DONNELLY MFG. CO.
580 Winter St., Waltham 54, Mass. (Tel. TW 3-5700)
Purch. Agent: John L. Lawlor
Asst. Purch. Agent: James V. McDaid
Pres.: Arthur T. McManmon

DONNER SCIENTIFIC CO.
Concord, Calif. (Tel. MUlberry 2-6161)
Purch. Agent: W. H. Burr, Jr.
Sales Mgr.: James Story G, CT, RD, HSE

DORAU-CALZA HAIRSPRING CO., INC.
Yale Ave., Wallingford, Conn. (Tel. Colony 9-7630)
Pres.: Walter Dorau
Treas.: Roger Calza
V. P.: Ernest Calza

JOHN L. DORE CO.
P. O. Box 7772, Houston 7, Texas (Tel. UN 9-3401)
Purch. Agent: Oscar Fraley
Sales Mgr.: Harry I. Thompson, Jr. M

DORNE & MARGOLIN, INC.
29 New York Ave., Westbury, L. I., N. Y. (Tel. EDgewood 4-3200)
Purch. Agent: J. Escalette
Buyer: O. M. Portocarrero
Sales Supvr.: David L. Ward MS, G, CT, TT, RD

DORSETT ELECTRONIC LABS., INC.
119 W. Boyd St., P. O. Box 862, Norman, Okla. (Tel. JEfferson 4-3750)
Purch. Agent: Joseph Tackwell
V. P.-Engrg: J. D. Warren
Dir.-Sales: D. G. Wantland TT, RD

DOUBLE "E" PRODUCTS CO.
208 Standard St., El Segundo, Calif. (Tel. EAstgate 2-2501)
Purch. Agent: B. A. Allan
Gen. Mgr.: S. S. Trier
Sales Mgr.: J. S. Trier MS, G, CT, RD

DOUGLAS AIRCRAFT CO.
3000 Ocean Park Blvd., Santa Monica, Calif. (Tel. EX 9-9311)
Chief Purch. Agent: W. E. Ferguson
Purch. Agent, Equip. Group: H. C. Brackney
Purch. Agent, Parts Group: R. L. Kane
V. P.-Comm. Program: J. R. McGowen
V. P.-Defense Programs: C. R. Able
S, MS, M, G, CT, TT, RD, HSE

DOUGLAS MICROWAVE CO., INC.
252 E. Third St., Mt. Vernon, N. Y. (Tel. MOunt Vernon 8-6900)
Purch. Agent: Leonard G. Geier
Buyer: H. Gordon
Sales Mgr.: Herbert M. Hendlin G, TT, RD

DOW CHEMICAL CO.
Midland, Mich. (Tel. MElrose 6-1000)
Dir.-Purch.: M. E. LeFevre (Tel. ME 6-4324)
Dir.-Sales: D. K. Ballman M

DOW CORNING CORP.
Midland, Mich. (TEmple 2-2371)
Dir.-Purch.: D. R. Coultrip
Purch. Dept.: P. C. Philbrick & R. E. Neal
Dir.-Sales: O. D. Blessing M

DOW INDUSTRIAL SERVICE DIV.-DOW CHEMICAL CO.
20575 Center Ridge Rd., Cleveland 16, Ohio (Tel. EDison 3-1544)
Sales Mgr.: H. H. Walther
Gen. Purch. Agent: V. M. Lewis, P. O. Box 536, Tulsa, Okla. (Tel. LUther 2-0101) PS, M

DOW-ELCO, INC.
1313 W. Olympic Blvd., Montebello, Calif. (Tel. RAymond 3-1288)
Pres.: J. W. Eldridge
V. P.: E. F. Huffines

DOW-KEY CO.
Hwy. 59 S. E., Thief River Falls, Minn. (Tel. Murdock 1-3075)
Treas. & Gen. Mgr.: Lowell T. Swenson
Pres.: Gordon M. Dow
Engr.: Paul Schiebe M

DRAYER HANSON DIV., CRANE CO.
P. O. Box 2215, Terminal Annex, Los Angeles 54, Calif. (Tel. ANgelus 9-0321)
Purch. Agent: C. A. Hasenstab
Buyer: L. Adams
Chief, Defense Prod.: Don Murray S, MS, M, CT

DREMEL MFG. CO.
2420 18th St., Racine, Wisc. (Tel. MElrose 3-8267)
E. A. Erdman

DRESSEN-BARNES CORP.
250 N. Vinedo Ave., Pasadena, Calif. (Tel. MUrray 1-8844)
Purch. Agent: J. B. Thompson
Customer Services Mgr.: S. A. Visconti MS, CT, RD

DRESSER ELECTRIC CO.
2705 Wight St., Detroit 7, Mich. (Tel. LOrain 8-1855)
Purch. Agent: A. J. Muylaert
Sales Dir.: D. P. Friedt GS

DRESSER INDUSTRIES, INC.
Republic Natl. Bank Bldg., Dallas, Tex. (Tel. RIverside 8-6411)
Dir.-Purch: Robert D. Crane

DRESSER MFG. DIV., DRESSER INDUSTRIES, INC.
41 Fisher Ave., Bradford, Pa. (Tel. BRadford 3131)
Acting Purch. Mgr.: G. G. Thomas
Supvr.-Purch.: W. L. Dawson
Sales Mgr.: George R. Leonard

DRESSER-IDECO CO., DIV.-DRESSER INDUSTRIES, INC.
875 Michigan Ave., Columbus 15, Ohio (Tel. AXminster 9-2123)
Dir.-Purch.: Leo Wildermuth
Asst. Purch. Agent: E. L. Frey
Product Mgr., Twr. Div.: J. M. Hogan G, TT

DRIAIRE, INC.
26 Fitch St., East Norwalk, Conn. (Tel. TEmple 8-0686)
Mgr.-Purch.: M. S. Miller
Mgr.-Prod.: R. W. Haines
Mgr.-Sales: J. H. Donovan MS, M, CT

DRICO INDUSTRIAL CORP.
100 Eighth St., Passaic, N. J. (Tel. Gregory 3-4221)
Pres.: Felix Dayton
Purch. Agent: Werner Koburger
Sales Mgr.: Louis Putter

DRILL MFG. CO.
546 S. Meridian St., Indianapolis 25, Ind. (Tel. MElrose 4-2434)
Gen. Mgr.: P. L. Thatcher
Dir.-Sales: R. A. Thatcher M

DRILUBE CO.
723 W. Broadway, Glendale, Calif. (Tel. CH 5-1806)
V. P.: Roy W. Young, Jr.

WILBUR B. DRIVER CO.
1875 McCarter Hwy., Newark 4, N. J. (Tel. HUmboldt 2-5550)
Purch. Agent: Edwin J. Looges
Asst. Purch. Agent: Arthur Knittel
V. P.-Sales: Norman P. Norlie M

DRIVER-HARRIS CO.
205 Middlesex St., Harrison 14, N. J. (Tel. HU 3-4800)
Purch. Agent: J. H. Green
Sales Mgr.: K. H. Hobbie
Asst. Sales Mgr.: W. P. Smith M

DRYOMATIC CORP.
806 N. Fairfax St., Alexandria, Va. (Tel. King 9-3060)
Purch. Agent: C. E. Wells
Sales Mgr.: Anthony Hass MS

DU-CO CERAMICS CO.
Box 278, Saxonburg, Pa. (Tel. FL 2-1511)
Secy-Treas.: Reldon W. Cooper
Pres.: John J. Duke M

M. DUCOMMUN CO.
580 Fifth Ave., New York 36, N. Y. (Tel. PLaza 7-2540)
Mgr.: A. G. Stepchuk

R. C. DUDEK & CO.
407 N. Maple Dr., Beverly Hills, Calif., (Tel. BRadshaw 2-8097)
Richard C. Dudek

DUDWALLEN MFG. CO., INC., THE
71 George St., E. Hartford 8, Conn. (Tel. BU 9-4391)
Pres.: Dave L. Weinbaum
Dir.-Purch.: Norman W. Burke S, MS

DU KANE CORP.
St. Charles, Ill. (Tel. JU 4-2300)
Purch. Mgr.: E. E. Swick
Purch. Agent: R. H. Magden
Mgr.-Govt. & Contract Div.: R. W. Robbins

DUKES CO., INC.
3999 N. 25th Ave., Schiller Park, Ill. (Tel. GLadstone 5-5795)
Purch. Agent: G. Tidd
Sales Mgr.: J. C. Wetter

DULOCK, INC.
1306 E. 55th St. S., Wichita 16, Kans. (Tel. JA 4-4865)
Pres.: Oscar N. Davis
Mgr.: Laurence A. Davis
Sales Rep.: Homer E. Evans S

ALLEN B. DU MONT LABS., INC.
750 Bloomfield Ave., Clifton, N. J. (Tel. PRescott 3-2000)
Dir.-Purch.: Michael Mecca
Dir.-Sales: John W. Bjorkman CT, TT, RD

DUMONT ENGRG. CO.
1401 Freeman Ave., Long Beach 4, Calif. (Tel. GEneva 3-4931)
Dir.-Purch.: Ed French
Buyers: Helen Hoffman & Shirley Wedekind
Sales Mgr.: Edith Lowery M

DUNBAR-KAPPLE INC.-AIRCRAFT COMPONENTS DIV.
Island Ave., Batavia, Ill. (Tel. TRemont 9-5400)
Mgr.-Procurement: E. Ricker
Buyer: J. VanLeirsburg
Sales Mgr., Aircraft Div.: H. M. Lockhart PS, MS, RD

DUNHAM-BUSH INC.
179 South St., West Hartford, Conn. (Tel. CHapel 9-8671)
V. P.-Purch.: Frank Carney
Purch. Agent: T. Logan
V. P.-Sales: J. A. Mulcahey MS, G

DUNLAP & ASSOCIATES, INC.
429 Atlantic St., Stamford, Conn. (Tel. Fireside 8-9271)
V. P.: H. E. Blank, Jr.
Asst. V. P.: J. T. Fucigna
Indsl. Designer: R. Callow RD, HSE

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

DUNN ENGRG. ASSOCIATES INC.
225 O'Brien Hwy., Cambridge 41, Mass. (UNiversity 4-6700)
Purch. Agent: Kenneth A. Smith
Mgr., Govt. & Indsl. Rel.: John V. Rauseo
G, CT, RD

M. W. DUNTON CO. INC., THE
350 Kinsley Ave., Providence, R. I. (Tel. DExter 1-3600)
V. P. & Gen. Mgr.: Raymond T. Wilber M

DUOTONE CO., INC.
Locust St., Keyport, N. J. (Tel. COlfax 4-2200)
Pres.: Stephen Nester
V. P.-Purch.: B. Rosenberg

E. I. DU PONT DE NEMOURS & CO., INC.
Wilmington 98, Del. (Tel. PP 4-1000)

DURA PLASTICS OF N. Y., INC.
303 Fifth Ave., New York 16, N. Y. (Tel. Murray Hill 6-5645)
Purch. Agent: D. Wexler
Pres.: Joseph Layman
Sales Mgr.: S. Baliner

DURACOTE CORP.
350 N. Diamond St., Ravenna, O. (Tel. AXminster 6-3487)
V. P.-Purch.: W. Randle Truog
Pres.: John B. Schneller M, RD

DURAKOOL, INC.
1010 N. Main St., Elkhart, Ind. (Tel. CO 4-1116)
Purch. Agent: J. B. Witcher
Sales Mgr.: V. H. Hoehn CT

DURALAB EQUIPMENT CORP.
979-995 Linwood St., Brooklyn 8, N. Y. (Nightingale 9-0581)
Eng. Purch.: Dominick Rannucci
Office Mgr.: Louis P. Liano RD

DURALITH CORP.
1025 Race St., Philadelphia 7, Pa. (Tel. WAlnut 3-1900)
Gen. Sales Mgr.: Jack M. Smith M

DURAMARK, INC.
2 Secatoag Ave., P. O. Box 231, Port Washington, N. Y. (Tel. Port Washington 7-3232)
Purch. Agent: Mrs. Ada P. Schweder
Plant Mgr.: I. D. Wallach
V. P.-Sales: Andrew T. Callan M

DURAMIC PRODUCTS, INC.
426 Commercial Ave., Palisades Park, N. J. (Tel. WIndsor 7-0310)
Dir.-Purch. & Sales: H. Schwartz
Plant Mgr.: C. Saso M

DURANT MFG. CO.
1900 N. Buffum, Milwaukee 1, Wisc. (Tel. LOcust 2-5035)
Purch. Agent: A. M. Jones
Exec. V. P.: Robert B. Winkler

DUREZ PLASTICS DIV., HOOKER CHEMICAL CORP.
1980 Walck Rd., North Tonawanda, N. Y. (Tel. LUdlow 1860)
Gen. Mgr.: J. C. Searer
Gen. Sales Mgr.: J. W. Ferguson
Purch. Mgr.: C. W. Selover, Buffalo Ave. & 47th Sts., Niagara Falls, N. Y. (Tel. BUtler 5-6655) M

DURO SPECIALTY CO., INC.
811 Boston St., Lynn, Mass. (Tel. LYnn 3-3585)
Purch. Agent: William I. Frankel
Sales Dir.: S. Joseph Hoffman M

DUVAL MARINE CO.
333 Riverside Ave., Jacksonville 2, Fla. (Tel. EL 3-0977)
Gen. Mgr.: S. J. Gefen CT, RD

DYNACOR, INC.
1010 Westmore Ave., Rockville, Md. (Tel. GArden 4-6900)
Purch. Agent: H. R. Veazey
Sales Mgr.: John Cook M

DYNAMETRICS CORP.
N. W. Industrial Park, Burlington, Mass. (Tel. BRowning 2-1600)
Mfg. Mgr.: Fred Hugel
Buyer & Sub-Contract: Malcolm Winsor
Sales Mgr.: Andrew S. Kariotis MS, CT, RD

DYNAMIC AIR ENGRG., INC.
7412 Maie Ave., Los Angeles 1, Calif. (Tel. LUdlow 8-3292)
Purch. Agent: A. M. Brown
Sales Mgr.: H. E. Lever MS, HSE

DYNAMIC CONTROLS CO.
2225 Massachusetts Ave., Cambridge, Mass. (Tel. ELiot 4-3633)
Dir.-Purch.: S. M. Smith
Dir.-Sales: J. J. Gano CT

DYNAMIC CONTROLS CORP.
30 Thomas St., E. Hartford, Conn. (Tel. BU 9-6808)
Purch. Mgr.: W. Piotrowski
Gen. Mgr.: T. P. Farkas PS, MS, CT, RD

DYNAMIC FILTERS INC.
1565 Oakman Blvd., Detroit 38, Mich. (Tel. TOwnsend 9-2600)
Purch. Agent: A. L. Pomaville
Dir.-Sales: Ray Okonski PS, RD

DYNAMIC GEAR CO., INC.
175 Dixon Ave., Amityville, L. I., N. Y. (Tel. AM 4-4788)
Purch. Agent: Jaques Edeline
Asst. to Purch. Agent: Ed Bain
Sales Mgr.: Thomas J. Smith RD

DYNAMIC INSTRUMENT CORP.
59 New York Ave., Westbury, L. I., N. Y. (Tel. EDgewood 3-1600)
Purch. Agent: Robert J. Messina
Buyer: Miss J. Loomis
Gen. Mgr.: Harold E. Sulger PS, MS

DYNAMICS INSTRUMENTATION CO.
1118 Mission St., South Pasadena, Calif. (Tel. MUrray 2-3318)
Pres.: Nathan Brownstone
Buyer: Richard Getty
Sales Mgr.: O. E. Strickland CT

DYNA-THERM CHEMICAL CORP.
3813 Hoke Ave., Culver City, Calif. (Tel. UPton 0-4751)
Purch. Agent: J. M. Maddock
Sales Mgr.: Robert Dawson
V. P.-Research: Elbert Davis S, MS, M, RD

DYNATRONICS, INC.
P. O. Box 2566, Orlando, Fla. (Tel. MIdway 7-5200)
Dir.-Purch.: William M. Reed
Mgr.-Subcontracts: H. Von Allen
Dir.-Contracts: Edward A. Hughes MS, CT, TT, RD

DYNISCO, INC.
42 Carleton St., Cambridge 42, Mass. (Tel. UN 4-7260)
Purch. Mgr.: Dan Shea
Chief Engr.: Harvey L. Pastan
Sales Mgr.: Ralph Bruce CT

DYTRONICS CO.
P. O. Box 3676, Columbus 14, Ohio (Tel. AM 3-0890)
Dir.-Purch.: P. Ryan
Sales Mgr.: K. Gregersen CT, TT, RD

DZUS FASTENER CO., INC.
125 Union St., West Islip, N. Y. (Tel. Mohawk 9-0494)
Purch. Agent: H. A. Kerr
Sales Mgr.: L. F. Acker

ESC CORP.
534 Bergen Blvd., Palisades Park, N. J. (Tel. WIndsor 7-0400)
Purch. Agent: S. Kuno
V. P.-Sales: Stanley S. Packer M

E-Z-HOOK TEST PRODUCTS
1536 Woodburn Ave., Covington, Ky. (Tel. COlonial 1-1495)
Sales Mgr.: Robert N. Youger CT, RD

E-Z WAY TOWERS, INC.
5901 E. Broadway, Tampa, Fla. (Tel. 4-2171)
Asst. Treas.: N. Leo Dubois
Pres. & Sales Mgr.: Clarence Jax S

EAGLE ELECTRIC MFG. CO. INC.
23-10 Bridge Plaza S., Long Island City 1, N. Y. (Tel ST 4-9200)
Purch. Agent: I. Sobol
Asst. Purch. Agent: A. Feiner
Sales Mgr.: S. Jay Atkin

EAGLE OTTAWA LEATHER CO.
P. O. Box 308, Beachtree St., Grand Haven, Michigan (Tel. 8)
Purch. Agent: E. O. Harbeck
V. P.-Sales: Donald H. McCree M

EAGLE SIGNAL CO.
202-20th St., Moline, Ill. (Tel. Moline 2-5571)
Purch. Agent: C. A. Boardman
Asst. Purch. Agent: Elmer Lorenz
Sales Mgr.: V. C. Blecker MS, M, TT

EAGLE-PICHER CO., THE
American Bldg., Cincinnati 1, Ohio (Tel. PArkway 1-7010)
V. P. & Gen. Mgr., Chemicals & Metals Div.: Miles M. Zoller
Asst. Gen. Mgr., Chem. & Metals Div.: Don R. Carter
V. P. & Gen. Mgr., Insulation Div.: G. J. Christner
Sales Mgr., Indsl. Insulation Dept.: W. O. Myers
M, G, CT, TT, RD

EASTERN CHEMICAL DIV., HOOKER CHEMICAL CORP.
Buffalo Ave. at 47 St., Niagara Falls, N. Y. (Tel. BUtler 5-6655)
Purch. Mgr.: Charles W. Selover
Purch. Agent: Robert J. Baker

EASTERN INDUSTRIES INC.
100 Skiff St., Hamden 14, Conn. (Tel. CHestnut 8-3841)
Purch. Agent: C. Phillips
Asst. Purch. Agent: R. Jerzyk
Sales Mgr.: H. W. Whitaker PS, MS, G, CT, TT, RD

EASTERN ROTORCRAFT CORP.
Swamp Rd., P. O. Box 110, Doylestown, Pa. (Tel. Fillmore 8-3518)
Purch. Agent: C. P. Montague
Sales Mgr.: Marshall Lewis S, MS

EASTERN SMELTING & REFINING CORP.
109 W. Brookline St., Boston 18, Mass. (Tel. COmmonwealth 6-7504)
Treas.: Maurice G. Alperin
Comptroller: Frank E. Wandrey M

EASTERN SPECIALTY CO., THE
3617 N. Eight, Philadelphia 40, Pa. (Tel. BAldwin 8-0500)
Dir.-Purch.: H. F. McGinley
Dir.-Sales: Edward P. Cornely

EASTERN STAINLESS STEEL CORP.
P. O. Box 1975, Baltimore 3, Md. (Tel. ATwater 8-2000)
Buyer: E. J. Thon
V. P.-Sales: R. C. Cunningham

EASTMAN KODAK CO.
343 State St., Rochester, N. Y. (Tel. LOcust 2-6000)
Dir.-Purch., Kodak Park Works: Jerome E. Doyle
Dir.-Purch., Apparatus & Optical Div.: John T. Harbison
V. P.-Sales: J. E. McGhee

EATON MFG. CO.
739 E. 140th St., Cleveland 10, O. (Tel. GLenville 1-5600)
Dir.-Purch.: H. A. Williams
V. P.-Sales: E. M. de Windt

EATON MFG. CO., RELIANCE DIV.
25 Charles Ave., S. E., Massillon, Ohio (Tel. TE 2-1511)
Div. Purch. Agent: J. W. Morton
Buyer: W. Matthey
Gen. Sales Mgr.: R. B. Little M

EATON MFG. CO., VALVE DIV.
Ave. C at 20th St., Battle Creek, Mich. (Tel. WOodward 2-7571)
Purch. Agent: J. B. Smith
Sales Mgr.: D. D. Roberts S

EBERLINE INSTRUMENT CORP.
805 Early St., Santa Fe, N. M. (Tel. YUcca 2-1881)
Chief Purch. Agent: John C. Harvey
Asst. Purch. Agent: Frank Slowen
Acting Mktg. Dir.: Don E. Mitchell

EBERT ELECTRONICS CORP.
212-26 Jamaica Ave., Queens Village 28, N. Y. (Tel. SPruce 6-1800)
Purch. Agent: L. Mitchell
Sales Mgr.: V. Horowitz G

HUGH H. EBY CO.
4701 Germantown Ave., Philadelphia 44, Pa. (Tel. DAV. 4-7000)
Dir. Purch.: Arthur Hankinson
Sales Mgr.: W. A. Telmoss M

ECKEL VALVE CO.
1425 First St., San Fernando, Calif. (Tel. EMpire 1-6251)
Purch. Agent: Edward Beinfest
Gen. Mgr.: J. R. Bly PS, G, CT

ECLIPSE FUEL ENGRG. CO.
1100 Buchanan, Rockford, Ill. (Tel. Woodland 8-3751)
Purch. Agent: W. T. Whitcomb
V. P.-Plant Operations: E. A. Stoner

Exec. V. P.: J. H. Sands

ECLIPSE-PIONEER DIV., BENDIX AVIATION CORP.
Teterboro, N. J. (Tel. Atlas 8-2000)
Dir.-Purch.: J. Quinn
Dir.-Sales & Service: J. P. Buckley **MS, G, CT, RD**

ECO ENGRG. CO.
12 New York Ave., Newark 1, N. J. (Tel. MArket 4-6565)
Purch. Agent: Vernon Davis
Sales Mgr.: James Eisenberg **MS, M, CT**

ECONOWELD CORP.
519 Hunter Ave., Dayton, O. (Tel. BAldwin 3-7295)
V. P.-Purch.: Bart Wilgus
Engr. Sales: C. A. Thomas

ED-BERL PRODUCTS, INC.
96 S. Grand Ave., Baldwin, L. I., N. Y. (Tel. BAldwin 3-1636)
Dir.-Purch.: Fred W. Will
V. P.-Sales: Howard Kaufman **RD**

EDCLIFF INSTRUMENTS
1711 S. Mountain Ave., Monrovia, Calif. (Tel. ELiott 8-4571)
Purch. Agent: John Smith
Mgr., Tech. Serv.: D. W. Marks **MS, G, CT, TT, RD**

EDDINGTON METAL SPECIALTY CO.
3088 Bristol Pike, Eddington, Pa. (Tel. MErcury 9-3600; ORchard 3-8383)
Purch. Agent: Walter V. Czamecki, Jr.
Asst. Purch. Agent: Kenneth Leatherman
Gen. Mgr.: George S. Vavra
Sales Mgr.: Stanley Czamecki, Jr. **RD**

EDER INSTRUMENT CO. INC.
2293 N. Clybourn Ave., Chicago 14, Ill. (Tel. EAstgate 7-2131)
Sales: L. Streifeneder

EDGERTON, GERMESHAUSEN & GRIER, INC.
160 Brookline Ave., Boston 15, Mass. (Tel. COpley 7-9700)
Dir.-Product Sales: R. L. Purrington **CT, TT, RD**

EDGEWATER STEEL CO.
Box 478, Pittsburgh 30, Pa. (Tel. OAkmont 280)
Purch. Agent: L. W. Engel
Asst. Purch. Agent: W. Schano
V. P.-Sales: W. M. Cree
Mgr., Indsl. Sales: W. O. Fleming **M**

THOMAS A. EDISON IND. INSTRUMENT DIV.-McGRAW-EDISON CO.
85 Lakeside Ave., W. Orange, N. J. (Tel. ORange 3-6800)
Purch. Agent: Harry Keirnan
Gen. Sales Mgr.: George J. Bindewald **G, CT, TT**

EDMUND SCIENTIFIC CO.
101 E. Gloucester Pike, Barrington, N. J. (Tel. LIncoln 7-3488)
Pres.: Norman W. Edmund
Purch. Div.: Carl Gabriel

EDO CORP.
13-10 — 111th St., College Point 56, N. Y. (Tel. Hickory 5-6000)
Dir.-Purch.: W. F. Konrad
V. P.: A. M. Brown **RD**

EDWARDS ENGRG. CO.
21 Yennicock Ave., Port Washington, N. Y. (Tel. PO 7-6700)
Gen. Mgr.: John E. Kane **TT, RD**

EDWARDS HIGH VACUUM LTD.
P. O. Box 515, Cumberland Ave., Burlington, Ont., Canada (Tel. NE 4-7757)
Purch. Agent: J. R. Morgan
Asst. Purch. Agent: P. Stone
Sales Mgr.: R. G. Webster
Purch. Agent, Niagara Falls, N. Y., (Tel. BU 3-2363): F. R. Barnes **RD**

EFCON, INC.
Patterson Pl., Roosevelt Field, Garden City, L. I., N. Y. (Tel. Pioneer 1-4200)
Purch. Agent: A. J. Cucco
Chief Exec.: Paul D. Alley
Pres.: Alfred B. Rossip **M**

EICOR DIV.-SCRANTON
4059 W. North Ave., Chicago, Ill. (Tel. HUmbolt 6-2060)
Purch. Agent: R. Farneti, 517 W. Walnut St., Oglesby, Ill. (Tel. 3-8453)

EIDAL MFG. CO., INC.
250 Woodward Rd., S. E., Albuquerque, N. M. (Tel. CHapel 2-5223)
Purch. Agent: W. A. Muff
V. P.-Sales: S. J. Woodin **MS**

EIDSON ELECTRONIC CO.
1902 N. 3rd, Temple, Texas (Tel. PR 3-3901)
Owner & Chief Engr.: Merrill Eidson **M, CT**

EIMCO CORP., THE
P. O. Box 300, Salt Lake City 10, Utah (Tel. DAvis 8-8831)

EISLER ENGRG. CO., INC.
769 S. 13th St., Newark 3, N. J. (Tel. Bigelow 3-5310)
Purch.: Herman Goldstein
Prod.: Otto J. Thaler
Pres.: Charles Eisler, Jr.

EITEL-McCULLOUGH, INC.
301 Industrial Way, San Carlos, Calif. (Tel. LYtell 1-1451)
Purch. Agent: Donald Rogers
Mgr.-Proc.: John Stenson
Dir.-Mktg.: O. H. Brown **M, RD**

ELASTIC STOP NUT CORP. OF AMERICA
2330 Vauxhall Rd., Union, N. J. (Tel. MUrdock 6-6000)
Purch. Agent: Everett F. Howell
Gen. Sales Mgr.: D. E. Lally

ELCO CORP.
"M" St. Below Erie Ave., Philadelphia 24, Pa. (Tel. CUmberland 9-5500)
Purch. Agent: Henry Marks
V. P.-Sales: Leo Kagan

ELCOR, INC.
1225 W. Broad St., Falls Church, Va. (Tel. JEfferson 2-7718)
Purch. Agent: John F. Walton
Pres.: John H. Reaves **RD**

ELDEMA CORP.
1805 Belcroft Ave., El Monte, Calif. (Tel. CUmberland 3-3498)
Dir.-Purch.: W. C. Whiffen
V. P.-Sales: J. A. Moore **G, CT**

ELDORADO ELECTRONICS
2821 10th St., Berkeley, Calif. (Tel. THornwall 1-4613)
Purch. Agent: A. E. Cummins
Sales Mgr.: H. J. Lewenstein

ELECTRA MFG. CO.
4051 Broadway, Kansas City, Mo. (Tel. WEstport 1-6864)
Purch. Agent: D. E. Aitken
V. P.-Electronic Sales: R. R. Burton
Sales Mgr., Resistor Dept.: R. T. Means **MS**

ELECTRALAB PRINTED ELECTRONICS CORP.
175 "A" St., Needham Hgts. 94, Mass. (Tel. HIllcrest 4-3912)
Purch. Agent: K. B. Lorey
V. P.-Sales: R. G. Zens

ELECTRIC AUTO LITE CO., THE
1201 Champlain St., Toledo 1, O. (Tel. CHerry 3-3131)
V. P.-Purch.: J. H. Lambrix
V. P.-Sales: Edwin Stroh **RD**

ELECTRIC AUTO LITE CO., THE, WIRE & CABLE DIV.
3529 24th St., Port Huron, Mich. (Tel. YUkon 5-6131)
Purch. Agent: A. L. Bailey
Gen. Sales Mgr.: S. T. Rose

ELECTRIC CORDS & SUPPLY CORP.
413 E. Third St., Los Angeles 13, Calif. (Tel. MA 8-2278)
Purch. Agent: Alfreda Chandler
Sales Engr.: J. W. Hemphill **MS**

ELECTRIC DESIGN & MFG. CO.
722 Jefferson St., Burlington, Iowa (Tel. PLaza 2-7685)
Pres.: Fred Bulmahn

ELECTRIC HOSE & RUBBER CO.
Wilmington, Del. (Tel. OLympia 5-6261)
Purch. Agent: S. M. Howard
Sales Mgr.: V. W. Wells

ELECTRIC INDICATOR CO. INC.
Camp Ave., Stamford, Conn. (Tel. DAvis 2-1671)
Purch. Agent: Alfred Green, Jr.
V. P.: J. L. Knight **MS, G, CT, TT**

ELECTRIC MACHINERY MFG. CO.
800 Central Ave., Minneapolis 13, Minn. (Tel. FEderal 9-6751)
Dir.-Purch.: J. Murnane
Purch. Agent: W. Fisher
Asst. Purch. Agents: Duane Larson, H. Roeger
V. P.-Sales: C. E. Buchan **MS, CT**

ELECTRIC MOTORS & SPECIALTIES, INC.
King & Hamsher Sts., Garrett, Ind. (Tel. FL 7-4141)
Purch. Agent: Keith W. Murray
Sales: J. A. Fuhrman

ELECTRIC REGULATOR CORP.
Pearl St., Norwalk, Conn. (Tel. VI 7-2401)
Purch. Agent: M. Gelfand
Sales Mgr.: W. H. Walter

ELECTRIC STEEL FOUNDRY CO.
2141 N. W. 25th St., Portland 10, Ore. (Tel. CApital 8-2141)
Purch. Agent: Marvin E. Price
Gen. Sales Mgr.: Joe McQuaid **M**

ELECTRIC TERMINAL CORP.
3 Bellows St., Warwick Industrial Park, Warwick, R. I. (Tel. STuart 1-2189)
Supt.: William Massie, Jr.
Pres.: Joseph P. Dunn **M**

ELECTRICAL INSULATION CO., INC.
1245 Marconi Blvd., Copiague, L. I., N. Y. (Tel. AM 4-6190)
V. P.-Purch.: Robert S. Goldstein
Dir.-Sales: H. W. Halm **M**

ELECTRICAL & MECHANICAL DESIGN CO.
P. O. Box 706, Clark, N. J. (Tel. FUlton 8-3381)
Purch. & Sales: Raymond E. Hall **PS**

ELECTRICAL & PHYSICAL INSTRUMENT CORP.
42-19 27th St., Long Island City 1, N. Y. (Tel. STillwell 4-6387)
Dir. Sales: U. E. Hovemeyer **CT**

ELECTRICAL REFRACTORIES CO., THE
East End, East Clark St., East Palestine, O. (Tel. GArden 6-9433)
Plant Supt.: Hector B. Moore
Gen. Mgr.: L. J. Turner **RD**

ELECTRICAL WINDINGS, INC.
2015 N. Kolmar Ave., Chicago, Ill. (Tel. BElmont 5-3360)
Purch. Agent: Arnold M. Topper
Sales Mgr.: L. C. Kammerer

ELECTRO ARC MFG. CO.
P. O. Box 448, Ann Arbor, Mich. (Tel. HU 3-4233)
Engr.: J. V. Wood
V. P.: H. W. Stark, Jr.
Sales Mgr.: T. J. O'Connor

ELECTRO ENGRG. WORKS
401 Preda St., San Leandro, Calif. (Tel. LO 9-3326)
Purch. Agent: Marvin C. Phillips
Sr. Buyer: Miss Lois C. Crigler
Sales Mgr.: Rex E. Brooks **M**

ELECTRO IMPULSE LAB., INC.
208 River St., Red Bank, N. J. (Tel. SHadyside 1-0404)
Pres.: Irving Rubin

ELECTRO INSTRUMENTS, INC.
3540 Aero Ct., San Diego 11, Calif. (Tel. BRowning 7-6590)
Purch. Agent: Wade C. Gilliland, Jr.
Buyer: James Greenfield
V. P.-Sales: R. H. Applin **MS, CT, RD**

ELECTRO POWERPACS, INC.
5 Hadley St., Cambridge 40, Mass. (Tel. TRowbridge 6-9220)
V. P. & Gen. Mgr.: Henry Dormitzer
Purch. Agent: Gerald Sullivan
Dir.-Sales: David J. Sanders

ELECTRO PRECISION CORP.
P. O. Box 669, Arkadelphia, Ark. (Tel. CHapel 6-4564)
Pres.: John H. Hosemann
Chief Engr.: Gary L. Sandlin
Purch. Agent: Mary B. Agar
Sales Mgr.: A. James Edwards **RD**

ELECTRO PRODUCTS LABS., INC.
4501 N. Ravenswood Ave., Chicago 40, Ill. (Tel. LOngbeach 1-1707)

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

Purch. Agent: E. V. Tetzner
Sales Mgr.: Lloyd A. Thatcher M

ELECTRO SCIENTIFIC INDUSTRIES
7524 S. W. Macadam, Portland 19, Ore. (Tel. CH 6-3331)
Purch. Agent: Lloyd Smith
Mktg. Mgr.: J. G. Kirwan MS, M, CT

ELECTRO SWITCH CORP.
King Ave., Weymouth 88, Mass. (Tel. EDgewater 5-5200)
Purch. Agent: J. P. Salters
Buyer: S. Sylvester
V. P.-Sales: T. K. Brydson MS

ELECTRO TEC CORP.
10 Romanelli Ave., South Hackensack, N. J. (Tel. HUbbard 7-4940)
Purch. Agent: George Parigoris
Sales Mgr.: Eugene Parks MS, G, TT, RD

ELECTRO TEC CORP., VIRGINIA DIV.
P. O. Box 219, Blacksburg, Va. (Tel. PRescott 2-8208)
Purch. Agent: Thomas F. Mantz
Sales Mgr.: Gene Parks, South Hackensack, N. J. (Tel. HUbbard 7-4940)

ELECTRO TECHNICAL PRODUCTS DIV., SUN CHEMICAL CORP.
113 E. Centre St., Nutley 10, N. J. (Tel. NUtley 2-7070)
Gen. Sales Mgr.: W. F. Hugger M

ELECTRO-CAPACITORS CO.
10132 Edes Ave., Oakland 3, Calif. (Tel. LOckhaven 8-7910)
Sales Mgr.: H. Marquess M

ELECTROFILM, INC.
7116 Laurel Canyon Blvd., N. Hollywood, Calif. (Tel. POplar 5-4420)
Purch. Agent: R. R. Schweger, Jr.
Sales Mgr.: R. E. Crump PS, MS, RD

ELECTRO-FLEX HEAT, INC.
83 Woodbine St., Hartford 6, Conn. (Tel. CHapel 6-5413)
Purch. Agent: John Bulluss
Sales: Ronald J. Borrup MS

ELECTROID CORP.
95 Progress St., Union, N. J. (Tel. MUrdock 6-8290)
Dir.-Purch.: F. Alvarez
Dir.-Sales: Paul E. Plante PS, MS, G, RD

ELECTROL INC.
85 Grand St., Kingston, N. Y. (Tel. FEderal 1-1980)
Purch. Agent: J. Tyrrell
Sales Mgr.: D. C. Pierson MS

ELECTROMARK CORP., THE
2083 E. 19th St., Cleveland 15, Ohio (Tel. SU 1-7377)
V. P. & Purch. Agent: R. Hennie
Gen. Mgr.: B. W. Mayer PS, MS, M, G, CT, TT, RD

ELECTROMATH CORP.
115 Pleasant Ave., Roosevelt, L. I., N. Y. (Tel. MAyfair 3-3500)
Purch. Agent: Anthony T. Canova
Asst. Purch. Agent: George T. Parisi
V. P.-Sales: Thomas A. D. Canova M, CT, RD

ELECTROMATION CO., DIV.-DEL MAR ENGRG. LABS.
1646 18th St., Santa Monica, Calif. (Tel. EX 5-9975)
Purch. Agent: John Sheppird
Sales Mgr.: Bill Williams MS, G, CT, TT, RD

ELECTRO-MEC LAB. INC.
47-51 33rd St., Long Island City 1, N. Y. (Tel. STillwell 6-3402)
Purch. Agent: Leo F. Ostar
Sales Mgr.: Forbes Morse RD

ELECTRO-MECHANICAL RESEARCH, INC.
Box 3041, Sarasota, Fla. (Tel. RIngling 6-1148)
Purch. Agent: John Moore
V. P.-Sales: T. E. Stewart

ELECTRO-MECHANICAL SPECIALTIES CO., INC.
743 W. 39th St., Banning, Calif. (Tel. VIctor 9-6033)
Purch. Agent: R. L. Kritser
Gen. Mgr.: James Goodman

ELECTRO-MEDICAL LAB., INC.
South Woodstock 25, Vt. (Tel. WOodstock 144M4)
Pres.: Lovett Garceau
Treas.: D. S. Garceau HSE

ELECTRO-MINIATURES CORP.
630 Huyler St., South Hackensack, N. J. (Tel. HUbbard 9-7770)
Purch. Agent: L. A. Lopez
Asst. Purch. Agent: D. Dunn
Dir.-Sales: L. R. Sonders MS, G, TT

ELECTROMODE DIV.-COMMERCIAL CONTROLS CORP.
P. O. Box 1052, 570 Culver Road, Rochester 3, N. Y. (Tel. BUtler 8-1880)
Dir. Purch.: Joseph A. Ehrstein
Gen. Sales Mgr.: Paul D. Hawkins M

ELECTRON PRODUCTS DIV., MARSHALL INDUSTRIES
430 N. Halstead, Pasadena, Calif. (Tel. MUrray 1-0666)
Purch. Agent: F. S. Pirrie
Sales Mgr.: R. M. Green

ELECTRONIC APPLICATIONS, INC.
194 Richmond Hill Ave., Stamford, Conn. (Tel. DAvis 5-1574)
Secy.-Treas.: T. M. Skee
Pres.: Vincent J. Skee CT, TT, RD

ELECTRONIC ASSOCIATES, INC.
Long Beach, N. J. (Tel. CApital 9-1100)
Purch. Agent: E. F. Van Pelt
Sr. Buyers: L. W. Cavalier, J. H. Schachter & J. W. Thompson
Buyers: R. A. Grammer & E. Valente

ELECTRONIC BRAZING CO.
140 Glenridge Ave., Montclair, N. J. (Tel. PIlgrim 4-2160)
Dir.-Purch.: Walter J. Lambert CT

ELECTRONIC CIRCUITS
641 N. LaPeer Dr., Los Angeles 46, Calif. (Tel. BR 2-4535)
Dir.-Purch.: James M. Devitt, Jr.
Dir.-Sales: Robert V. Schupbach M

ELECTRONIC COILS, INC.
33 Lyman St., Springfield, Mass. (Tel. REpublic 6-6339)
Purch. Agent: Miss F. Jaworek
Chief Engr.: E. Bassett
Sales Mgr.: G. Lindstrom

ELECTRONIC COMMUNICATIONS, INC. (ECI)
1501 72nd St., N., St. Petersburg 10, Fla. (Tel. Dickens 5-9301); Maritime Base, St. Petersburg, Fla. (Tel. 5-7111)
V. P.-Mktg.: E. F. Coy (Tel. DI 5-3800)
Purch. Mgr.: Russell Walworth (Tel. 5-7111)
Purch. Agents: George Doescher & Wesley Magwood (Tel. 5-7111) MS, G, TT, RD

ELECTRONIC COMPUTER CO., INC.
618 Maple St., Conshohocken, Pa. (Tel. TAylor 8-3967)
Purch. Agent: Kenneth Webb
Asst. Purch. Agent: James Hausman
Sales Mgr.: Frank Hause CT, TT

ELECTRONIC CONTROL CORP.
1573 E. Forest Ave., Detroit 7, Mich. (Tel. TEmple 2-6625)
Dir.-Purch.: S. C. Lawrence

ELECTRONIC DEVICES INC.
429 12th St., Brooklyn 15; N. Y. (Tel. SOuth 8-3530)
Purch. Agent: Peter Buenahora
Gen. Mgr.: Harold B. Rosenberg
Chief Engr.: Jack D. Weiner
Sales Admin.: Francis J. Brooks M

ELECTRONIC ENGRG. CO. OF CALIFORNIA
1601 E. Chestnut Ave., Santa Ana, Calif. (Tel. KImberly 7-5501)
Purch. Agent: A. R. Harman
Buyers: Gene Frake & Steve Gandolfo
Sales Mgr.: W. R. McQuiston CT, RD

ELECTRONIC MEASUREMENTS CO., INC.
Lewis St. & Maple Ave., Eatontown, N. J. (Tel. LIberty 2-0300)
Purch. Agent: B. DeBlasio
Sales Mgr.: Douglas Stevens MS

ELECTRONIC MEASUREMENTS CORP.
625 Broadway, New York 12, N. Y. (Tel. GRamercy 5-0610)
Purch. Agent: L. Stans
Sales Mgr.: M. Lieblich

ELECTRONIC MECHANICS, INC.
101 Clifton Blvd., Clifton, N. J. (Tel. GRegory 3-4108)
Purch. Agent: D. Carlson
Dir.-Sales: F. M. Grafton S, M

ELECTRONIC PARTS MFG. CO., INC.
508 25th St., Union City, N. J. (Tel. UNion 5-4028) M, RD

ELECTRONIC PROCESSES CORP. OF CALIFORNIA
436 Bryant, San Francisco 7, Calif. (Tel. EXbrook 7-3881)
Pres.: E. H. Stewart
V. P. & Sales Mgr.: A. F. Hogland PS

ELECTRONIC SPECIALTY CO.
5121 San Fernando Rd., Los Angeles 39, Calif. (Tel. CHapman 5-3771)
Purch. Agent: H. A. Venturino
Sales Mgr.: Ted M. Duay

ELECTRONIC SPECIALTY CO., EEMCO DIV.
4612 W. Jefferson Blvd., Los Angeles 16, Calif. (Tel. REpublic 3-0151)
Purch. Agent: H. W. Freese
Sales Mgr.: T. Perry
Dir.-Mktg.: Tom Cataldo

ELECTRONIC TRANSFORMER CO., INC.
70 Washington St., Brooklyn 1, N. Y. (Tel. MAin 5-6123)
Purch. Mgr.: Herman Leighton
Sales Mgr.: Treslian Park M

ELECTRONIC TUBE CORP.
1200 E. Mermaid Lane, Philadelphia 18, Pa. (Tel. CHestnut Hill 7-6800)
V. P.-Purch.: Kenneth C. Meinken, Jr.
Pres.: Kenneth C. Meinken MS, CT, RD

ELECTRONICS OF CLEARFIELD, INC.
P. O. Box 792, Clearfield, Pa. (Tel. POplar 5-5597)
Purch. Agent: Katherine Patterson
Exec. V. P.: James C. Boyd MS

ELECTRONICS CORP. OF AMERICA
One Memorial Dr., Cambridge, Mass. (Tel. UNiversity 4-8000)
Dir.-Purch.: Herbert Preble
Dir.-Sales, Military Div.: B. H. Dean MS, G, CT, RD

ELECTRONICS DEPT., HAMILTON STANDARD DIV., UNITED AIRCRAFT CORP.
Broad Brook, Conn. (Tel. NAtional 3-1621)
Purch. Agent: K. Williams
Sales Mgr.: Boone T. Guyton

ELECTRONICS DIV.-THE NATIONAL CASH REGISTER CO.
1401 E. El Segundo Blvd., Hawthorne, Calif. (Tel. PLymouth 7-1811)
Purch. Agent: A. G. Krumm
Buyers: Arthur Lloyd & J. C. Krause
Mgr., Mktg. Dept.: L. J. Hines MS, CT, RD

ELECTRON-RADAR PRODUCTS
4806 W. Chicago Ave., Chicago 51, Ill. (Tel. ESterbrook 9-1232)
Laboratory: Rt. 30, P. O. Box 50, North Aurora, Ill.
Purch. Agent: W. A. Bailey
Proprietor: J. J. Bailey

ELECTRONS, INC.
127 Sussex Ave., Newark 3, N. J. (Tel. HUmboldt 2-5977)
Dir.-Purch.: W. I. Relyea
Purch. Dept.: F. Fodor
Sales Mgr.: R. F. Roberts

ELECTRO-PULSE, INC.
11861 Teale St., Culver City, Calif. (Tel. UPton 0-9193)
Gen. Mgr.: J. E. Niebuhr
Purch. Agent: S. Green CT, TT

ELECTRO-SEAL CORP.
946 North Ave., DesPlaines, Ill. (Tel. VA 4-6173)
Dir.-Engrg.: Paul E. Labus

ELECTROSOLIDS CORP.
13745 Saticoy, Panorama City, Calif. (Tel. TR 3-3172)
Mtl. Mgr.: N. Karchem
Sales Mgr.: John F. Lohr G, CT, TT

ELECTRO-SWITCH & CONTROLS, INC.
5755 Camille Ave., Culver City, Calif. (Tel. TExas 0-4643)
Gen. Sales Mgr.: J. K. Brose
Buyer: R. E. Preston

ELECTRO-VOICE, INC.
Cecil & Carroll Sts., Buchanan, Mich. (Tel. Oxbow 5-6831)
Purch. Agent: J. N. Grieveson
Buyers: Frank Stroempl & Tom Fitzpatrick
V. P.-Sales: Lawrence LeKashman

ELECTRO-WINDERS CO. INC.
854 W. Front St., Covina, Calif. (Tel. EDgewood 2-6207)

Plt. Mgr.-Purch. Agent: George Payne
Sales Mgr.: Jack Ratner M

ELEKTRO-SERV CO.
480 Johnson Ave., Brooklyn 37, N. Y. (Tel. HY 7-0053)
Purch. Agent: B. Jeffries
Asst. Purch. Agent: D. Stephens

ELGEET OPTICAL CO., INC.
838 Smith St., Rochester 6, N. Y. (Tel. BEverly 5-8080)
Purch. Agent: S. J. Rayburn
Pres.: David Goldstein RD

ELGENCO, INC.
1555 14th St., Santa Monica, Calif. (Tel. EXbrook 3-3023)
V. P.-Purch.: D. E. Beecher
Pres.: Henry Low MS, CT, RD

ELGIN MICRONICS DIV.-ELGIN NATIONAL WATCH CO.
366 Bluff City Blvd., Elgin, Ill. (Tel. SHerwood 2-5700)
Purch. Mgr.: E. F. Antonson

ELGIN MICRONICS, WEST COAST DIV.-ELGIN NATIONAL WATCH CO.
21001 Nordhoff St., Chatsworth, Calif. (Tel. Diamond 0-7220)
Purch. Agent: Joe Huff
Gen. Mgr.: W. M. Wochos MS, CT, RD

ELGIN NATIONAL WATCH CO.
107 National St., Elgin, Ill. (Tel. SHerwood 2-3300)
Dir.-Purch., Watch Div.: W. H. Miller
Gen. Sales Mgr., Watch Div.: Harold Rich

ELIN DIV., INTERNATIONAL ELECTRONIC RESEARCH CORP.
145 W. Magnolia Blvd., Burbank, Calif. (Tel. VIctoria 9-2481)
Purch. Agent: Philip T. Solomon
V. P.: John E. Markley, Jr.
Sales Mgr.: John R. Foster

ELJAY CORP.
2900 Herbert St., Baltimore 16, Md. (Tel. WIlkens 5-2902)
Purch. Mgr.: Stanley A. Sladek
Shop Prod. Mgr.: J. Earl Jacobs

B. W. ELLIOTT MFG. CO., INC.
221 Prospect Ave., Binghamton, N. Y. (Tel. RA 4-2512)
Purch.: E. M. Twining PS

GEORGE D. ELLIS & SONS, INC.
American & Luzerne Sts., Philadelphia 40, Pa. (Tel. BAldwin 3-3405)
Purch. Agent: G. M. Hansen
Purch. Dept.: T. T. Taylor
V. P.: L. C. Sossaman M

ELLIS & WATTS PRODUCTS, INC.
8407 Monroe Ave., Cincinnati 36, Ohio (Tel. TWeed 1-8000)
Admin. Supvr.: Robert J. Lammert
Purch. Agent: James Macke
V. P.-Sales: Arnold Dunkelman MS, RD

ELLISON DRAFT GAGE CO., INC.
548 W. Monroe St., Chicago 6, Ill. (Tel. RA 6-2296)
Treas. & Purch. Agent: Richard L. Coco
Dir.-Sales: Martin Coco

ELLWOOD IVINS STEEL TUBE WORKS INC.
Valley Rd. & Coventry Ave., Oak Lane, Philadelphia 26, Pa.
Prod. Mgr.: G. I. Bartleson, Jr.

ELMET DIV.-NORTH AMERICAN PHILIPS CO., INC.
Lisbon Rd., Lewiston, Me. (Tel. STate 4-5478)
V. P., Elmet Div.: R. Lowit
Purch. Agent: C. Erikson
Sales, Elmet Div.: D. R. Donovan

ELWELL-PARKER ELECTRIC CO., THE
4205 St. Clair Ave., Cleveland 3, Ohio (Tel. UT 1-6200)
Purch. Agent: P. F. Mitchell
Sales Mgr.: J. A. Ackermann

ELZEE METAL PRODUCTS CO., INC.
775 39th St., Brooklyn 32, N. Y. (Tel. GEdney 5-5000)
Gen. Mgr.: Milton M. Lynn
Dir.-Sales: Mel Leipzig

EMELOID CO. INC., THE
1239 Central Ave., Hillside 5, N. J. (Tel. ELizabeth 2-1944)
V. P.-Purch.: J. S. Freundlich
Purch. Agent: Mrs. Florence Headley
Sales Mgr.: George W. Emerson S

EMERSON & CUMING, INC.
869 Washington St., Canton, Mass. (Tel. CAnton 6-1066)
Purch. Agent: C. B. McSorley
Buyer: J. Healey
Sales Mgr.: C. L. Emerson, Jr. M

EMERSON ELECTRIC MFG. CO., THE, ELECTRONICS & AVIONICS DIV.
8100 Florissant Ave., St. Louis 36, Mo. (Tel. COlfax 1-800)
Dir.-Purch.: John A. Alles, 59th & Industrial Aves., Washington Park, Ill. (Tel. Bridge 1-6060, Sta. 850)
Purch. Agent: M. Randall, Washington Park (Tel. Bridge 1-6060, Sta. 852)
Mgr., Sales Dept.-E & A Div.: C. F. Pizac
S, PS, MS, M, G, CT, TT, RD, HSE

EMERSON PLASTICS CORP.
1383 Seabury Ave., Bronx 61, N. Y. (Tel. SYcamore 2-4400)
Purch. Agent: Al Schoenberger
Gen. Mgr.: Gene Greck
Dir.-Sales: W. Elsfelder S, M

EMERTRON, SUB.-EMERSON RADIO & PHONOGRAPH CORP.
14th & Coles Sts., Jersey City 2, N. J. (Tel. SWarthmore 5-3500; 1140 East-West Hwy., Silver Spring, Md. (Tel. JUniper 8-7273)
Mgr., Mfg.: William O. Hayward (Tel. SWarthmore 5-3500)
V. P.-Mktg.: George Rappaport (Tel. JUniper 8-7273)
Dir.-Purch., Research Labs.: Walter M. Prichard (Tel. JUniper 8-7273) MS, G, CT, TT, RD, HSE

EMHART MFG. CO., MAXIM DIV.
85 Homestead Ave., Hartford 1, Conn. (Tel. JA 7-9285)
Purch. Mgr.: F. N. Dull
Dir.-Sales: T. S. Willets PS, MS, RD

EMHART MFG. CO., SKYWORKER DIV.
766 Windsor St., Hartford 1, Conn. (Tel. CHapel 9-0671)
Gen. Sales Mgr.: Stephen B. Doss MS

EMMCO PLASTIC FABRICATORS
68 Vine St., Everett 49, Mass. (Tel. DUnkirk 9-1660)
Dir.-Purch.: John Oljey
Dir.-Sales: David McAuliffe

EMMERT MFG. CO.
1051 E. Main St., Waynesboro, Pa. (Tel. 848)
Pres.: A. B. Sollenberger

EMPIRE ELECTRONICS CO., INC.
60 Spruce St., Paterson 1, N. J. (Tel. ARmory 4-8282)
V. P.: George Surasky
Pres.: Milton Surasky MS, G, CT, TT

EMPIRE PRODUCTS SALES CORP.
37 Prospect St., Amsterdam, N. Y. (Tel. VIctor 2-8400)
Purch. Agent: Allen Cohen
Buyer: James Behlen
Pres.: Joseph Lorch MS, G, CT, TT, RD

ENDEVCO CORP.
161 E. California Blvd., Pasadena, Calif. (Tel. SYcamore 5-0271)
Purch. Agent: Alex Zielinski
Prod. Mgr.: John Daly
Sales Mgr.: Warren D. Hancock CT

ENDICOTT FORGING & MFG. CO., INC.
1901 North St., Endicott, N. Y. (Tel. 5-3331)
Gen. Sales Mgr.: A. L. Coleman S, G

ENFAB INC.
312 E. Brokaw Rd., San Jose, Calif. (Tel. CY 5-1801)
V. P.-Purch.: Mac C. Cutler
Plant Mgr.: R. B. Taylor
Dir.-Sales: H. Paul Sherlock M, RD

ENGELHARD INDUSTRIES, INC.
133 Astor St., Newark, N. J. (Tel. BIgelow 2-2700)
Purch. Agent: W. Marks
Sr. V. P. & Sales Mgr.: D. L. Alexandre

ENGELHARD INDUSTRIES INC., D. E. MAKEPEACE DIV.
Pine & Dunham Sts., Attleboro, Mass. (Tel. 2-0089)
Purch. Agent-Main Div. & Slip Ring Assm. Div.: George Aucoin
V. P.-Sales: W. F. Mittendorf

ENGELHARD INDUSTRIES, INC., NATIONAL ELECTRIC INSTRUMENT DIV.
92-21 Corona Ave., Elmhurst 73, N. Y. (Tel. HA 9-2890)
Optical Engr.: F. Kelly CT

ENGINEERED PLASTICS, INC.
Chase St., Gibsonville, N. C. (Tel. 2411)
Purch. Agent: C. V. Long, Jr.
Sales Mgr.: Dan Davidson, Jr.

ENGINEERED PRECISION CASTING CO.
Box 68, Hwy. 79, Matawan, N. J. (Tel. LOwell 6-2204)
Dir.-Purch.: W. A. Dubovick

ENGRG. DEVELOPMENTS, INC.
P. O. Box 149, Newport, R. I. (Tel. VIking 6-9100)
Purch. Mgr.: Dana J. Mulholland
Sales Dept.: P. Panaggio, Jr.
V. P.: L. F. Gill

ENGRG. SPECIALTIES
8115 Camargo Rd., Madeira, Cincinnati 43, Ohio (Tel. Locust 1-6803)
Purch. Agent: V. J. Berlage
Dir.-Sales: C. A. Schneider MS, CT

***ENGIS EQUIPMENT CO.**
431 S. Dearborn St., Chicago 5, Ill. (Tel. HArrison 7-3223)
Treas.: Mrs. C. L. Morton
V. P.: E. J. Schneider G
*(See advertisement this issue)

ENSCO, INC.
3100 Eldredge St., Salt Lake, Utah (Tel. HUnter 5-9162)
Gen. Mgr.: Frank W. Longson CT

ENSIGN-BICKFORD CO., THE
660 Hopmeadow St., P. O. Box 308, Simsbury, Conn. (Tel. OLdfield 8-4411)
Purch. Mgr.: P. W. Nielson
Dir.-Mktg.: William S. Sherman M, RD

ENTHONE, INC.
442 Elm St., New Haven 8, Conn. (Spruce 7-5581)
Purch. Agent: Carl Schaefer
Sales Mgr.: C. C. Helmle M

ENTRON, INC.
P. O. Box 287, Bladensburg, Md. (Tel. APpleton 7-9585)
Purch. Agent: Carl D. Jones
V. P.-Sales: Robert J. McGeehan RD

EPCO PRODUCTS INC.
Foot of Cottage St., Box 298, Wallkill, N. Y. (Tel. Twinbrook 5-3300)
Pres.: E. Mullin M

EPIC, INC.
150 Nassau St., New York 38, N. Y. (Tel. DIgby 9-2470)
Purch. Dept.: B. Wagner
Head-Sales: Peter Letica CT

EPOXY PRODUCTS, INC., DIV.-JOSEPH WALDMAN & SONS
137 Coit St., Irvington 11, N. J. (Tel. ESsex 5-6000)
Purch. Agent: Edward Sagerman
Sales Mgr.: Sam Ringel M

EPSCO INC.
275 Massachusetts Ave., Cambridge, Mass. (Tel. UNiversity 4-4950)
Dir.-Materiel: John J. Kelly
Buyers: Robert R. Doucette & Sal Pantano
V. P.-Mktg.: Eugene Cobel MS, G, CT, TT, RD

***EQUIPMENT DIV., RAYTHEON CO.**
Waltham, Mass. (Tel. TWinbrook 9-8040)
Mktg. Mgr.: L. G. Walker
Purch. Agent: P. L. Gatchell, 225 Crescent St., Waltham, Mass. G, TT, RD
*(See advertisement this issue)

ERA ENGRG. INC.
1009 Montana Ave., Santa Monica, Calif. (Tel. EX 5-9995)
Pres.: H. Hutchinson
Dir.-Sales & Contracts: M. Cramer

ERDCO ENGRG. CORP.
Addison, Ill. (Tel. KIngswood 3-6733)

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

Purch. Agent: William E. Huntsha
Dir.-Sales: John T. Shartle MS, CT

ERIE INSTRUMATION, DIV.-ERIE RESISTOR CORP.
12932 S. Weber Way, Hawthorne, Calif. (Tel. ORegon 8-5418)
Mktg. Mgr.: R. J. Miller
Mgr.-Purch.: Joseph Simmons
Gen. Mgr.: Ross E. Hupp

ERIE RESISTOR CORP.
644 W. 12th St., Erie 6, Pa. (Tel. GLendale 6-8592)
Purch. Agent: George T. Griswold
Buyer: Roger Lusk
Buyer, Electronics Div.: A. G. Hall
V. P.-Mktg.: Allen J. Shenk M, TT

ERIEZ MFG. CO.
1945 Grove Dr., Erie, Pa. (Tel. GL 6-2041)
Purch. Agent: G. A. Amidon
Asst. Purch. Agent: Walter Nesgoda
Office Sales Mgr.: M. L. Cramer M

ERWIN-NEWMAN CO., THE
P. O. Box 1308, Houston 1, Tex. (Tel. JAckson 4-8186)
Partners: R. J. Newman, C. P. Erwin
Chief Engr.: J. F. Irvine S

ESSEX MFG. CO., INC.
8213 Gravois, St. Louis 23, Mo. (Tel. VErnon 2-4500)
Purch. Agent & Dir.-Sales: Harold Guller PS, MS, RD

ESSEX WIRE CORP.
1601 Wall St., Fort Wayne, Ind. (Tel. E-0311)
Purch.: G. Brown
V. P.-Sales: J. W. Stewart MS, M, G

ESSEX WIRE CORP., MAGNET WIRE DIV.
1601 Wall St., Ft. Wayne, Ind. (Tel. EAstbrook 0311)
Dir.-Purch.: G. Kohlmeier
V. P.-Sales: J. W. Stewart M

ESSO STANDARD, DIV.-HUMBLE OIL & REFINING CO.
15 W. 51st St., New York 19, N. Y. (Tel. PL 7-1200)
Mgr.-Purch.: A. J. Kelly
Gen. Mgr.-Mktg.: R. O. Goodykoontz

ESTERLINE-ANGUS CO., THE
P. O. Box 596, Indianapolis, Ind. (Tel. CHapel 4-3318)
Purch. Agent: J. T. Casebourne
Sales Operation Mgr.: James Gall
Sales Promotion: Lewis Meier, Jr. MS

ETS-HOKIN & GALVIN
551 Mission St., San Francisco, Calif. (Tel. EXbrook 7-2722); 218 N. Avalon Blvd., Wilmington, Calif. (Tel. TErminal 5-5601); 2295 E. Belt St., San Diego, Calif. (Tel. BElmont 4-6301)
Chief Purch. Agent: Fred Oakey
Sales, San Francisco: Jack Frost, Louis Bruni, Jack Pehrson
Sales, Wilmington: Milton Schug, Anthony Carbone, William Brown
Sales, San Diego: A. C. Eddy, Fred Byrum, Don Burgar

EUBANKS ENGRG. CO.
260 N. Allen Ave., Pasadena, Calif. (Tel. Murray 1-5905)
Purch. Agent: Ben Bentley
Gen. Mgr.: E. F. Eubanks

EUBANKS INDUSTRIES, INC.
2855 E. 11th Ave., Hialeah, Fla. (Tel. OXford 1-7552)
V. P.: E. B. Cohen
Pres.: W. S. Eubanks, Jr. S, MS, M, TT

EUCLID ELECTRIC & MFG. CO., THE
50 Edwards St., Madison, Ohio (Tel. HAzel 8-3511)
Purch. Agent: C. A. Bauer
Asst. Purch. Agent: E. Jacobson
Exec. V. P.: C. J. Rowles M

EUREKA WILLIAMS CORP.
1201 E. Bell St., Bloomington, Ill. (Tel. 76041)
Dir.-Purch.: Lloyd Hoover
Mgr., Contract Div.: G. W. Phister RD

EUTECTIC WELDING ALLOYS CORP.
40-40 172nd St., Flushing 58, N. Y. (Tel. FLushing 8-4000)
National Sales Mgr.: R. F. Fox M

EVANS RESEARCH & DEVELOPMENT CORP.
250 E. 43rd St., New York 17, N. Y.
Dir.-Sales: Dr. William F. Holland RD

EWALD INSTRUMENTS
Rt. 7-G, Kent, Conn. (Tel. WAlker 7-3278)
Gen. Mgr.: L. H. Ewald CT

EXACT ENGRG. & MFG. INC.
2375 Canyon Dr., Oceanside, Calif. (Tel. SAratoga 2-2144)
Purch. Agent: O. O. Padget
Dir.-Sales: George A. Brusch MS, G, RD

***EXCELCO DEVELOPMENTS INC.**
Mill St., Silver Creek, N. Y. (Tel. YE 4-2651)
Pres.: L. A. Brooks PS, MS, RD
*(See advertisement this issue)

EXCELLEX ELECTRONICS INC.
39-51 60th St., Woodside 77, N. Y. (Tel. OL 1-3370)
Dir.-Purch.: Murray Weinstein
Dir.-Sales & Engrg.: Herman W. Tackel M, RD

EX-CELL-O CORP.
1200 Oakman Blvd., Detroit 32, Mich. (Tel. TOwnsend 8-3900)
Dir.-Purch.: F. D. Sicklesteel
Purch. Agent: F. Grimm
V. P.-Indsl. Sales: D. H. McIver PS, MS, G

EXCELSIOR LEATHER WASHER MFG. CO. INC.
720-730 Chestnut St., Rockford, Ill. (Tel. WOodland 8-2203)
Pres.: C. E. Duclon
Treas.: W. E. Duclon

EXECUTONE, INC.
415 Lexington Ave., New York 17, N. Y. (Tel. MUrray Hill 7-7440)
Purch. Agent: Bernard Loew, 47-37 Austell Place, Long Island City 1, N. Y. (Tel. RAvenswood 9-7031)
Gen. Sales Mgr.: Ed Brody

EXIDE INDUSTRIAL DIV.-THE ELECTRIC STORAGE BATTERY CO.
Rising Sun & Adams Ave., Philadelphia 20, Pa. (Tel. FIdelity 2-8000)
Purch. Agent: H. S. Stevenson
Sales: C. J. Moore PS

EYELET TOOL CO. INC.
31 Carleton St., Cambridge 42, Mass. (Tel. UN 4-8170)

FMC CHLOR-ALKALI DIV.
161 E. 42nd St., New York 17, N. Y. (Tel. MU 7-7400)
Mgr. Dimazine Sales: Beverly Rose M

FWD CORP.
Clintonville, Wisc. (Tel. VAlley 3-2141)
Dir.-Purch.: Lloyd Pinkowsky
Asst. Dir.-Purch.: Leroy Hughes
Buyer: C. Pederson
Dir., Defense & Special Products: Wesley H. Peters MS

FXR, INC.
26-12 Borough Pl., Woodside 77, N. Y. (Tel. RAvenswood 1-9000)
Chief Purch. Agent: Lou Eskanazy
Asst. Purch. Agent: Jim Terlizzi
Buyer: Al Stiuso
Dir.-Sales Engrg. Dept.: Neal Deoul MS, CT, RD

FABER PEN & PENCIL CO. INC., EBERHARD
Crestwood-Wilkes-Barre, Pa. (Tel. GRanite 4-6711)
Dir.-Purch.: A. H. Dietze
V. P. & Sales Mgr.: C. P. Mailloux M

A. W. FABER-CASTELL PENCIL CO., INC.
41-47 Dickerson St., Newark 3, N. J. (Tel. HU 3-1997)
Supt.-Purch.: Otto Miller
Pres. & Gen. Mgr.: H. G. Bittman
Sales Mgr.: Charles Wyer M

FABRICON CORP.
19 Mill St., Unionville, Conn. (Tel. ORchard 3-2571)
Dir.-Purch. & Sales: M. V. Fields
Purch. Dept.: John McPhee & Harry Fitzgearld

FABRI-FORM CO., THE
258 W. Main Ave., Byesville, O. (Tel. 5416)
Buyer: E. E. Wray
Dir.-Sales: K. F. Kirkland S, HSE

FAE INSTRUMENT CORP.
42-61 Hunter St., L. I., N. Y. (Tel. STillwell 6-4959)
V. P.-Purch.: A. Mankes
Pres.: A. Onyskin
Sales Mgr.: A. Blake PS, MS, G, CT, TT, RD

FAFNIR BEARING CO., THE
37 Booth St., New Britain, Conn. (Tel. BAldwin 5-5151)
Purch. Agent: F. H. Hetzler
V. P.-Sales: R. W. Powell PS, G, TT, RD

FAIRBANKS CO., THE
393 Lafayette St., New York 3, N. Y. (Tel. SPring 7-8800)
V. P.-Sales: E. T. Flanagan

FAIRCHILD AIRCRAFT & MISSILES DIV., FAIRCHILD ENGINE & AIRPLANE CORP.
Hagerstown 10, Md. (Tel. REgent 3-3600)
Mgr.-Materials: S. T. Mulroney
Dir.-Sales: Leo W. Killen S, MS, CT, RD

FAIRCHILD ASTRIONICS DIV., FAIRCHILD ENGINE & AIRPLANE CORP.
Straight Path Rd., Wyandanch, L. I., N. Y. (Tel. Midland 3-7171)
Materials Mgr.: B. B. Kimball
Asst. Purch. Agents: C. F. Baggett & R. Stocker
Customer Relations Dir.: E. C. Leeson MS, G, CT, RD

FAIRCHILD CAMERA & INSTRUMENT CORP.
580 Midland Ave., Yonkers, N. Y. (Tel. GReenleaf 6-0201)
Purch. Agent: William B. Crooker
Purch. Dept.: Redmond Scott
Chief Engr.: Kenneth LiDonnici

FAIRCHILD CAMERA & INSTRUMENT CORP., INDUSTRIAL PRODUCTS DIV.
580 Midland Ave., Yonkers, N. Y. (Tel. GReenleaf 6-0201)
Purch. Agent: William B. Crooker
Asst. Purch. Agent: Redmond Scott
Mktg. Mgr.: H. M. Oshan

FAIRCHILD CONTROLS CORP.
225 Park Ave., Hicksville, L. I., N. Y. (Tel. WEIls 8-5600)
Purch. Mgr.: R. Crockett
Gen. Sales Mgr.: T. F. D'Andrade
Sales Mgr., East Coast: A. A. Budde G

FAIRCHILD CONTROLS CORP., COMPONENTS DIV.
255 Park Ave., Hicksville, L. I., N. Y. (Tel. Wells 8-5600); 6111 E. Washington Blvd., Los Angeles, Calif. (Tel. RAymond 3-5191)
Purch. Agent: Robert Crockett
Natl. Contracts Admin.: T. F. D'Andrade G, CT, TT

FAIRCHILD SEMICONDUCTOR CORP.
545 Whisman Rd., Mountain View, Calif. (Tel. YOrkshire 8-8161)
Purch. Agent: Lee Swasey
Sr. Buyer: Don Chaney
Mktg. Mgr.: Thomas Bay

FAIRFIELD ALUMINUM CASTINGS CO.
Fairfield, Iowa (Tel. 194)
Pres.: August Van Lantschoat
V. P.-Sales: Tom B. Hunt
Purch.: Merle Haney M

FAIRFIELD ENGRG. CORP.
114 Manhattan St., Stamford, Conn. (Tel. DAvis 5-1561)
V. P.-Mfg.: H. B. Frankel
Buyer: Mrs. E. Stelmach
Sales Mgr.: Kenneth L. Kline G, RD

FALCON MACHINE & TOOL CO.
211 Concord Tpke., Cambridge 40, Mass. (Tel. TRobridge 6-3269)
Treas.: Sal Leto
Pres.: Joseph Leto
Sales Mgr.: Stephen Kniffen M, RD

FALGE ENGRG. DIV., PEN MAC NYE CO.
4733 Elm St., Bethesda 14, Md. (Tel. OL 4-3020)
Purch. Agent: A. T. Medkeff
Pres.: J. A. Bares
Dir.-Sales: C. T. Smith M

FALSTROM CO.
75 Falstrom Ct., Passaic, N. J. (Tel. PRescott 7-0013)
Purch. Agent: P. W. Kievit
Purch. Agent: R. L. Chapman
Sales Mgr.: R. E. Hill S, MS, G, CT, RD

FANSTEEL METALLURGICAL CORP.
North Chicago, Ill. (Tel. DExter 6-4900)
Dir.-Purch.: J. A. Teece
Purch. Agent: G. E. Powell
Buyers: L. W. Carter, W. Laser, E. A. Weidman, H. Nelson, K. Garrity, H. Chase M

FARLEY & LOETSCHER MFG. CO., PLASTICS DIV.
7th & White St., Dubuque, Iowa (Tel. 2-5451)
Purch. Agent: L. J. Streinz
Div. Mgr.-Purch.: F. R. Loetscher
Asst. Div. Mgr.: C. E. Walz M

FARMER ELECTRIC PRODUCTS CO., INC.
2300 Wash. St., Newton Lower Falls 62, Mass. (Tel. DEcatur 2-8383)
Purch. Agent: T. L. Parker

V. P.-Sales: J. M. Farmer

FARWELL METAL FABRICATING
75 W. Fairfield Ave., St. Paul 7, Minn. (Tel. CApitol 4-5318)
Purch. Agent: Arnold Portugal
Asst. Purch. Agent: Mike Daddario
Sales Mgr.: W. J. Marzolf — S, MS

FARWEST MFG. DIV., INC.
209 1st Ave., S. Seattle 4, Wash. (Tel. MA 4-5656)
Pres.: Ron K. Bustad
Sales Mgr.: Bob Birdseye — MS, M, CT, RD

FASCO INDUSTRIES INC.
255 N. Union St., Rochester, N. Y. (Tel. HAmilton 6-1800)
Dir.-Purch.: C. Weiland
Asst. Purch. Agent: E. Bulloch
Sales Mgr.: S. Dean

FAULTLESS CASTER CORP.
1427 N. Garvin St., Evansville 7, Ind. (Tel. HArrison 5-9041)
V. P.-Purch.: Elmer H. Noelting
Purch. Agent, Parts: Robert Morris
Purch. Agent, Raw Materials: George L. Wood
Gen. Sales Mgr.: C. Bernard Noelting

J. W. FECKER DIV., AMERICAN OPTICAL CO.
6592 Hamilton Ave., Pittsburgh 6, Pa. (Tel. EMerson 1-7617)
Purch. Agent: Bert DeMarco
Dir.-Sales: Joseph Kalla — MS, CT, TT

FEDERAL BEARINGS CO. INC., THE
Fairview Ave., Poughkeepsie, N. Y. (Tel. GL 2-6000)
Dir.-Purch.: E. Wallin
Dir.-Sales: E. Sweeney

FEDERAL ELECTRIC CORP.
621-671 Industrial Ave., Paramus, N. J. (Tel. COlfax 1-7200)
Purch. Mgr.: J. L. McBride
Dir.-Mktg.: R. A. Marshall

FEDERAL ELECTRONIC PRODUCTS INC.
1380 Pompton Ave., Cedar Grove, N. J. (Tel. CLifford 6-1600)
V. P.-Purch.: A. R. Dutcher
Chief Engr.: Eric Pohle
Plant Mgr.: A. R. Johnson — M

FEDERAL MACHINE CO. INC.
841 Garfield Ave., Jersey City 5, N. J. (Tel. HEnderson 5-1500)
Purch. Agent: H. Shapiro
Pres.: Harold H. Butler — S

FEDERAL METAL HOSE CORP.
277 Military Rd., Buffalo 7, N. Y. (Tel. DE 4893)
Pres.: Harry C. Neff
Purch.: K. E. Lehr

FEDERAL PRODUCTS CORP.
1144 Eddy St., Providence 1, R. I. (Tel. STuart 1-9300)
Purch. Agent: H. E. Gilson
V. P.-Sales: L. B. Colt — M

FEDERAL SCIENTIFIC CORP.
615 W. 131st St., N. Y., N. Y. (Tel. AU 6-4400)
Purch. Agent: Murray Wiener
Asst. Purch. Agent: Donald Mintz — TT, RD

FEDERAL SCREW PRODUCTS INC.
3917 N. Kedzie Ave., Chicago 18, Ill. (Tel. IRving 8-5744)
Pres.: Joseph M. Levine
Purch. Agent: Ted Eisman
Sales Mgr.: L. L. Harris — M

FEDERAL TOOL & MFG. CO.
3600 Alabama Ave., Minneapolis 16, Minn. (Tel. WEst 9-7843)
Purch. Agent: W. A. Bergman
Pres.: E. J. Skramstad — RD

FEEDBACK CONTROLS, INC.
8 Erie Dr., Natick, Mass. (Tel. OL 3-3441)
Purch. Agent: S. W. Block
Regional Sales Mgr.: F. C. Thompson — G, TT

FELTERS CO., THE
210 South St., Boston 11, Mass. (Tel. LIberty 2-7021)
V. P.-Purch.: J. G. Bowden, 22 W. St., Millbury, Mass. (Tel. UNion 5-4404)
V. P.-Sales: G. C. Howe
Asst. Sales Mgr.: G. J. Harrington — M

FELTON-SIBLEY & CO., INC.
136 N. 4th St., Philadelphia 6, Pa. (Tel. MArket 7-3860)
Secy.: J. F. McMenamin
Asst. Purch. Agent: Herbert Kutz
Sales Mgr.: Ben Smith — M

FENN MFG. CO., THE
Fenn Rd., Newington, Conn. (Tel. MOhawk 6-2471)
Purch. Agent: D. F. Paternostro
V. P., Aircraft Sales: R. T. Holt — S, PS

FENSKE, FEDRICK & MILLER INC.
12820 Panama St., Los Angeles 66, Calif. (Tel. UPton 0-6041)
Dir.-Material: Charles Lichten
Buyer: Arnold Colman
Sr. Buyer: Milt Mitsingas
Mktg. Mgr.: R. L. LaCroix — MS, CT, TT, RD

FENWAL ELECTRONICS, INC.
Mellen St., Framingham, Mass. (Tel. TRinity 3-7455)
Pres.-Purch.: R. S. Goodyear
Sales Mgr.: H. J. Andrews — M

FENWAL INC.
Pleasant St., Ashland, Mass. (Tel. TRinity 5-6111)
Purch. Agent: F. Stockwell
Buyers: J. Mahoney & R. Thorne
Gen. Sales Mgr.: S. Edgerly — CT, RD

L. W. FERDINAND & CO. INC.
2300 Washington St., Newton 62, Mass. (Tel. DEcatur 2-5307)
Pres.: Paul B. Herrick — M, RD

FERROTRAN ELECTRONICS CO., INC.
693 Broadway, New York 12, N. Y. (Tel. ALgonquin 4-5810)
Gen. Mgr.: Edward A. Abbot — RD

FERROXCUBE CORP. OF AMERICA
50 E. Bridge St., Saugerties, N. Y. (Tel. CHerry 6-2811)
Purch. Agent: J. P. O'Reilly
Sales Mgr.: W. J. Crosby — M

FIBERCRAFT, INC.
328 East Ave. N., Lyons, Kans. (Tel. CLifford 7-2376)
Dir.-Purch.: Arlan G. Potwin
Pres. & Gen. Mgr.: John B. Sabine — S, M

FIBERFIL, INC.
Fox Farm Rd., Warsaw, Ind. (Tel. AMherst 7-7176)
Plant Mgr.: R. G. Duncan
Purch.: Allen Young
Development Mgr.: T. P. Murphy
Dir.-Sales: W. H. Chadbourne — M

FIDELITONE, INC.
6415 N. Ravenswood St., Chicago 26, Ill. (Tel. BR 4-0075)
Purch. Agent: H. C. Rutherford
V. P. & Gen. Mgr.: William R. Anton — M

FIDELITY CHEMICAL PRODUCTS CORP.
470 Frelinghuysen Ave., Newark 12, N. J. (Tel. BI 2-4110)
Gen. Mgr.-Purch.: Maurice Bick
Head-Sales: S. B. Lonyai — M

FIDELITY INSTRUMENT CORP.
1000 E. Boundary Ave., York, Pa. (Tel. 7675)
Purch. Agent: George Dietz
Pres.: A. A. Wolf
V. P.: L. E. Witmyer — M

FIELD EMISSION CORP.
210 N. Ford St., McMinnville, Ore. (Tel. 12951)
Bus. Mgr.: Carter Stanley
Proj. Leader: Frank Grundhauser
Engr.: Norman Stunkard
V. P.-Sales: Stanton D. Bennett — CT, RD

FILM CAPACITORS, INC.
3400 Park Ave., New York 56, N. Y. (Tel. CY 2-5180)
Dir.-Purch.: Sydel Nebel
Pres.: Sam Lipman — M

FILMOHM CORP.
48 W. 25th St., New York 10, N. Y. (Tel. WAtkins 4-6605)
Purch. Agent: Bob Latin
Buyer: M. Rosten
V. P.-Sales: J. N. Popper — M

FILTERS INC.
51 Calaveras Rd., Milpitas, Calif. (Tel. AM 2-2440)
Pres.: James Osterman — M, RD

FILTORS, INC.
30 Sagamore Hill Dr., Port Washington, N. Y. (Tel. 7-8220)
Purch. Agent: D. Bochicchio
V. P.-Sales: C. G. Barker — MS, G, CT, TT, RD

FILTRON CO., INC.
131-15 Fowler Ave., Flushing 55, N. Y. (Tel. HIckory 5-7000)
Dir.-Purch.: Lou Kerestury
V. P.-Sales: Sam Perry — M, CT, RD

FINN AERONAUTICAL DIV., T. R. FINN & CO. INC.
275 Goffle Rd., Hawthorne, N. J. (Tel. HA 7-7123)
Purch. Engr.: T. B. Malloy
Sales: William Grimm

FINNELL SYSTEM, INC.
500 East St., Elkhart, Ind. (Tel. JA 2-0586)
V. P.-Purch.: W. S. Finnell, Jr.
V. P.-Sales: James E. Bates — M

FINNEY CO., THE
34 W. Interstate St., Bedford, Ohio (Tel. Bedford 2-6161)
Pres.-Purch.: L. H. Finneburgh
V. P.-Purch.: M. L. Finneburgh, Sr.
Gen. Sales Mgr.: M. L. Finney, Jr. — M, TT

FIRESTONE INDUSTRIAL PRODUCTS CO., DIV.-THE FIRESTONE TIRE & RUBBER CO.
Noblesville 2, Ind. (Tel. PR 3-0650)
Purch. Agent: L. W. Irving
Buyer, Metals & Tools: H. T. Parson
Buyer, Machinery: C. Wyman
V. P.-Sales: R. J. Mitchell

FIRTH STERLING INC.
3113 Forbes, Pittsburgh 30, Pa. (Tel. MUseum 2-4600)
Purch. Agent: Harry K. Stern
Asst. Purch. Agent: George L. Miller
Gen. Sales Mgr., Carbine Div.: E. William Kalb
Gen. Sales Mgr., Steel Div.: Carl C. Krogh — M

FISCHER & PORTER CO.
6 Warminster Rd., Warminster, Pa. (Tel. OSborne 5-6000)
Dir.-Purch.: Daniel Steelman
Sales Mgr.: Harold Russell

FISHER & CROME
109 N. Camac St., Philadelphia 7, Pa. (Tel. LOcust 4-5054)
Buyer: John C. Bucher
Sales Mgr.: Albert Crome — M, G, CT

FISHER ENGRG., INC.
2060 U. S. 24 East, P. O. Box 327, Huntington, Ind. (Tel. 315)
Pres.: C. C. Fisher
Purch. Agent: W. S. Fisher — MS

FISHER GOVERNOR CO.
Box 307, Marshalltown, Iowa (Tel. 5561)
Purch. Agent: A. M. Chard
Asst. Sales Mgr.: Bruce Price — PS, MS

FISHER SCIENTIFIC CO.
711 Forbes Ave., Pittsburgh 22, Pa. (Tel. EXpress 1-1330)
Asst. to V. P.-Merchandising: D. A. Adams
Purch. Agent: E. A. Eyerman
Sales Mgr.: J. Cramer — M, RD

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

FISHER SCIENTIFIC CO., MARYLAND
7722 Woodbury Dr., Silver Spring, Md. (Tel. JUniper 7-7000)
Purch. Agent: John P. Callahan

FISH-SCHURMAN CORP.
70 Portman Rd., New Rochelle, N. Y. (Tel. New Rochelle 6-1300)
Purch. Agent: N. Raptoulis
Pres.-Sales: Murray Yawitz M

FIVE STAR CO., THE
W. Main St., Plantsville, Conn. (Tel. Southington, MArket 8-5561)
Purch. Mgr.: J. E. Carlson
Purch. Dept.: S. Nyberg & H. de Paiva
V. P.-Sales: R. Parnigoni MS, G, CT

FLA. AIRCRAFT RADIO & MARINE
5365 N. W. 36th St., Miami Springs, Fla. (Tel. TU 8-4614)
Pres.: Wm. C. Rogers
Gen. Mgr.: H. A. Thomas
Sales & Export Mgr.: Wayne Jeffries CT

FLEETWOOD LABS., INC.
300 Victory Blvd., New Rochelle, N. Y. (Tel. BEverly 5-0831)
Pres.: W. B. Lurie CT

FLEXAUST CO., THE
100 Park Ave., New York 17, N. Y. (Tel. ORegon 9-1300)
Supt.-Purch.: J. H. Burbank, Chestnut St., Amesbury, Mass. (Tel. 1396)
Gen. Sales Mgr.: H. J. Johnson M

FLEXIBLE METAL HOSE MFG. CO.
777 W. 16th St., Costa Mesa, Calif. (Tel. Midway 6-4851)
Pres.: Elton Hallett

FLEXIBLE TUBING CORP.
New Whitfield St., Guilford, Conn. (Tel. GLendale 3-2777)
Purch. Agent: Robert F. Moran
Asst. to Pres.: G. William Loveday MS, G, CT

FLEXONICS CORP.
1414 S. Third Ave., Maywood, Ill. (Tel. FIllmore 3-8000)
Dir.-Purch.: R. Ferguson
Mgr., Aeronautical Prod.: D. Ankeny
V. P.-Mktg.: E. A. Mailing

FLIGHT REFUELING, INC.
P. O. Box 1701, Baltimore 3, Md. (Tel. SOuthfield 6-5000)
Treas.-Purch.: Albert Roeper
Buyer: Lloyd Lilly, Jr.
Asst. to Pres. & Dir.-Customer Rel.: Richard C. Dickinson PS, MS, CT, RD, HSE

FLIGHT RESEARCH, INC.
P. O. Box 1-F, Richmond 1, Va. (Tel. REpublic 7-4163)
Purch. Agent: William J. Waymack, Jr.
V. P.-Sales: John C. Pennock MS, CT, TT, RD

FLIGHT SUPPORT, INC.
159 Forrest St., Metuchen, N. J. (Tel. LIberty 9-3500)
Purch. Agent: Herbert Hugo
Sr. Buyer: Peter Rogers
Sales Mgr.: Howard Kelly MS, CT, RD

FLIGHTEX FABRICS INC.
93 Worth St., New York 13, N. Y. (Tel. Worth 6-3630)
Exec. V. P.-Purch.: George P. Young
V. P.-Sales: Arlene M. Pinkham M

FLITE-TRONICS, INC.
3312 Burton Ave., Burbank, Calif. (Tel. VI 9-3376)
Dir.-Purch.: Harry Shulman
V. P.-Mktg.: J. Trevor Downer MS, CT

FLORIDA GEARS & SYSTEMS, INC.
16550 N. W. 10th Ave., Miami 64, Fla. (Tel. NAtional 4-3626)
Purch. Agent: M. B. Woolf
Pres.: Harry Frohman
Chief Engr.: O. A. Johnson RD

FLOCK PROCESS CO. INC.
371 Main Ave., Norwalk, Conn. (Tel. VIctor 7-4586)
Head-Purch. Dept.: R. J. Leff
Head-Sales: H. A. Leff M

FLOW CORP.
85 Mystic St., Arlington 74, Mass. (Tel. MIssion 8-6740)
Purch. Agent: Richard Mycko
Sales Mgr.: Robert T. Pritchard CT

FLOW MEASUREMENTS CORP.
10506 Wheatley St., Kensington, Md. (Tel. LOckwood 4-0122)
Purch. Agent: Robert L. Watts
Sales Mgr.: Don Pardue

FLOWLINE CORP.
P. O. Box 860, New Castle, Pa. (Tel. OLiver 4-5541)
Mgr.-Purch.: A. F. Giesecke
Purch. Agent: N. J. Simpson
Sales Mgr.: Roger S. Brown, Jr. MS

FLUID POWER INC.
P. O. Box 162MR, Macedonia, Ohio (Tel. IMperial 7-7141)
Purch. Agent: E. R. Fenger
Dir.-Sales: N. Fenger

FLUID REGULATORS CORP.
313 Gillette St., Painesville, Ohio (Tel. ELmwood 2-3319)
Purch. Agent: Ray W. Honeywell
Sales Mgr.: Ralph W. Barnes

FLUIDWICK CO.
5319 E. Outer Dr., Detroit 34, Mich. (Tel. DR 1-2920)
Sales Mgr.: Edward Tann M

JOHN FLUKE MFG. CO., INC.
P. O. Box 7161, Seattle 33, Wash. (Tel. PR 6-1171)
Purch. Agent: Dusty Rhodes
Sales Mgr.: John Zevenbergen CT

FLUOROCARBON CO., THE
1206 E. Ash Ave., Fullerton, Calif. (Tel. MA 6-9369)
Purch. Agent: Frank Willey
Sales Mgr.: Sandy Poteet
Plant Supt.: Frank Highfield M, RD

FLUORO-CHEM CORP.
82 Burlews Ct., Hackensack, N. J. (Tel. DIamond 3-8703)
V. P.-Purch.: Rex C. Connor
Sales Mgr.: William Cassanos

FLUORULON LABS., INC.
Box 305, Caldwell, N. J. (Tel. CA 6-8228)
Pres.-Purch.: F. B. DuVall
Sales Mgr.: Max B. Olbeter PS, M

FLUSH WALL RADIO CO.
1012 Cleveland St., Clearwater, Fla. (Tel. 34-6061)
Pres.: L. R. Schenck

FONDA GAGE CO., INC.
Box 1050, 200 Henry St., Stamford, Conn. (Tel. DA 4-5787)
Office Mgr.: D. A. Romaniello
Gen. Mgr.-Purch.: H. Wunsch
Sales Mgr.: A. J. Erickson CT

FOOD MACHINERY & CHEMICAL CORP., CHEMICAL DIVISIONS
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Purch. Dir.-Chemical Divs.: J. A. Mooney PS, MS, M, RD

FOOD MACHINERY & CHEMICAL CORP., CHEMICAL & PLASTICS DIV.
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Mgr., Mktg. & Purch.: Bert S. Taylor M

FOOD MACHINERY & CHEMICAL CORP., DAPON DEPT.
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Dir.-Purch.: Bert S. Taylor
Sales Mgr., Dapon Resin Dept.: J. L. Shafer
Purch. Agent: C. W. Scully, Ohio-Apex Plant, Nitro, W. Va. (Tel. PLeasant 5-3351) M

FOOD MACHINERY & CHEMICAL CORP., EPOXY DEPT.
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Dir.-Purch.: J. A. Mooney
Purch. Agent: R. E. Fillmore, Baltimore Plant (Tel. ELgin 5-6400)
Tech. Dir.: F. P. Greenspan S, PS, M

FOOD MACHINERY & CHEMICAL CORP., MINERAL PRODUCTS DIV.
161 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-7400)
Sales Mgr.: Raymond C. Tower
Purch.: John E. Tomko, Carteret, N. J. Plant (Tel. Kimble 1-4171)
Purch.: Kenneth Callicott, Lawrence, Kans. Plant (Tel. Viking 3-3880)
Purch.: F. E. Cauhape, Newark, N. J. Plant (Tel. Sycamore 3-1230) M

FOOD MACHINERY & CHEMICAL CORP., ORDNANCE DIV.
P. O. Box 367, 1105 Coleman Ave., San Jose, Calif. (Tel. CYpress 4-8124)
Procurement Mgr.: H. L. Hall
Purch. Agent: H. V. Rogers
Asst. Purch. Agent: F. P. Gorentz
Sales: J. J. MacRostie S, PS, MS, RD

FOOTE BROS. GEAR & MACHINE CORP.
4545 So. Western Blvd., Chicago 9, Ill. (Tel. VIrginia 7-4200)
V. P.: R. W. Johnson

FOOTE MINERAL CO.
18 W. Chelten Ave., Philadelphia 44, Pa. (Tel. VIctor 8-4000)
Dir.-Purch.: W. M. Raynor
Asst. Dir.-Purch.: W. J. Brooking
Gen. Sales Mgr.: John Gates M

FORBES, GEORGE F., INDUSTRIAL MATHEMATICIAN
13745 Eldridge Ave., Sylmar (San Fernando), Calif. (Tel. EMpire 7-1219) G, RD

FORBES & WAGNER, INC.
345 Central Ave., Silver Creek, N. Y. (Tel. YEllowstone 4-2691)
Purch. Agent: R. L. Hollowood
V. P.-Sales & Engrg.: John C. Pontius G, TT

M. A. FORD MFG. CO., INC.
1545 Rockingham St., Davenport, Iowa (Tel. 7-3251)
Secy.: Stanley Hill
Sales Mgr.: L. E. Schumann M

FORD INSTRUMENT CO., DIV.-SPERRY RAND CORP.
31-10 Thomson Ave., Long Island City 1, N. Y. (Tel. STillwell 4-9000)
Purch. Agent: J. A. Prince
Sr. Buyer, Subcontracts: R. Burkitt
Sr. Buyer, General: E. Datfer
Gen. Sales Mgr.: W. V. Warner MS, G, CT, TT, RD

FORD RADIO & MICA CORP.
536 63rd St., Brooklyn 20, N. Y. (Tel. GEdney 9-8300)
Purch. Agent: Alan J. Long
Sales Mgr.: Delos Maynard M

FOREDOM ELECTRIC CO., INC.
Bethel, Conn. (Tel. Pioneer 8-3521)
Purch. Agent: Henry Holmes
Sales Mgr.: Douglas E. Kellogg

FOREST ELECTRIC CO., THE
1001 N. 25th St., Melrose Park, Ill. (Tel. MUrray 1-0180)
Dir.-Purch.: Louis Picchietti
Dir.-Sales: Charles F. King M

FORMICA CORP.
4614 Spring Grove Ave., Cincinnati 32, Ohio (Tel. KIrby 1-3670)
Purch. Agent: L. Baumgartner
Prod. Mgr.: F. H. Hamilton M

FORM-IT PRODUCTS, INC.
1619 W. Walnut St., Chicago 12, Ill. (Tel. HAymarket 1-7337)
V. P.-Purch.: E. S. Jamison

FORMSPRAG CO.
23601 Hoover Rd., Warren, Mich. (Tel. JEfferson 6-9000)
Purch. Agent: E. D. Mackie
Buyer: R. F. Agnelly
V. P.-Sales: Charles F. Trapp, Jr.

FORSBERG MFG. CO., THE
125 Seaview Ave., Bridgeport 1, Conn. (Tel. EDison 4-9469)
Purch. Agent: C. M. Toomey
Plant Mgr.: John W. Nystrom
Sales Mgr.: H. S. Forsberg MS, RD, HSE

FORT WAYNE METALS, INC.
3211 MacArthur Dr., Ft. Wayne 6, Ind. (Tel. SHerwood 3181)
V. P.-Purch.: Frank B. Didier
Pres.: Ardelle Glaze

FOSTER WHEELER CORP.
666 Fifth Ave., New York 19, N. Y. (Tel. JUdson 2-6600) MS

FOSTORIA CORP., INFRA-RED DIV.
1200 N. Main St., Fostoria, Ohio (Tel. HEmlock 5-7721)
Purch. Agent: R. L. Hill
Sales Mgr.: D. E. Kralovec

FOTO-VIDEO LABS., INC.
36 Commerce Rd., Cedar Grove, N. J. (Tel. CEnter 9-6100)
Purch. Agent: W. Hums

Controller: John Soldavini RD

FOUCH ELECTRIC MFG. CO., INC.
900 N. Stanton St., P. O. Box 3978, Portland 8, Ore. (Tel. AT 8-5566)
Purch. Agent: W. E. Reynolds
Plant Engr.: D. E. Holcomb
Pres.: E. M. Fouch, Jr.
Sales Mgr.: H. M. Sidwell M

FOURSOME MFG. CO., INC.
79 Farmington Ave., Bristol, Conn. (Tel. LU 2-7461)
Pres.: Charles G. Monroe, Jr.

FOXBORO CO., THE
38 Neponset Ave., Foxboro, Mass. (Tel. Kingswood 3-5311)
Purch. Agent: Ralph Hayden
Gen. Sales Mgr.: H. O. Ehrisman CT

FRAM CORP.
105 Pawtucket Ave., Providence 16, R. I. (Tel. GEneva 4-7000)
Dir.-Purch.: H. Keough
V. P.-Sales: H. R. Robinson
Mgr., Aviation Div.: John J. McKee PS, MS, RD

FRANKE GEAR WORKS, INC.
4401 Ravenswood Ave., Chicago 40, Ill. (Tel. LOngbeach 1-0950)
Dir.-Purch.: Robert H. Bayer
Gen. Mgr.: Arthur Mackmann
Pres.: Carl T. Franke MS, G, CT, TT

FRANKLIN ELECTRONICS INC.
East Fourth St., Bridgeport, Pa. (Tel. BRoadway 2-4800)
Purch. Agent: H. H. DuVinage
Gen. Mgr.: William C. Quance
Pres.: Philip Sharples CT

FRANKLIN FIBRE-LAMITEX CORP.
E. 18th St.-on P.R.R. Siding, Wilmington, Del. (Tel. OL 8-5269)
Purch.: A. R. Campbell

FREBANK CO.
711 W. Broadway, Glendale 4, Calif. (Tel. CHapman 5-6558)
Purch. Agent: R. L. Harris
Sales Mgr.: J. G. Tillery PS, MS, CT, RD

FREED TRANSFORMER CO., INC.
1718 Weirfield St., Brooklyn 27, N. Y. (Tel. EVergreen 6-1300)
Purch. Agent: G. Lesser
Sales Mgr.: M. Salzberg G, TT

FREEMAN CO., THE
8th & Walnut Sts., Yankton, S. Dak. (Tel. North 5-2829)
Purch.: E. W. Freeman M

FRENCHTOWN PORCELAIN CO.
Harrison & 8th Sts., Frenchtown, N. J. (Tel. 480)
Purch. Agent: Wilson Anderson
Sales Mgr.: William E. Glosby M, G, TT, RD

FRIEZ INSTRUMENT DIV., BENDIX AVIATION CORP.
1400 Taylor Ave., Baltimore 4, Md. (Tel. VAlley 3-4040)
Purch. Agent: H. J. Grady
Gen. Sales Mgr.: R. B. Stevenson MS, RD

FRICK CO.
W. Main St., Waynesboro, Pa. (Tel. 1245)
Purch. Agent: John H. Reeve, Jr.
Asst. Purch. Agent: Paul E. Devor
Sales Mgr., Air Cond. & Refrig. Div.: John T. Sanders, III RD

FRUEHAUF TRAILER CO., MILITARY EQUIPMENT DIV.
10940 Harper Ave., Detroit 32, Mich. (Tel. WA 1-2410)
Dir.-Purch.: Bruce M. Kirsten
Purch. Agent: H. E. Vermillion
Purch.: Robert Liggett, Delphos, O. (Tel. 2-6015)
Dir.-Military Equip.: E. R. Neumann S, MS, RD

FUGLE-MILLER LABS. INC.
301 Central Ave., Clark, N. J. (Tel. FUlton 1-2727)
Purch. Agent: F. L. Fugle, Jr.
Sales Mgr.: Conrad Miller TT

FULLER CO.
124 Bridge St., Catasauqua, Pa. (Tel. COngress 4-2841)
Purch. Agent: J. A. Nork
Sales Mgr.: C. C. Kaesemeyer MS

FURANE PLASTICS INC.
4516 Brazil St., Los Angeles 39, Calif. (Tel. CHapman 5-1151)
Purch. Agent: J. Allen
Div. Mgr., Electrical, Adhesives, Bldg. Trades: Hadden S. Pierce
Div. Mgr., Tooling, Coatings, Structures: William S. Whyte M

FURNAS ELECTRIC CO.
1000 McKee St., Batavia, Ill. (Tel. TR 9-3410)
Purch. Agent: C. R. Mead
V. P.-Sales & Engrg.: W. F. Lisman M

FUSION ENGRG.
17921 Roseland, Cleveland 12, Ohio (Tel. IVanhoe 6-2333)
Purch. Agent: W. R. Johns
Sales Mgr.: B. R. Williams M

FUSITE CORP.
6000 Fernview Ave., Cincinnati 13, O. (Tel. REdwood 1-2020)
Purch. Agent: J. Fox
Asst. Purch. Agent: Don Makin
V. P.-Sales: J. H. Marsh, Jr.

FUTURECRAFT CORP.
1717 N. Chico Ave., El Monte, Calif. (Tel. CUmberland 3-2113)
Purch. Agent: Wesley Jones
Buyer: Claude Knight
Prod. Control: Ray Curtis
Supt.: Aage Hansen
Chief Test Engr.: Richard Fewell
Sales Mgr.: Robert Burke

FYR-FYTER CO., THE
221 Crane St., Dayton 1, Ohio (Tel. BAldwin 2-3751)
Purch. Agent: T. T. Coble
Dir.-Mktg.: A. C. Trautwein S, MS, CT

GAR PRECISION PARTS, INC.
190 Henry St., Stamford, Conn. (Tel. FI 8-2671)
Purch. Agent: J. Bernhard G

GAR PRODUCTS CORP.
71 Park St., Beverly, Mass. (Tel. WA 2-1626)
Purch. Agent: Jerome B. Bates
Asst. Purch. Agent: Charles K. Brown
Dir.-Sales: Arthur D. Stone M

G-C ELECTRONICS CO., DIV.-TEXTRON INC.
400 S. Wyman St., Rockford, Ill. (Tel. WOodland 8-9661)
Purch. Agent: George Kampmeier
Buyers: Stanley Anderson & Donald Bogdonas
Dir.-Sales: Edward J. Noretta M, RD

G-L ELECTRONICS CO., INC.
2921 Admiral Wilson Blvd., Camden 5, N. J. (Tel. WOodlawn 6-2780)
Purch. Agent: Frank E. Meller
Dir.-Sales: Stephen G. Lax

G-M LABS. INC.
4300 N. Knox Ave., Chicago 34, Ill. (Tel. PEnsacola 6-1800)
Purch. Agent: Irving M. Temen
Sales Mgr., Components Div.: A. G. Bradt

GPL DIV., GENERAL PRECISION, INC.
63 Bedford Rd., Pleasantville, N. Y. (Tel. ROgers 9-5000)
Dir.-Purch.: A. C. Schreiber
Asst. Dir.-Purch.: C. Adler
Gen. Purch.: C. Goodwin
V. P.-Sales & Engrg.: W. J. Tull G, RD

G-V CONTROLS INC.
Okner Pkwy., Livingston, N. J. (Tel. WYman 2-6200)
Gen. Sales Mgr.: Robert F. Stockton, III
Buyer: Richard Maloney
Production Mgr.: Ray Weckstein

GABRIEL CO., THE, GABRIEL ELECTRONICS DIV.
Main & Pleasant Sts., Millis, Mass. (Tel. FRontier 6-2953)
Purch. Agent: Charles Nolan
Dir.-Sales: John B. Hamre
Pres. & Gen. Mgr.: Stanton L. Yarbrough MS, TT, RD

GABRIEL CO., ROCKET POWER/TALCO
Box 847, Falcon Field, Mesa, Ariz. (Tel. WOodland 4-1711)
Purch. Agent: John Burger
V. P.-Planning & Mktg.: A. L. Pittinger PS, MS, RD

GAERTNER SCIENTIFIC CORP., THE
1262 Wrightwood Ave., Chicago 14, Ill. (Tel. BUckingham 1-5335)
Purch. Agent: L. V. Mosbarger
Sales Mgr.: Lyman W. Higgins CT

GAHAGAN INC.
Waterman Ave., Esmond 17, R. I. (Tel. CEnterdale 1-4000)
Purch. Agent: E. Johnson
Sales: E. S. Holland M, RD

GALLAND-HENNING MFG. CO., NOPAK DIV.
2753 S. 31st St., Milwaukee 46, Wisc. (Tel. MItchell 5-6000)
Sales Mgr.: R. W. Peterman
Purch. Agent: R. B. Gruettner
Dir.-Purch.: Roy F. Gruettner MS

GAMEWELL CO., THE
1238 Chestnut St., Newton Upper Falls, Mass. (Tel. BIgelow 4-1240)
Purch. Agent: E. O'Halloran
Sales Mgr., Potentiometer Div.: C. J. Manning M, CT, TT, RD

GAP INSTRUMENT CORP.
116 E. Merrick Rd., Freeport, N. Y. (Tel. FR 8-1040)
V. P.-Purch.: G. M. Tracy
Pres.: A. S. Goodrich MS, CT, RD

GARDE MFG. CO.
53 John St., Cumberland, R. I. (Tel. PAwtucket 6-4200)
Purch. Agent: Charles H. O'Koomian
Pres.: A. C. Demurjian

GARDEN CITY FAN & BLOWER CO.
801 N. Eighth St., Niles, Mich. (MUtual 3-1150)
Purch. Agent: W. T. Sims
V. P.-Engrg.: R. H. Freevol
Sales Engr.: E. E. Folkers
Pres.: G. E. Bauer

GARDINER ELECTRONICS
2545 E. Indian School, Phoenix, Ariz. (Tel. CR 4-9681)
R. F. Gardiner

GARDNER-DENVER CO.
Front St., Quincy, Ill. (Tel. BAldwin 2-5400)
Dir.-Purch.: E. E. Groves
Gen. Sales Mgr.: G. W. Gutekunst M

GARDNER LABORATORY, INC.
P. O. Box 5728, Bethesda 14, Md. (Tel. OL 6-3600)
Purch. Agent: W. J. Furmage
V. P.-Sales: Henry A. Gardner RD

GARLOCK PACKING CO.
402 Main St., Palmyra, N. Y. (Tel. LYric 7-4811)
Mgr., Purch. Div.: A. D. Trautman
Sr. Buyer: L. B. Black
V. P.-Mktg.: J. B. Sewell PS, M

GARLOCK PACKING CO., THE, ELECTRONIC PRODUCTS
600 N. 10th St., Camden 1, N. J. (Tel. WO 4-2212)
Purch. Agent: W. Cowan
Asst. Purch. Agent: M. Lickfeld
Mgr., Elec. Prods. Sales: F. O. Dutton M, RD

GEORGE K. GARRETT CO., INC.
Torresdale Ave. at Tolbut St., Philadelphia 36, Pa. (Tel. DEvonshire 2-6000)
Purch. Agent: Joseph Armstrong
Sales Mgr.: Walter G. Johnson
Govt. Sales Mgr.: Jules Freedman S

GARRETT CORP., THE, AIR CRUISERS DIV.
Rt. 34, Wall Township, N. J.; P. O. Box 180, Belmar, N. J. (Tel. MUtual 1-3527)
Purch. Agent: W. Howard Trowbridge
Div. Mgr.: Walter L. Clark
Mgr., Contract Admin.: Earl E. Dix

GARWIN, INC.
1326 S. Walnut St., Wichita 13, Kans. (Tel. HO 4-4621)
Purch. Agent: R. E. Eberle
Buyer: S. Jones
Sales Mgr.: Roy Thompson MS, G, CT

GARWOOD INDUSTRIES INC.
Wayne, Mich. (Tel. PA 1-6300)
Dir.-Purch.: W. A. Glimn
Purch. Agents: W. S. Kephart & W. H. Little
Dir.-Sales: D. J. Davis MS

GAS ATMOSPHERES INC.
20011 Lake Rd., Cleveland 16, Ohio (Tel. EDison 1-7070)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch. Agent: L. E. Highley
Chief Engr.: W. A. Marquardt
Sales Mgr.: Max H. Priddy **RD**

GASKET MFG. CO. INC.
319 W. 17th St., Los Angeles 15, Calif. (Tel. RIchmond 9-4063)
Purch.: C. Lane
Sales: D. W. Goodin

GATES ELECTRONIC CO.
1705 Taylor Ave., Bronx 60, N. Y. (Tel. TYrone 2-6490)
Chief Engr.: Stanley Lander
Purch.: J. Phillips
Sales Engr.: J. Regen **CT, TT**

GATES RADIO CO.
123 Hampshire St., Quincy, Ill. (Tel. BAldwin 2-8202)
Purch. Agent: John Bowers
Sales Mgr.: L. J. Cervone **MS, G, TT**

GATES RUBBER CO., THE
999 S. Broadway, Denver 17, Colo. (Tel. SHerman 4-1911)
Purch. Dir.: Thomas Paterson
Exec. V. P.-Mktg.: C. H. Mingle
Indsl. Sales Mgr.: Mark Gilkison **M**

GATEWOOD PRODUCTS, INC.
P. O. Box 1095, 420 East St., Parkersburg, W. Va. (Tel. HU 5-4406)
Secy.-Treas.: Eric Lehman
Purch. Dept.: James T. Metheny & Betty James
V. P.-Sales: E. R. Gateman **S, M**

GEAR SPECIALTIES, INC.
2635 W. Medill Ave., Chicago 47, Ill. (Tel. DIckens 2-3200)
Purch. Agent: F. E. Wampach
V. P.-Sales: W. C. Kozak **M**

GEMEX CORP., THE, INDUSTRIAL DIV.
1200 Commerce Ave., Union, N. J. (Tel. MUrdock 6-4100)
Dir.-Operations: E. L. Ackley **M, RD**

GENERAL ALLOYS CO.
367-405 W. First St., Boston, Mass. (Tel. ANdrew 8-1710)
Purch. Agent: John Barnes
Asst. Sales Mgr.: Allyn S. Crawford
V. P.-Sales Mgr.: Thomas E. Franks **M**

GENERAL AMERICAN TRANSPORTATION CORP.
135 S. LaSalle St., Chicago 3, Ill. (Tel. FInancial 6-4100)
Dir.-Purch.: C. Ingraham
Asst. Dir.-Purch.: W. Graham **S, MS, M, RD**

GENERAL ANILINE & FILM CORP., ANSCO DIV.
Vestal Pkwy., E., Binghamton, N. Y. (Tel. RAymond 9-6555)
Purch. Agent: W. J. Thomas
Mechanical Buyer: J. D. Taylor
Mgr., Special Contracts: T. R. Griffith **G, TT, RD**

GENERAL ASTRONAUTICS CORP.
P. O. Box 6285, Washington 15, D. C. (Tel. STerling 3-3453)
Pres.: Frederick I. Ordway, III
V. P.: Ronald C. Wakeford
Treas.: Roswell B. Wing **RD**

GENERAL AUTOMATIC CORP.
111 33rd St., Union City, N. J. (Tel. UNion 4-1867)
Dir.-Sales: Mort D. Barron **MS, M**

GENERAL BOX CO.
1825 Miner St., Des Plaines, Ill. (Tel. VAnderbilt 4-4181) **M**

GENERAL BRONZE ELECTRONICS CORP.
Hook Creek Blvd., Valley Stream, N. Y. (Tel. LO 1-8300)
Purch. Agent: Warren Cook
Buyers: W. Kennedy & R. Potter
Dir.-Sales: M. Jungman **TT, RD**

GENERAL CABLE CORP.
730 Third Ave., New York 17, N. Y. (Tel. YUkon 6-3800)
V. P.-Purch.: E. B. McGrew
V. P.-Sales: H. G. Richardson **M**

GENERAL CERAMICS DIV., INDIANA GENERAL CORP.
Keasbey, N. J. (Tel. VAlley 6-5100)
Purch. Agent: E. R. Parsells
V. P.-Sales: John P. Manley **M**

GENERAL COIL PRODUCTS CORP.
147-12 Liberty Ave., Jamaica 35, N. Y. (Tel. AXtel 1-8390)
Pres.: J. F. Siegel

GENERAL COMMUNICATION CO.
677 Beacon St., Boston 15, Mass. (Tel. COpley 7-6030)
Purch. Agent: J. M. Orsillo
Buyers: B. E. Johnston & D. A. Colignon
Sales Mgr.: Clinton E. Roche **MS, CT, TT, RD**

GENERAL COMPONENTS INC.
225 E. 144th St., New York 51, N. Y. (Tel. MOtthaven 5-0740)
Purch. Agent: Michael Meola
Chief Engr.: Sal De Ianni
Sales Mgr.: Henry Meola

GENERAL CONTROLS CO.
801 Allen Ave., Glendale 1, Calif. (VIctoria 9-2181)
Mgr., Purch.: M. J. Kouf
V. P.-Sales: John F. Ray **PS, MS, CT**

GENERAL DEVICES, INC.
P. O. Box 253, Princeton, N. J. (Tel. DAvis 9-2323)
Purch. Agent: J. B. Schmidt
Asst. Purch. Agent: V. Sawyer
Buyer: R. Torgeson
Sales Mgr.: J. L. Malony **G, TT, RD**

GENERAL ELECTRIC CO.
6901 Elmwood Ave., Philadelphia 42, Pa. (Tel. SAratoga 9-4200)
Purch. Agent: R. D. Bowman
Buyer, Mech. Components: E. F. Finley
Buyer, Elec. Components: J. J. Donoghue
Sales Mgr., C.A.M.P.S.: J. R. Topper **MS, CT, RD**

GENERAL ELECTRIC CO., APPARATUS SALES DIV.
1 River Rd., Schenectady 5, N. Y. (Tel. FRanklin 4-2211)

GENERAL ELECTRIC CO., ARMAMENT & CONTROL SECTION, LIGHT MIL. ELECTRONICS DEPT.
600 Main St., Johnson City, N. Y. (Tel. RA 9-2511)
Mgr., Materials: W. H. Bobear
Mgr., A & C Section: M. R. Johnson
Mgr., Engrg.: D. E. Garr
Mgr., Mktg.: G. R. Harris
Mgr., Mfg.: F. B. Law **MS, G, CT, RD, HSE**

GENERAL ELECTRIC CO., CATHODE RAY TUBE DEPT.
Electronics Park, Syracuse, N. Y. (Tel. GR 6-4411)
Purch. Agent: D. R. Coffman
Sales Mgr.: R. E. McBride **RD**

GENERAL ELECTRIC CO., COMPUTER DEPT.
13430 N. Black Canyon Hwy., Box 270, Phoenix, Ariz. (Tel. WI 3-2351)
Purch. Agent: G. H. Gurler
Purch. Specialists: S. P. Brown, L. L. Kelly & J. D. Durtz
Mgr., Mktg.: G. A. Hagerty
Mgr., Sales: L. R. Sheeley **MS, G, CT, TT, RD**

GENERAL ELECTRIC CO., DEFENSE SYSTEMS DEPT.
300 S. Geddes St., Syracuse, N. Y. (Tel. GRanite 6-4411)
Purch. Agent: J. M. Parmelee
Sr. Buyer: C. F. Moore
Subcontracts Admin.: G. P. Dittmar
Subcontracts Admin.: J. E. Gaitley
Mgr., Mktg. Operations: Warner R. Sinback **MS, G, CT, TT, RD, HSE**

GENERAL ELECTRIC CO., HEAVY MILITARY ELECTRONICS DEPT.
Court St., Syracuse, N. Y. (Tel. GRanite 6-4411)
Purch. Agent: R. H. Pickett
Mgr., Mktg.: R. J. Brown **MS, G, CT, TT, RD**

GENERAL ELECTRIC CO., INSTRUMENT DEPT.
40 Federal St., Lynn, Mass. (Tel. LY 3-3400)
Purch. Mgr.: H. A. Hamilton
Mgr., Aircraft Instr. Sales: H. E. Brown **G, RD**

GENERAL ELECTRIC CO., INSULATOR DEPT.
S. Charles & Cromwell Sts., Baltimore, Md. (Tel. PLaza 2-8020)
Mgr.-Materials: K. W. Ashman
Buyers: R. J. Mytke & E. H. Rickels
Mgr., Mktg.: C. B. Vaughn

GENERAL ELECTRIC CO., LAMP GLASS DEPT.
Nela Park, Cleveland, Ohio (Tel. IVanhoe 6-3000)
Mktg. Mgr.: W. R. Becker

GENERAL ELECTRIC CO., LAMP METALS & COMPONENTS DEPT.
21800 Tungsten Rd., Cleveland 17, Ohio (Tel. KEnmore 1-5050)
Purch. Mgr.: F. P. Nemec, Nela Park 12, O. (Tel. GLenville 1-6600)
Mktg. Mgr.: A. MacKenzie **M**

GENERAL ELECTRIC CO., LIGHT MILITARY ELECTRONICS DEPT.
French Rd., Utica, N. Y. (Tel. SW 7-1000)
Mgr., Materials: E. P. Heinemann
Purch. Agent: I. C. Andrews
Mgr., Mktg.: C. D. Brown
Mgr., Sales: W. A. Kinnaman **G, CT, RD, HSE**

GENERAL ELECTRIC CO. LTD. OF ENGLAND
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Sales Mgr.: Sy Bosworth

GENERAL ELECTRIC CO., METALLURGICAL PRODUCTS DEPT.
11177 E. 8 Mile Rd., Detroit 32, Mich. (Tel. JEfferson 6-9100)
Purch. Mgr.: H. Millar
Mgr.-Specialty Alloy Mfg.: G. Hemmeter
Mgr.-Sales, Specialty Alloys: J. Stevenson

GENERAL ELECTRIC CO., MISSILE & SPACE VEHICLE DEPT.
Lakeside Ave., Burlington, Vt. (Tel. UNiversity 3-3411)
Mgr.-Materials: G. W. Curry
Purch. Agent: J. H. Drury
Mktg. Mgr.: R. G. Loecher **S, MS, M, CT**

GENERAL ELECTRIC CO., MISSILE & SPACE VEHICLE DEPT. (PA.)
3198 Chestnut St., Philadelphia 4, Pa. (Tel. EVergreen 2-7800)
Purch. Mgr.: J. P. Benzie
Mgr., Sub-contracting: K. N. Thompson
Mgr.-Mktg.: D. T. Atkinson **S, MS, M, CT, TT, RD, HSE**

GENERAL ELECTRIC CO., ORDNANCE DEPT.
100 Plastics Ave., Pittsfield, Mass. (Tel. HI 3-3561)
Mgr., Materials: J. V. Terhune
Purch. Mgr., Polaris Guidance: R. J. Michaud
Purch. Mgr., Polaris Program: E. R. Lee
Mgr., Advance Projects & Mktg.: R. C. Berendsen **MS, G, TT, RD**

GENERAL ELECTRIC CO., ROCKET ENGINE SECTION
Lockland Hwy., Evendale Plant, Cincinnati 15, Ohio (Tel. PO 1-4100)
Mgr., Mfg.: R. H. Wettach
Mgr., Materials: L. A. Wuenschel
Mgr., Mktg.: G. G. Cudhea **PS, RD**

GENERAL ELECTRIC CO., TECHNICAL PRODUCTS OPERATION
Communication Products Dept., Electronics Park, Bldg. #7, Syracuse, N. Y. (Tel. GRanite 6-4411)
Purch. Agent: F. M. Brown
Mgr., Market Dev.: C. J. Simon

GENERAL ELECTRIC CO., WIRE & CABLE DEPT.
1285 Boston Ave., Bridgeport 2, Conn. (Tel. EDison 4-1012)
Purch. Agent: J. A. Hevern
Buyers: D. F. Cummings & W. F. Major
Mgr., Mktg.: J. S. Overstreet
Mgr., Mfg.: E. A. Reiss

GENERAL ELECTRIC CO., X-RAY DEPT.
4855 Electric Ave., Milwaukee 1, Wisc. (Tel. EVergreen 3-3211)
Mgr.-Materials: S. D. Hayward
Mgr.-Indsl. Sales: J. W. Webster **G, CT, TT, RD**

GENERAL ELECTRODYNAMICS CORP.
4430 Forest Lane, Garland, Texas (Tel. BRoadway 6-1161)
Purch. Agent: William Lawson
Exec. V. P.: Francis J. Salgo
Mgr., Electronic Equip. Div.: B. W. Griffith, Jr.
Mgr., Electronic Tube Div.: Herman Albertine, Jr. **G, TT, RD**

GENERAL ELECTRO-MECHANICAL CORP.
785 Hertel Ave., Buffalo 7, N. Y. (Tel. BE 9685)
Purch. Agent: E. Kurtz
Sales Mgr.: J. A. Randolph **M, G, TT, RD**

GENERAL FILTERS, INC.
43800 Grand River Ave., Novi, Mich. (Tel. Fieldbrook 9-2481)
V. P.-Purch.: Roland A. Redner
Pres.: Mrs. Grace Redner
V. P.-Res. Engrg.: Robert P. Redner

GENERAL FINDINGS & SUPPLY CO., INDUSTRIAL DIV.
School St., Attleboro, Mass. (Tel. Att. 1-1155)

Purch. Agent: Thomas Ireland
Gen. Mgr.: G. F. Tucci

GENERAL FIRE EXTINGUISHER CORP., THE
8740 Washington Blvd., Culver City, Calif. (Tel. UPton 0-6644)
Purch. Agent: T. L. Windsor
V. P.-Sales: E. K. Paine
Asst. Sales Mgr.: J. J. Ray

GENERAL GASKET INC.
Middletown, Conn. (Tel. Diamond 6-6203)
V. P.-Purch.: E. London
V. P.-Sales: D. London M

GENERAL INDUSTRIES CO., THE
Olive & Taylor Sts., Elyria, Ohio (Tel. FAirfax 3-3136)
Purch. Agent: C. W. Heidrich
Asst. Purch. Agents: L. D. Acheson & Del Roig
Sales Mgr., AC Motors: F. N. McGlynn CT, RD

GENERAL INSTRUMENT CORP., DEFENSE & ENGRG. PRODUCTS GROUP
Field Office: 81 N. 4th St., Brooklyn 11, N. Y. (Tel. EVergreen 8-6000); 65 Gouverneur St., Newark 4, N. J. (Tel. HUmbolt 5-2100)
Purch. Agents: Robert Dalzell & Maurice Markowitz
Asst. to Corporate V. P.-Mktg.: S. D. Gurian
Dir.-Purch. & Subcontracting: J. A. Heimbruch (Tel. HUmbolt 5-2100) G, CT, TT, RD

GENERAL INSTRUMENT CORP., SEMICONDUCTOR DIV.
65 Gouverneur St., Newark 4, N. J. (Tel. HUmboldt 5-2100)
Purch. Agent: M. Ostaszewski
Sales Mgr.: J. Tucker M

GENERAL INSULATED WIRE WORKS, DIV.-GENERAL CABLE
Box F1746, Providence 5, R. I. (Tel. HOpkins 1-2100)
Purch. Agent: M. Fargnoli
Sales Mgr.: C. J. Craig, Jr. M

GENERAL KINETICS, INC.
555 23rd St., S., Arlington 2, Va. (Tel. OTis 4-7555)
Purch. Agent: S. P. Vanderslice
V. P.-Sales: W. L. Anderson RD

GENERAL LABORATORY ASSOCIATES, INC.
17 E. Railroad St., Norwich, N. Y. (Tel. 4-3264)
Purch. Agent: Harold H. Horton
Dir.-Sales & Service: L. A. DeMellier
Sales Mgr.: Ogden M. Hamilton S, PS, MS, RD

GENERAL MAGNETIC CORP.
10001 Erwin Ave., Detroit 34, Mich. (Tel. WA 1-7558)
Purch. Agent: Clarence Hardoin
Chief Engr.: J. R. Hoven
Application Engr.: R. H. Campbell
V. P.-Sales: W. E. Gilman M

GENERAL MAGNETICS, INC.
135 Bloomfield Ave., Bloomfield, N. J. (Tel. PIlgrim 8-2400)
V. P.-Sales: M. G. Tekosky
Secy.-Treas.: Ralph W. Froese MS, G

GENERAL METAL PRODUCTS CO.
Centre & Glendale St., Easton, Pa. (Tel. BLackburn 8-9122)
Purch. Agent: R. Schwartz
Sales Mgr.: G. J. Hepp CT, TT

GENERAL MILLS, INC.
1620 Central Ave., N. E., Minneapolis 13, Minn. (Tel. STerling 9-8811)
Mgr., Purch.: A. E. Wickman
Purch. Agents: E. F. Wojciak & W. Thurston
Dir.-Mktg.: R. J. Wright MS, G, CT, RD

GENERAL PLASTICS CORP.
165 3rd Ave., Paterson, N. J. (Tel. ARmory 4-4710)
Purch. Agent: H. Barto
Sales: E. W. Davidson M, RD

GENERAL PRECISION, INC.
92 Gold St., New York 38, N. Y. (Tel. BEekman 3-4170)
Sales Coordinator: Andrew Georgia MS, G, CT, RD, HSE

GENERAL PRECISION, INC., LINK DIV.
Binghamton, N. Y. (Tel. RAymond 3-9311)
Purch. Agent: Marshall B. Bird

GENERAL PRECISION LAB. INC.
63 Bedford Rd., Pleasantville, N. Y. (Tel. ROgers 9-5000)
Dir.-Purch.: A. C. Schreiber
V. P.-Avionic Sales: W. J. Tull
V. P.-Ind. Sales: B. Foulds

GENERAL PRODUCTS CORP.
Salem St., Union Springs, N. Y. (Tel. 7-7367)
Purch. Agent: D. L. Webb
Sales Mgr.: C. Howard Leaf G, CT

GENERAL RADIO CO.
22 Baker Ave., West Concord, Mass. (Tel. EMerson 9-4400)
Purch. Mgr.: Colby E. Kelly
Sales Mgr.: William R. Saylor MS, CT

GENERAL REGULATOR CORP.
666 Fifth Ave., New York 19, N. Y. (Tel. JUdson 2-6600) CT

GENERAL R-F FITTINGS, INC.
702 Beacon St., Boston, Mass. (Tel. KEnmore 6-2290)
Purch. Agent: George Jumes
Office Sales Mgr.: Bryno Cohen

GENERAL SCIENTIFIC EQUIPMENT CO.
Limekiln Pike & Williams Ave., Philadelphia 50, Pa. (Tel. HAncock 4-1550)
Purch. Agent: J. Q. Kline
Head-Sales: M. Kline

GENERAL TESTING LABS., INC.
58 Washington Ave., Carlstadt, N. J. (WEbster 9-6933)
Dir.-Purch.: D. A. Hill
Sales Engr.: A. N. Purdy CT

GENERAL TIRE & RUBBER CO., THE, INDUSTRIAL PRODUCTS DIV.
1218 Garfield, Wabash, Ind. (Tel. 1440)
Purch. Agent: R. W. Flack
Dir.-Sales: Howard C. Sommer M

GENERAL TRANSISTOR CORP.
91-27 138th Pl., Jamaica 35, N. Y. (Tel. HIckory 1-1000)
Purch. Agent: John Grillo M

GENERAL VACUUM CORP.
400 Border St., E. Boston 28, Mass. (Tel. LOgan 7-8800)
Purch. Agent: D. J. Tobin
Dir.-Sales: W. G. Overacker M, RD, HSE

GENISCO, INC.
2233 Federal Ave., Los Angeles 64, Calif. (Tel. BRadshaw 2-2706)
Purch. Agent: G. F. Coyle
Mktg. Mgr.: J. Kimble MS, G, CT, RD

GENISCO INC., INSTRUMENT DIV.
2233 Federal Ave., Los Angeles 64, Calif. (Tel. BRadshaw 2-2706)
Purch. Agent: Gerry Coyle
Sales Mgr.: W. J. Barmore MS, G, CT

GENISTRON, INC.
6320 W. Arizona Circle, Los Angeles 45, Calif. (Tel. ORegon 8-9094)
Purch. Agent: John Brunskill
Pres.: Fred J. Nichols
V. P.'s: Paul M. Kuefler & John F. Harrison MS, M, CT

GENTAPE CORP., DIV.-GENERAL PLASTICS CORP.
165 Third Ave., Paterson 4, N. J. (Tel. ARmory 4-4710)
Sales Mgr.: Paul R. Farley MS, G, CT

GENTEX CORP.
450 Seventh Ave., New York 1, N. Y. (Tel. CHickering 4-6400)
Purch. Agent: Robert McLaughlin, Carbondale, Pa. (Tel. CArbondale 1840) M, RD

GEORATOR CORP.
315 Tudor St., Manassas, Va. (Tel. EMpire 8-2101)
Pres.: Shelley Krasnow
Purch. Agent: Worth Hatch MS, M, CT

GERBET HAIRSPRING CO.
Bridge St., Thomaston, Conn. (Tel. ATlas 3-4857)
Partner: Jack Weiss

PAUL E. GERST & CO.
4868 N. Clark St., Chicago 40, Ill. (Tel. LO 1-5897)
V. P.-Purch.: Robert D. Grahn
Purch. Dept.: Daniel T. Ballard & Casimer Wiecek
V. P.-Engrg.: Paul R. Gerst MS, RD

***GIANNINI CONTROLS CORP.**
1600 S. Mountain Ave., Duarte, Calif. (Tel. ELliott 9-9141)
Pres.: Donald H. Putnam
V. P. & Sales Mgr.: D. R. Gero
V. P. & Dir.-Engrg.: T. J. Harriman
*(See advertisement this issue)

GIANNINI PLASMADYNE CORP.
3839 S. Main St., Santa Ana, Calif. (Tel. KImberly 5-7171)
Head Buyer: Murray Sturmer
Dir.-Sales: R. D. Webb

GIBSON ELECTRIC CO.
Box 559, Delmont, Pa. (Tel. HOward 8-7701)
Purch. Agent: Raymond C. Hannegan
Buyer & Asst. Purch. Agent: Miss Addie Glaub
Sales Mgr.: Frederick R. Farnham M

FRED S. GICHNER IRON WORKS, INC.
1214 24th St., N. W., Washington 7, D. C. (Tel. FE 3-6500)
Dir.-Purch.: Albert V. Wade
Purch. Agent: Wayne M. Edge
Pres.: Henry Gichner MS

GIDDINGS & LEWIS MACHINE TOOL CO.
142 Doty St., Fond du Lac, Wis. (Tel. WA 1-9400)
Purch. Agent: Harry A. Stangby
Gen. Sales Mgr.: George K. Cassady S, PS

GIDEON & RAMEY MFG. CO.
585 Venice Blvd., Venice, Calif. (Tel. UP 0-4659)
V. P.-Purch.: J. McMurdo
Sales Mgr.: W. F. Downs

GIFFELS & ROSSETTI
1000 Marquette Bldg., Detroit 26, Mich. (Tel. WO 1-2084)
Pres.: R. F. Giffels
Proj. Dir.: N. K. Van Osdol, Jr.
Chief, Contracts Dept.: R. H. Steketee
Dir.-Development: M. M. Bush S, MS, RD

GILFILLAN BROS. INC.
1815 Venice Blvd., Los Angeles, Calif. (Tel. DUnkirk 1-3441)
Purch. Agent: John L. Forrest
Asst. Purch. Agent, Electrical Parts: George Steil
Asst. Purch. Agent, Outside Production-Machined Parts: William Chew
Asst. Purch. Agent, Outside Production-Sheet Metal: Joseph Copeland
V. P.-Sales: A. Jennings Brown MS, G, CT, TT, RD

DUNCAN M. GILLIES CO. INC.
66 Central, West Boylston, Mass. (Tel. TEmple 5-4445)
Pres.: Duncan M. Gillies G, TT

MARTY GILMAN, INC.
Gilman, Conn. (Tel. TUrner 9-7334)
Pres.: Martin J. Gilman M, RD

GILMORE INDUSTRIES, INC.
13015 Woodland Ave., Cleveland 20, O. (Tel. RA 1-6400)
Purch. Agent: M. Nager
V. P.-Sales: L. S. Winston S, PS, MS

GIRARD-HOPKINS
1000 40th Ave., Oakland 1, Calif. (Tel. KEtogg 2-8477)
Dir.-Purch.: A. R. Stack
Dir.-Sales: J. C. Hopkins M

GITS BROTHERS MFG. CO.
1846 S. Kilbourn Ave., Chicago 23, Ill. (Tel. LAwndale 1-3554)
Purch. Agent: R. Sherman
Gen. Sales Mgr.: E. Wahl M

GLADDING, McBEAN & CO.
2901 Los Feliz Blvd., Los Angeles 39, Calif. (Tel. NOrmandy 3-3361)
Purch. Agent: Boyd Moon
Gen. Mgr., Tech. Ceramic Div.: F. C. Arrance
Prod. Supvr., Tech. Ceramic Div.: J. D. Welterlen RD

GLAR-BAN CORP.
3807 Harlem Rd., Buffalo 15, N. Y.

GLASSCO INSTRUMENT CO.
777 S. Arroyo Pkwy., Pasadena 2, Calif. (Tel. SYcamore 5-3278)
Factory Supt.: George Northrop
V. P.-Sales: C. W. Froude

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

GLEASON WORKS
1000 University Ave., Rochester, N. Y. (Tel. GReenfield 3-1000)
Purch. Agent: M. D. Barker
Gen. Sales Mgr.: R. W. Doell **PS, G**

GLOBAR PLANT, REFRACTORIES DIV.-THE CARBORUNDUM CO.
Niagara Falls, N. Y. (Tel. 5715)
Sales Mgr.: D. S. Bowman **M, RD**

GLOBE AUTOMATIC SPRINKLER DIV., THE FYR-FYTER CO.
Rt. 1, Box 750, Newark 1, N. J. (Tel. BIgelow 8-2200)
V. P.: C. T. Mallory **S**

GLOBE ELECTRICAL MFG. CO.
1729 W. 134th St., Gardena, Calif. (Tel. FAculty 1-3311)
Purch. Agent: William Ostendorf
V. P.-Sales: R. D. Hitchiner **G, CT, TT**

GLOBE ELECTRONICS, DIV.-TEXTRON ELECTRONICS, INC.
22-30 S. 34th St., Council Bluffs, Iowa (Tel. 32-8-1414)
Purch. Agent: George Thomas
Gen. Mgr.: Owen L. Meyerson **CT**

GLOBE INDUSTRIES, INC.
1784 Stanley Ave., Dayton, O. (Tel. BAldwin 2-3741)
Purch. Agent: John Trostle
Purch.: Lester Zartman & Robert McRose
Sales Mgr.: Yale J. Holt

GLOBE INDUSTRIES, INC., SUPERMET DIV.
1468 Cincinnati St., Dayton 8, Ohio (Tel. BA 3-4253)
Gen. Mgr.: John R. Powers **M**

FRED GOAT CO. INC., THE
314 Dean St., Brooklyn 17, N. Y. (Tel. TRiangle 5-0940)
Purch. Agent: E. Maggio
Sales Mgr.: John T. McMahon, Jr. **M**

GOE ENGRG. CO.
219 S. Mednik Ave., Los Angeles 22, Calif. (Tel. ANgeles 1-2183)
Pres.: Bob Relly
Gen. Sales Mgr.: Milton Terkla **M**

GOLDSMAN
1328-34 N. 4th St., Philadelphia 22, Pa. (Tel. POplar 5-4468)
Gen. Mgr.: Ronald Goldsman
Purch. Dept.: Al Goldsman
Engr.: Robert Blasi
Sales Dept.: Chester A. Milewski & Richard H. Sager **M, RD**

GOLDSMITH BROS. DIV., NATIONAL LEAD CO.
900 W. 18th St., Chicago 8, Ill. (Tel. CAnal 6-3700)
Dir.-Purch.: Elmer Luedtke
Sales Mgr.: A. G. Wahlen

JOHN GOMBOS CO., INC.
Webro Rd., Clifton, N. J. (Tel. PRescott 3-6633)
Buyer: J. M. Fuller
Sales Mgr.: Harold J. Schatz **MS, G, RD**

GONSET DIV., YOUNG SPRING & WIRE CORP.
801 S. Main St., Burbank, Calif. (Tel. THornwall 5-8711)
Purch. Agent: Paul Kilmer
Gen. Sales Mgr.: William Hunter **M, TT, RD**

GOOD ELECTRONIC CORP.
P. O. Box 2406, West Palm Beach, Fla. (Tel. VIctor 8-3241)
Pres.: Lewis F. Good, Sr. **M, CT, RD**

GOOD-ALL ELECTRIC MFG. CO.
112 W. First St., Ogallala, Nebr. (Tel. 28-4-3611)
Purch. Agent: Frank Pincheon
Sales Mgr.: E. M. Sheridan

B. F. GOODRICH AVIATION PRODUCTS
500 S. Main St., Akron, O. (Tel. BLackstone 3-1171)
Gen. Mgr.-Sales: E. H. Fitch **S, PS, MS, RD, HSE**

B. F. GOODRICH CHEMICAL CO.
3135 Euclid Ave., Cleveland 15, Ohio (Tel. UTah 1-8200)
Chemical Purch.: H. L. Coulter
Engrg. Purch.: H. C. Katzenmeyer
Mgr., Propellant Materials: M. W. Osborne **PS, M, RD**

B. F. GOODRICH CO., THE
Shelton, Conn. (Tel. REgent 5-4661)
Purch. Agent: Robert Nicol
Asst. Purch. Agent: Edward Grant
Buyers: Alfred Fisher & Samuel Goodman
Sales Mgr.: J. I. Gillis **M**

B. F. GOODRICH INDUSTRIAL PRODUCTS CO.
500 S. Main St., Akron 18, O. (Tel. BLackstone 3-1171)
Dir.-Purch.: H. C. Catt
Purch. Agents: E. A. Hughes & L. H. Finley
V. P.-Sales: J. C. Richards **M**

B. F. GOODRICH SPONGE PRODUCTS
Shelton, Conn. (Tel. REgent 5-4661)
Purch. Agent: R. G. Nicol
Buyer: Samuel E. Goodman
Asst. Purch. Agent: Edward C. Grant
Sales Mgr.: J. I. Gillis

GOODRICH-HIGH VOLTAGE ASTRONAUTICS, INC.
Box 98, Burlington, Mass. (Tel. BRowning 2-1313)
Purch. Agent: Richard W. Chase **PS, RD**

GOODYEAR AIRCRAFT CORP.
1210 Massillon Rd., Akron 15, O. (Tel. REpublic 3-6361)
Purch. Agent: H. A. Delaney
Mgr.-Material Purch.: A. L. Gravesmuehl
Mgr.-Subcontract Purch.: W. R. Reed
V. P.-Sales: R. W. Richardson **S, MS, G, CT, RD**

GOODYEAR TIRE & RUBBER CO., THE AVIATION PRODUCTS DIV.
1144 E. Market St., Akron 16, Ohio (Tel. FRanklin 6-1411)
Dir.-Purch.: I. S. Gharky
Buyer: A. J. Bartel
Gen. Mgr., Aviation Products Div.: E. M. Eickmann **MS, M, G, RD**

CLAUD S. GORDON CO.
3000 S. Wallace St., Chicago 16, Ill. (Tel. VIctory 2-6525)
Purch. Agent: M. J. McDonagh
Sales Mgr.: F. C. Collins **M, CT**

GORDON ENTERPRISES
5362 N. Cahuenga Blvd., N. Hollywood, Calif. (Tel. POplar 6-3725)
Dir.-Purch.: Ralph Cohn
Sales Mgr.: Kenneth Knipe **MS, G, CT, TT, RD**

GORDON RUBBER & PACKING CO. INC.
126 Oak Ave., Shelton, Conn. (Tel. REgent 5-7441)
Pres.: S. R. Nichols
Secy. & Treas.: Alexander Mazur **M**

GORHAM ELECTRONICS, DIV.-GORHAM MFG. CO.
333 Adelaide Ave., Providence 7, R. I. (Tel. Williams 1-1000)
Purch. Agent: William G. Pearce
Sales Mgr.: Robert S. Gordon **MS, RD**

GORMAN-RUPP CO., THE
305 Bowman St., Mansfield, O. (Tel. LAfayette 4-4211)
Dir.-Purch.: C. R. Rupp
Purch. Agent: George York
Sales Mgr.: James C. Gorman **MS**

GORN ELECTRIC CO., INC., AIRCRAFT CONTROLS DIV.
845 Main St., Stamford, Conn. (Tel. FIreside 8-7591)
Purch. Agent: A. J. Saraceno
Assoc. Sales Mgr., West. Div.: Scott L. Whipple
Assoc. Sales Mgr., East. Div.: H. H. Merritt, Jr. **MS, M**

GORN ELECTRIC CO., INC., CONNECTOR DIV.
845 Main St., Stamford, Conn. (Tel. FIreside 8-7591)
Purch. Agent: A. J. Saraceno
Div. Mgr.: L. Rumely **MS**

GORN ELECTRIC CO., INC., GORN ELECTRONICS DIV.
845 Main St., Stamford, Conn. (Tel. FIreside 8-7591)
Div. Mgr.: L. M. Rumely, Jr. **M**

GEORGE GORTON MACHINE CO.
1321 Racine St., Racine, Wisc. (Tel. MElrose 4-6644)
V. P.-Proc.: Charles Gorton
Purch. Agent: P. C. Paulson
Sales Mgr.: K. E. Christopherson **MS, RD**

GOSHEN RUBBER CO., INC.
641 E. Iowa St., Goshen, Ind. (Tel. KEystone 3-1111)
Purch. Agent: C. N. Everingham
Sales Mgr.: Joseph L. Lantz **M**

GOSLIN ELECTRIC & MFG. CO.
2921 W. Olive Ave., Burbank, Calif. (Tel. VIctoria 9-3025)
Purch. Agent: A. M. Galbraith
Sales Mgr.: W. S. Williams **G, TT, RD**

J. D. GOULD CO.
4707 Massachusetts Ave., Indianapolis 18, Ind. (Tel. LIberty 7-5289)
Dir.-Sales: John D. Gould, Jr.

GOULDS PUMPS INC.
300 Fall St., Seneca Falls, N. Y. (Tel. LOgan 8-5811)
Purch. Agent: C. H. Kissel
V. P. & Sales Mgr.: E. E. Backlund **S**

GOW-MAC INSTRUMENT CO.
100 Kings Rd., Madison, N. J. (Tel. FRontier 7-3450)
Pres.: James L. McFadden

W. R. GRACE & CO., DAVISON CHEMICAL DIV., NUCLEAR REACTOR MATERIALS PLANT
P. O. Box 218, Erwin, Tenn. (Tel. Ploneer 2-1721)
Gen. Mgr.: T. C. Runion
Asst. Gen. Mgr.: E. R. Johnson **M**

GRAFLEX, INC.
3750 Monroe Ave., Rochester 3, N. Y. (Tel. LUdlow 6-2020)
Purch. Agent: C. S. Krembel
Asst. Purch. Agent: H. W. Griffith
Buyer-Expediter: A. M. McGovern
Contract Sales Mgr.: G. W. Lehman **MS, G**

GRAFO COLLOIDS CORP.
310 Wilkes Place, Sharon, Pa. (Tel. DI 6-5023)
Purch. Agent: Edw. A. Willson
Sales Mgr.: Ronald R. States **M**

GRAMM TRAILER CORP.
425 E. O'Connor Ave., Lima, Ohio (Tel. CA 9-7015)
Purch. Agent: V. D. Buchanan
Sales Mgr., Military Products: William J. Saelzler **MS**

GRAND CENTRAL ROCKET CO.
Box 111, Redlands, Calif. (Tel. PYramid 3-2211)
Dir.-Material: Jack Edwards
V. P.-Mfg., Test.: Jerome Belsky
Dir.-Mktg.: James T. Harker
V. P. & Gen. Mgr.: Cledo Brunetti **PS, RD**

GRANT GEAR WORKS, INC.
154 W. 2nd St., Boston, Mass. (Tel. AN 8-4408)
Purch. Agent: J. F. Cromwell
Sales & Adv. Mgr.: F. E. Emery
Plant Supt.: W. J. MacDonald

GRANT MFG. & MACHINE CO., THE
90 Missile Ave., Bridgeport 5, Conn. (Tel. FOrest 6-4557) **S**

GRANT PULLEY & HARDWARE CORP.
High St., West Nyack, N. Y. (Tel. ELmwood 8-4400)
Purch. Agent: Mrs. Kay Saller
Gen. Sales Mgr.: William M. Linden **M**

GRANT-LEHR CORP.
1911 N. 4th St., Baton Rouge, La. (Tel. DI 2-7638)
Dir.-Purch.: Edward D. Grant
Dir.-Sales: R. A. Lehr **M**

GRAPHIK CIRCUITS DIV., CINCH MFG. CO.
200 S. Turnbull Canyon Rd., City of Industry, Calif. (Tel. EDgewood 3-1201)
Purch. Agent: H. A. Clinch
V. P. & Gen. Mgr.: George J. Hart
Chief Engr.: R. A. Ihel
Gen. Sales Mgr.: S. L. Glasdell **M**

GRAPHITE METALLIZING CORP.
1050 Nepperhan Ave., Yonkers, N. Y. (Tel. YOnkers 8-8400)

GRAVER TANK & MFG. CO., DIV.-UNION TANK CAR CO.
4811 Tod Ave., E. Chicago, Ind. (Tel. EXport 7-0204)
Dir.-Purch. & Proc.: T. Harle
Purch. Agent: M. L. Graves
Gen. Sales Mgr.: Clark Root **PS**

GRAY CO., INC.
60 11th Ave., N. E., Minneapolis 13, Minn. (Tel. FEderal 6-9331)
Purch. Agent: W. F. Bloedow
Asst. Purch. Agent: L. Wandel
Ind. Sales Mgr.: H. A. Murphy, Jr.

GRAY INSTRUMENT CO.
448 Mill Rd., Andalusia, Pa. (Tel. HObart 4-2100)
Prod. Engr.: C. Scharle
Treas.: Tom Mather
V. P.-Sales: A. R. Bechtel **CT**

GRAY MFG. CO., THE
16 Arbor St., Hartford 1, Conn. (Tel. ADams 3-1271)
Purch. Agent: R. Wahatalo
Electronic Buyers: W. Allyn & R. Roy
Indsl. Sales Mgr.: J. T. Kane **MS, M, G, RD**

GRAYHILL, INC.
561 Hillgrove Ave., La Grange, Ill. (Tel. FLeetwood 4-1040)
Dir.-Purch.: Phil Tylin
Dir.-Sales: R. M. Hill

GREAT EASTERN METAL PRODUCTS CO.
22 Woodworth Ave., Yonkers, N. Y. (Tel. GReenleaf 6-7300)
Pres.: Lester Weinberg M

GREAT LAKES CARBON CORP., ELECTRODE DIV.
18 E. 48th St., New York 17, N. Y. (Tel. ELdorado 5-6200)
Gen. Sales Mgr.: Samuel H. Reynolds
Purch. Dept.: P. O. Box 637, Pine Ave. at 58th St., Niagara Falls, N. Y. (Tel. BUtler 3-7611)
Purch.-Dir.: George H. Carney M

GREAT LAKES MFG. CORP.
4223 Monticello Blvd., Cleveland 21, Ohio (Tel. EVergreen 2-5500)
Purch. Agent: R. A. Swanson
Buyer: S. E. Baginski
Pres.: J. A. Kanuch PS, MS, G

GREEN INSTRUMENT CO.
385 Putnam Ave., Cambridge 39, Mass. (Tel. ELiot 4-2989)
Purch. Agent: Lynd F. Tillyer
Sales Mgr.: W. Franklin Fullerton

ARNOLD GREENE TESTING LABS., INC.
E. Natick Industrial Park, Oak St., Natick, Mass. (Tel. CE 5-7330)
Pres.: Arnold Greene
V. P.: Robert Halliday
Sales Mgr.: Ted Mongeau

GREENE, TWEED & CO.
340 Elm Ave., North Wales, Pa. (Tel. OXbow 9-4821)
Purch. Agent: M. Dorothy Segall M

GREENFIELD TAP & DIE, DIV.-UNITED-GREENFIELD CORP.
Sanderson St., Greenfield, Mass. (Tel. PR 3-3611)
Purch. Agent: Avery Bates
Sales: W. J. Eberlein RD

GREENLEAF MFG. DIV., THE, MANDREL IND. INC.
7814 Maplewood Ind. Ct., St. Louis 17, Mo. (Tel. STerling 1-9888)
Purch. Agent: P. J. Mahony
Sales Mgr.: Paul B. Bruns G, CT

GREER HYDRAULICS, INC.
5930 W. Jefferson Blvd., Los Angeles 16, Calif. (Tel. UP 0-9161)
Purch. Mgr.: Richard Gmernicki
Sales Mgr.: Donald K. Marsh
Eastern Sales-Service Offices: 496 Grand Blvd., Westbury, L. I. (Tel. ED 4-8666)
Sales Mgr.: Leonard Seeman PS, RD

GREIBACH INSTRUMENTS CORP.
315 North Ave., New Rochelle, N. Y. (Tel. New Rochelle 3-7900)
Dir.-Purch.: Lester Kanarfogel
Dir.-Sales: J. M. Leopold CT, RD

GREMCO, INC.
P. O. Box 7115, 3535 N. Sylvania, Ft. Worth, Tex. (Tel. TErminal 4-2836)
Purch. Agent: A. Krsak
Sales Mgr.: J. D. Taliaferro MS, RD

GRIES REPRODUCER CORP.
125 Beechwood Ave., New Rochelle, N. Y. (Tel. NEw Rochelle 3-8600)
Purch. Agent: Robert Barlow
Asst. Purch. Agent: Thomas Veldron
Sales Mgr.: Carl L. Chase
Dir.-Sales: Joseph Saks

JOHN GRIFFIN CO.
2117 Grand Ave., St. Paul 5, Minn. (Tel. Midway 8-2810)
Purch. Agent: Art Carlson
Dir.-Sales: Jim Conway M

GRIGSBY CO., INC., THE
407 N. Salem Ave., Arlington Heights, Ill. (Tel. NEwcastle 1-8700)
Purch. Agent: A. Lassen
V. P.-Sales: W. S. Patterson
Sales Mgr.: L. J. Osberg M, RD

GRIMES MFG. CO.
515 N. Russell St., Urbana, O. (Tel. 3-5221)
Purch. Agent: John Davis
Asst. Purch. Agent: Paul Roles
V. P.-Sales: L. B. Moore MS, TT, RD

GRINNELL CO.
277 W. Exchange St., Providence 1, R. I. (Tel. TEmple 1-7000)
Purch. Agent: W. J. Duggan
Mgr., Saunders Valves Div.: A. G. Smith
Mgr., Fire Protection Div.: O. L. Swats S

GRIP NUT CO.
Broad & Maple, South Whitney, Ind. (Tel. S. W. 112)
Purch. Agent: M. H. Rudd
V. P.-Sales: G. A. Bovenkerk M

GRISCOM-RUSSELL CO., THE
Massillon, Ohio (Tel. TE 2-8751)
Purch. Agent: H. A. O'Neil
Sales Engr.: L. H. Bradley
Gen. Sales Mgr.: N. T. Griffiths
Contract Engr.: F. V. Huber PS

GROOV-PIN CORP.
1125 Hendricks Causeway, Ridgefield, N. J. (Tel. WHitney 5-6780)
Purch. Agent: H. Bernlohr
Sales Mgr.: R. G. Cummings M

GROTNES MACHINE WORKS, INC.
5454 N. Wolcott Ave., Chicago 40, Ill. (Tel. LOngbeach 1-7693)
Sales Mgr.: J. F. Coleman S, PS

GROVE VALVE & REGULATOR CO.
6529 Hollis St., Oakland 8, Calif. (Tel. OLympic 5-7700)
Purch. Agent: L. D. West
V. P.-Gen. Sales Mgr.: George Doty MS

GRUMMAN AIRCRAFT ENGINEERING CORP.
Bethpage, L. I., N. Y. (Tel. WEIls 1-1500)
Mgr.-Proc.: William N. Robertson, Jr.
Purch. Agent: Norman J. Egloff
Chief Buyer, R&D: Charles Nauss
V. P.-Contracts: George F. Titterton S, PS, RD, HSE

GUARANTEE SPECIALTY MFG. CO.
E. 96th St. & N. Y. C. R.R., Cleveland 8, Ohio (Tel. GLenville 1-9744)
Pres.: R. H. Wright
V. P.-Purch.: E. M. Rogert
Sales Mgr.: Stan Wygonik

GUARDITE CO., DIV.-AMERICAN-MARIETTA CO.
Box 188, Wheeling, Ill. (Tel. LEhigh 7-1000)
Purch. Agent: O. L. Carter
Sales Mgr., Environmental Equip.: S. P. Voak CT, HSE

GUDEBROD BROS. SILK CO., INC.
225 W. 34th St., New York 1, N. Y. (Tel. LAckawanna 4-5858)
Purch. Dept.: 12 S. 12th St., Philadelphia 7, Pa. (Tel. WAlnut 2-1212)
Dir.-Purch.: Fred Hooven
Dir.-Sales: F. W. Krupp M

GUDEMAN CO., THE
340 W. Huron St., Chicago 10, Ill. (Tel. DElaware 7-7400)
Purch. Agent: Robert Eggersted
V. P.-Sales: Thomas Klein
Sales Prom. Mgr.: Philip LaVecchio M

GUIDANCE CONTROLS CORP.
110 Duffy Ave., Hicksville, L. I., Nassau, N. Y. (Tel. WEIls 8-9500)
Purch. Agent: Charles Biasi
Exec. V. P.: Walter H. Niles MS, G, CT, TT, RD

GUIDED MISSILE DIV., THE FIRESTONE TIRE & RUBBER CO.
2525 Firestone Blvd., Los Angeles 54, Calif. (Tel. LUdlow 3-4411)
Purch. Agent, Coast Div.: J. D. Esterley
Mgr., Purch. Dept., Guided Missile Div.: N. H. Petersen
Gen. Mgr.: H. I. Gibson S, PS, MS, M, G, CT, TT, RD

GULF OIL CORP., DEPT. DM
P. O. Box 1166, Pittsburgh 30, Pa. (Tel. EXpress 1-2400)
Coordinator Dir. Sales: E. W. Campbell

GULTON INDUSTRIES, INC.
212 Durham Ave., Metuchen, N. J. (Tel. LIberty 8-2800)
Purch. Agent: Julius Furchheimer
Sales Coordinator: Edward Cohen MS, G, CT, TT, RD, HSE

W. & L. E. GURLEY
514 Fulton St., Troy, N. Y. (Tel. AShley 2-6300)
Purch. Agent: R. E. Kapps
V. P.-Sales: M. S. Dickson G, CT

GUSTIN-BACON MFG. CO.
210 W. 10th St., Kansas City 5, Mo. (Tel. HArrison 1-7788)
V. P. & Dir.-Purch.: M. Shields
Purch. Dept.: T. L. Fairfax, George Crowl, Ken Klann
V. P.-Sales: F. W. Muller

GWILLIAM CO., THE
370 Furman St., Brooklyn 1, N. Y. (Tel. MAin 4-2644)
Purch. Agent: Johannes E. Howay
Dir.-Sales: Mark R. M. Gwilliam S, PS, MS, M, G, CT, TT, RD, HSE

GYREX CORP., THE
3003 Pennsylvania Ave., Santa Monica, Calif. (Tel. EXbrook 3-0462)
Purch. Agent: W. J. Underwood, Jr.
Dir.-Sales: W. A. Barton MS, G, CT, TT, RD

H & H MFG. CO. INC.
Sycamore & Mill Rd., Clifton Heights, Pa. (Tel. MAdison 3-8900)
Purch. Agent: R. Schmid
Sales Mgr.: J. Farley PS

HPL MFG. CO.
15210 Miles Ave., Cleveland 28, Ohio (Tel. 216 WYoming 1-5000)
Purch. Agent: J. Yasenka
Sales Mgr.: M. Lorentz M

HRB-SINGER, INC., SUB.-SINGER MFG. CO.
Science Park, State College, Pa. (Tel. AD 7-7611).
Purch. Agent: James H. Smith
Dir.-Mktg.: L. D. Rexroat RD, HSE

HABERSTROH STUDIOS, INC.
9 W. 19th St., New York 11, N. Y. (Tel. AL 5-1827)
Dir.-Purch.: Alex Haberstroh

HACKENSACK CABLE CORP.
110 Orchard St., Hackensack, N. J. (Tel. HUbbard 7-1100)
Pres.: R. W. Alexander
V. P.-Sales: A. F. Brady, Jr.

B. H. HADLEY, INC.
1427 S. Garey Ave., Pomona, Calif. (Tel. NAtional 9-5075)
Purch. Agent: T. R. McCoun
Dir.-Mkt.: J. W. Salassi PS, MS, M, CT, RD

HAGAN CHEMICALS & CONTROLS, INC.
Hagan Ctr., Pittsburgh 30, Pa. (Tel. WA 2-3737)
Head-Purch.: C. E. Kaufman
Sales Mgr.: T. M. Nourse RD

HAGEN MFG. CO.
104 Walnut St., Baraboo, Wis. (Tel. 1195)
Purch. Agent: C. A. Boardman, 202 20th St., Moline, Ill. (Tel. Moline 2-5571)
Sales Mgr.: A. W. Rummery MS, M

HAHN & CLAY
5100 Clinton Dr., Houston 20, Tex. (Tel. ORchard 2-1671)
Mgr.-Purch.: Billie Sommers
V. P.-Purch.: Walter Clay
Gen. Mgr.-Fab. Steel: Lawrence F. Megow
V. P.-Sales: Gene Clay S, PS, MS, M, RD

HALEDY ELECTRONICS CO.
57 William St., New York 5, N. Y. (Tel. WHitehall 3-3140)
Dir.-Purch.: V. Spierer
Dir.-Sales: T. Careri

HALLAMORE ELECTRONICS CO., DIV.-SIEGLER CORP.
714 N. Brookhurst St., Anaheim, Calif. (Tel. PRospect 4-1010)
Dir.-Material: Fred Consiglio
Exec. Mgr., Customer Relations: Homer F. Starnes, Jr. MS, G, CT, TT, RD

HALLETT MFG. CO.
5910 Bowcroft St., Los Angeles 16, Calif. (Tel. UPton 0-7094)
Mgr.-Proc.: Robert D. Leeseman
V. P.-Sales: Stanley E. Estes MS, RD

HALLIBURTON, INC., MFG. DIV.
4724 S. Boyle Ave., Los Angeles 58, Calif. (Tel. LUdlow 8-3181)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch. Agent: E. V. Kampschmidt
Sales Mgr.: J. W. Murphy **MS, G, CT, TT, RD**

HALLICRAFTERS CO., THE
4401 W. Fifth Ave., Chicago 24, Ill. (Tel. VA 6-6300)
Dir.-Purch.: Cliff Matthews
Asst. Dir.-Purch.: Ed Corcoran
Dir.-Mktg.: William Peugh **G, TT, RD**

HALLIKAINEN INSTRUMENTS
1341 7th St., Berkeley 10, Calif. (Tel. LAndscape 4-1757)
Purch. Agent: W. C. Bagot
V. P. & Sales Mgr.: E. F. Schimbor

HALOCARBON PRODUCTS CORP.
82 Berlews Ct., Hackensack, N. J. (Tel. Diamond 3-8703)
V. P.-Purch.: Rex C. Conner
Sales Mgr.: William Cassanos

HALOGEN INSULATOR & SEAL CORP.
9960 Pacific Ave., Franklin Park, Ill. (Tel. GLadstone 5-9000)
Purch. Agent: Walter Lucas
Head-Sales: H. L. Asp

HALOID XEROX INC.
P. O. Box 1540, Rochester 3, N. Y. (Tel. GLenwood 3-9460)
Dir.-Purch.: F. W. Curtis, 175 Norman St., Rochester, N. Y. (Tel. GLenwood 3-9550)
V. P.-Sales: H. T. Hirst **M**

HAMILTON FOUNDRY INC.
1551 Lincoln Ave., Hamilton, Ohio **M**

HAMILTON KENT MFG. CO.
427 W. Grant St., Kent, O. (Tel. ORchard 3-9555)
Dir.-Purch.: D. E. Greene
Dir.-Sales: V. R. Mazer

HAMILTON STANDARD, DIV.-UNITED AIRCRAFT CORP.
Windsor Locks, Conn. (Tel. NAtional 3-1621)
Purch. Mgr.: John Spade
Sales Mgr.: John Burridge **MS, M, G, CT, RD**

HAMILTON WATCH CO.
Columbia Ave., Lancaster, Pa. (Tel. EXpress 4-7161)
Purch. Agent: Harold H. Quickel
Mgr., Proc. Dept.: William A. Dinges
Mgr., Contract Admin.: George F. Roberts
Dir.-Sales: Henry S. Tholen **RD**

HAMILTON WATCH CO.-INDUSTRIAL DIV.
Columbia Ave., Lancaster, Pa. (Tel. EXpress 4-7161)
Purch. Agent: H. H. Quickel
Sales Coordinator: G. W. Vatter **M, RD**

HAMILTON WATCH CO., MILITARY PRODUCTS DIV.
Lancaster, Pa. (Tel. EXpress 4-7161)
Purch. Agent: Harold H. Quickel
Mgr., Mil. Prod. Div.: Calvin F. Brown **CT, RD**

HAMLIN, INC.
Lake & Grove Sts., Lake Mills, Wis. (Tel. 208)
Dir.-Purch.: Ronald Ferguson **G**

HAMMARLUND MFG., CO., THE
460 W. 34th, New York 1, N. Y. (Tel. LOngacre 5-1300)
Head-Purch.: Wm. Griffin
Exec. V. P.: H. A. McCloskey **MS, CT**

HAMMEL-DAHL DIV.-GENERAL CONTROLS CO.
Warwick Industrial Park, Warwick, R. I. (Tel. STuart 1-6200)
Purch. & Prod. Coordinator: Forrest G. Brown
Div. Sales Mgr.: John E. Charsha, Jr.
Buyer: Eugene E. Collins **PS**

HAMMETT-MERCURY-REX DIV.
2311 Tauromee Ave., Kansas City 2, Kans. (Tel. ATwater 1-6501)
Dir.-Purch. & Sales: A. H. St. Clair **MS, M, CT, TT, RD**

HAMPDEN MFG. CO., INC.
Bridge St., Three Rivers, Mass. (Tel. ATlas 3-3451)
Pres.: Castle Day
Purch. Agent: T. H. Lasares

HANDICRAFT TOOLS, INC., DIV.-X-ACTO, INC.
48-41 Van Dam St., Long Island City 1, N. Y. (Tel. EXeter 2-3333)
Purch. Agent: Mrs. Agnes Tinkler **M**

HANDY & HARMAN
82 Fulton St., New York 38, N. Y. (Tel. BEekman 3-2460)
Dir.-Sales: Paul G. Feld **M**

HANLON & WILSON CO., THE
321 Penwood Ave., Pittsburgh 21, Pa. (Tel. CHurchill 2-8200)
Purch. Agent: H. Cleevely
Chief Engr.: S. J. Hannon
V. P. Sales: E. D. Gerhardt **PS, MS**

HANNIFIN CO., DIV.-PARKER-HANNIFIN CORP.
498-D S. Wolf Rd., Des Plaines, Ill. (Tel. VAnderbilt 7-1171)
Div. Secy.: M. R. Gault
Purch. Agent: Chester A. Miller
Buyer: W. W. Herrmann
Dir.-Sales: O. J. Maha

HANSEN ELECTRONICS CO.
Box 1302, Hollywood 28, Calif.
Pres.: H. R. Hansen
Gen. Mgr.: E. K. Stokes **M**

HANSEN MFG. CO. INC.
1004 S. Hart St., Princeton, Ind. (Tel. FUlton 5-3415)
Plant Supt.: J. E. Johnson
Pres.: Robert P. Hansen
Chief Engr.: H. G. Manson **G, TT, RD**

HANSON-VAN WINKLE-MUNNING CO.
Church St., Matawan, N. J. (Tel. LOwell 6-1000)
Asst. to Pres.: Edwin M. Close
V. P.-Sales: Robert M. Norton **M, RD**

HARBISON-WALKER REFRACTORIES CO.
307 Fifth Ave., Pittsburgh 22, Pa. (Tel. ATlantic 1-0942)
Mgr., Purch. & Engrg.: Richard P. Snyder
Gen. Sales Mgr.: R. S. Moore
V. P.-Sales: C. A. Brashares **M**

HARCO CONTAINERS DIV.-HARBOR BOAT BUILDING CO.
258 Cannery St., Terminal Island, Calif. (Tel. TErminal 2-5381)
Purch. Mgr.: Ray Rinderkneckt, Sr.
Sales Mgr.: A. W. Wall

HARCO LABS., INC.
77 Olive St., P. O. Box 1792, New Haven 7, Conn. (Tel. STate 7-6701)
Purch. Agent: J. E. Guetens
Asst. Sales Mgr.: A. A. Anderson **S, PS, MS, M, RD**

HAR-CONN CHROME CO.
603 New Park Ave., West Hartford 10, Conn. (Tel. AD 3-6225)
Gen. Mgr. & Purch. Agent: V. C. Hickey
Secy. & Sales Mgr.: T. J. O'Brien **S, PS, MS, G, RD**

PAUL HARDEMAN, INC.
10579 Dale St., Stanton, Calif. (Tel. TAylor 8-0230)
Purch. Dept. Mgr.: E. J. Lull
Admin. V. P.: H. J. Cail **RD, HSE**

DONALD C. HARDER CO.
2580 K St., San Diego 4, Calif. (Tel. BElmont 9-8021)
Dir.-Purch. & Sales: Donald C. Harder
Contract Admin.: L. L. La Zelle **M**

HARDINGE MFG. CO.
240 Arch St., York, Pa. (Tel. 33821)
Purch. Agent: R. E. Trout
Sales Dept.: J. R. Krout **M**

HARDMAN TOOL & ENGRG. CO.
1845 S. Bundy Dr., Los Angeles 25, Calif. (Tel. BRadshaw 2-0266)
Purch. Agents: W. T. Ferrand, Bryce Hampton, Ed Barr
V. P.-Sales: Stanley J. Hardman **MS, HSE**

HARDWICK, HINDLE, INC.
40 Hermon St., Newark 5, N. J. (Tel. MArket 2-8200)
Plant Mgr.: F. J. Phillips
Purch. Agent: H. Lehner
V. P.-Sales: Thomas B. Ure

HARMAN EQUIPMENT CO.
3605 E. Olympic Blvd., Los Angeles 23, Calif. (Tel. ANgeles 1-4113)
Purch. Agent: F. Van Zant
Sales Mgr., Filter Div.: G. J. Harman, Jr. **MS**

HARMON, LICHTENSTEIN & CO.
26 Broadway, New York 4, N. Y. (Tel. HAnover 2-8395)
Dir.-Sales: R. B. Harmon **M**

HARNISCHFEGER CORP., P & H DIESEL ENGINE DIV.
Main St., Crystal Lake, Ill. (Tel. CL 1700)
Purch. Mgr.: Gale Evenson
V. P.-Purch.: F. C. Edwards
Sales Mgr.: Fred Keller

H. M. HARPER CO.
8200 Lehigh Ave., Morton Grove, Ill. (Tel. OR 4-3000)
V. P.-Purch.: Theodore Wickman
V. P.-Sales: E. A. Channer
Purch. Agent: James Fairbairn **M**

HARPER-LEADER, INC.
1046 S. Main St., Waterbury 20, Conn. (Tel. PLaza 6-8164)
Pres.: P. J. Sloane
Secy.-Treas.: I. Cross

HARRELSON MFG. CO.
Calhoun City, Miss. (Tel. MAin 8-6417)
Purch. Agent: W. A. Young
Sales Mgr.: L. Ford Harrelson **S, MS, M,**

GEORGE E. HARRIS & CO., INC.
3241 E. Douglas, Wichita, Kans. (Tel. MUrray 2-2731)
V. P.-Purch.: V. L. Harris
Gen. Mgr.: T. O. Wallace **MS, M**

HARRIS REFRIGERATION CO.
308 River St., Cambridge 39, Mass. (Tel. UNiversity 4-4000)
Chief Engr.: Charles W. J. Harris
Sales Mgr.: Rolland S. Jamison

HARRISON LABS., INC.
45 Industrial Rd., Berkeley Hts., N. J. (Tel. CR 3-9123)
Purch. Agent: M. Barbour
Sales & Adv. Mgr.: A. M. Dorbie **MS, G, CT, TT, RD**

HART MFG. CO., THE
147 Bartholomew Ave., Hartford, Conn. (Tel. JAckson 5-3491)
Purch. Agent: R. W. James
Sales Mgr.: R. E. McIntosh

HARTFORD MACHINE SCREW CO., DIV.-STANDARD SCREW CO.
Box 1440, Hartford 2, Conn. (Tel. JAckson 5-0821)
Purch. Agent: D. T. Bacon
Asst. Purch. Agent: M. R. Derrick
Buyer: J. Braine
Gen. Sales Mgr.: J. F. Miller **S, PS, MS**

HARTMAN ELECTRICAL MFG. CO., THE
175 N. Diamond St., Mansfield, O. (Tel. LAfayette 4-1411)
Purch. Agent: W. M. Locke
Buyer: T. Roehm
Sales Mgr.: M. Trbovich

HARTWELL AVIATION SUPPLY CO.
9035 Venice Blvd., Los Angeles 34, Calif. (Tel. UPton 0-3781)
Purch. Agent: Grover Traphagen
Sales Mgr.: Al Pugh **MS**

HARVEY ALUMINUM
19200 S. Western Ave., Torrance, Calif. (Tel. SPruce 5-2181)
Dir.-Purch.: John Cherrie
Dir.-Sales: William De War **M, RD**

HASKEL ENGRG. & SUPPLY CO.
1236 S. Central Ave., Glendale 4, Calif. (Tel. CHapman 5-6811)
Mgr., Material: Carter Pierce (Tel. EDgemont 8-5573)
Exec. V. P.: Donald Driscol
Sales Mgr.: Ralph Moss **MS**

HASKELITE MFG. DIV., EVANS PRODUCTS CO.
701 Ann St., Grand Rapids 2, Mich. (Tel. GL 8-1331)
Dir.-Purch.: F. W. Mitchell
Asst. Dir.-Purch.: R. J. Williamsen
Sales Mgr.: D. G. Slawson, Jr. **M**

HASS INSTRUMENT CORP., THE
6173 Branch Ave., S. E., Washington 23, D. C. (Tel. Hickory 9-5454)
Pres.: Edward C. Hass
V. P.: Charles J. W. Hass
Shop Admin. Supt.: Theodore N. Stapel **MS**

JOHN HASSALL, INC.
Box 2179, Westbury, L. I., N. Y. (Tel. EDgewood 4-6200)
V. P.-Purch.: W. W. Smith
Sales Mgr.: E. F. Karnes **M**

HASTINGS PLASTICS, INC.
1551 12th St., Santa Monica, Calif. (Tel. EXbrook 3-7702)

Gen. Mgr.: Norry M. Hastings
Purch. Agent: Frank Lundstrom **S, PS, MS, M, RD**

HATHAWAY INSTRUMENTS, INC.
5800 E. Jewell Ave., Denver 22, Colo. (Tel. SKyline 6-8301)
Purch. Agent: Frank J. Knafelc
Asst. Purch. Agent: Alan T. Wilner
Asst. Sales Mgr.: James E. Carson **MS, G, CT**

HAVEG INDUSTRIES, INC.
900 Greenbank Rd., Wilmington 8, Del. (Tel. WYman 8-2271)
Purch. Agent: P. L. Reynier
Asst. Purch. Agent: C. Wall
Mkt. Mgr.: John B. Mackenzie

***HAWS DRINKING FAUCET CO.**
Fourth & Page Sts., Berkeley, Calif. (Tel. LAndscape 5-5801)
Gen. Mgr.: J. E. Traynor
Asst. Mgr.: T. R. Haws
*(See advertisement this issue)

A. W. HAYDON CO., THE
231-D N. Elm St., Waterbury, Conn. (Tel. PLaza 6-4481)
Purch. Agent: Roy E. Ahlberg
Buyers: Fred Lawton, D. Roberts, J. Thompson
Sales Mgr.: F. Hoffmann **M, G, CT, TT**

HAYDON SWITCH, INC.
536 S. Leonard St., Waterbury, Conn. (Tel. PLaza 6-7441)
Purch. Agent: John J. Leugminas
Sales Mgr.: Arthur N. Milliken **PS**

C. I. HAYES, INC.
800 Wellington Ave., Cranston 10, R. I. (Tel. HOpkins 1-3400)
Purch. Agent: Ray C. Arnold
Gen. Sales Mgr.: James R. Elliott **RD**

HAYNES STELLITE CO., DIV.-UNION CARBIDE CORP.
1020 W. Park Ave., Kokomo, Ind. (Tel. GLadstone 2-5421)
Purch. Agent: J. H. Wallsmith
Buyers: R. S. Rees, R. M. Tudor, H. M. Wolf, J. R. Clawson
V. P.-Sales: R. L. Lerch
Gen. Sales Mgr.: C. G. Chisholm **M**

HAYS CORP., THE
743 E. 8th St., Michigan City, Ind. (Tel. TRiangle 2-5561)
Purch. Agent: William Wagner
Mgr.-Sales: H. M. Twible
Asst. to Sales Mgr.: D. W. Meyer **CT, RD, HSE**

HAYS MFG. CO.
803 W. 12th St., Erie, Pa. (Tel. GLendale 2-3221)
Purch. Agent: P. N. Christensen
Sales Mgr.: H. H. Clemens

HAYWARD SCIENTIFIC GLASS CORP.
217 Magnolia Ave., Whittier, Calif. (Tel. OX 5-8213)
Secy.: Henry D. Shaw
V. P.-Sales: James L. Wood

HAZELTINE ELECTRONICS DIV.-HAZELTINE CORP.
59-25 Little Neck Pkwy., Little Neck 62, N. Y. (Tel. FAculty 1-2300)
Dir.-Proc.: B. H. Rogers
Asst. Dir.-Proc.: E. L. Roseberry
Dir.-Sales: S. M. Thomas **MS, G, TT, RD**

HEIL PROCESS EQUIPMENT CORP.
12901 Elmwood Ave., Cleveland 11, Ohio (Tel. CLearwater 2-4141)
Purch. Agent: George King
V. P.-Purch.: H. P. Heil
Mgr., Natl. Branch Sales: R. E. Scheel **S, M**

HEILAND DIV.-MINNEAPOLIS-HONEYWELL
5200 E. Evans Ave., Denver 22, Colo. (Tel. SKyline 6-3681)
Purch. Agent: R. V. Bertram
Asst. Purch. Agents: Warren Lindross & Robert Steele
Mgr.-Instrument Sales: Lloyd J. Moyer **MS, CT, TT, RD**

HEINEMANN ELECTRIC CO.
Pennsylvania Ave. & Plum St., Trenton 2, N. J. (Tel. EXport 4-1191)
Purch. Agent: James E. Shugars
Sales Mgr.: Edgar Bromberg **MS, CT**

HEIN-WERNER CORP.
1200 National Ave., Waukesha, Wisc. (Tel. LIberty 2-6611)
Purch. Agent: M. L. Lumb
Sales Mgr.: H. J. Scullin

HELDOR MFG. CO., INC.
238 Lewis St., Paterson, N. J. (Tel. ARmory 1-0900)
Purch. Agent: E. Jobes
Sales Mgr.: Ray Walker

HELICOID GAGE DIV., AMERICAN CHAIN & CABLE CO., INC.
929 Connecticut Ave., Bridgeport 2, Conn.

HELI-COIL CORP.
Shelter Rock Lane, Danbury, Conn. (Tel. Pioneer 3-7651)
Purch. Agent: Ted C. Gorman
Dir.-Sales: John E. Fasano

HELIO AIRCRAFT CORP.
Box 238, Norwood, Mass. (Tel. CA 6-0823)
Acting Purch. Agents: W. Conrad & R. Feeney
V. P.-Sales: R. Kimnach

HELIPOT DIV.-BECKMAN INSTRUMENTS, INC.
2500 Fullerton Rd., Fullerton, Calif. (Tel. OWen 7-1771)
Purch. Agent: Ed Schreiber
Mktg. Mgr.: Karl Heller **MS, G, CT**

HELWIG CARBON PRODUCTS, INC.
2550 N. 30th St., Milwaukee 10, Wisc. (Tel. HIlltop 2-7755)
Purch. Agent: C. E. Wendelburg
V. P.-Sales: J. E. Koenitzer

HEMINWAY & BARTLETT MFG. CO., THE
500 Fifth Ave., New York 36, N. Y. (Tel. LOngacre 4-0880)
Sales Mgr.: C. Duane Houk
Purch. Agent: Theodore Shove, Watertown, Conn. (Tel. CRestwood 4-2541)

HENDRICKSON MFG. CO.
8001 W. 47th St., Lyons, Ill. (Tel. HIckory 7-4600)
Purch. Agent: Miles Curda
Exec. V. P.-Sales: Edw. D. Hendrickson **MS**

HENLOPEN MFG. CO., INC.
178 Cook St., Brooklyn 6, N. Y. (Tel. GL 6-4461)
Purch. Agent: Allan Costa

HENRY & MILLER INDUSTRIES, INC.
675 Garfield Ave., Jersey 5, N. J. (Tel. HEnderson 4-4200)
Purch. Agent: Sol Ader
Sales Mgr.: Edmund B. Schnur **PS, G, RD**

HEPPENSTALL CO.
4620 Hatfield St., Pittsburgh 1, Pa. (Tel. MA 1-2000)
Purch. Agent: V. H. Lanahan

HERCULES POWDER CO., CHEMICAL PROPULSION DIV.
900 Market St., Wilmington 99, Del. (Tel. OLympia 8-7211)
Dir.-Purch.: Edwin S. Ladley
Dir.-Sales: Alexander F. Giacco
Dir.-Purch.: Robert Sawyer, Bacchus, Utah (Tel. MAgna 6321)
Dir.-Purch.: Thomas Brown, ABL, Pinto, W. Va. (Tel. REdwood 8-900) **PS, M, RD**

HERLO ENGRG. CORP.
549 N. Prairie Ave., Hawthorne, Calif. (Tel. OS 5-4435)
Pres. & Gen. Mgr.: R. E. Cole **PS, CT, RD**

HERMETIC SEAL CORP.
37 S. 6th St., Newark 7, N. J. (Tel. MArket 3-9400)
Purch. Agent: Ray Chapman
Sales Mgr.: Al Neumann **M**

HERMETIC SEAL CORP. & THERMAL CONTROLS, INC.
41-43 River Rd., North Arlington, N. J. (Tel. WY 8-8080)
Prod. Mgr.: Frank A. Restaino
Sales Exec.: Charles Ward **MS**

HERMETIC SEAL TRANSFORMER CO., DIV. DRESSER INDUSTRIES
555 N. 5th St., Garland, Texas (Tel. BR 6-5141)
Purch. Agent: R. Teer
Mktg. Mgr.: G. Guidi **MS**

HERTNER ELECTRIC CO., THE
12690 Elmwood Ave., Cleveland 11, O. (Tel. CLearwater 2-4242)
Purch. Agent: A.G. Lindrose
Buyer: R. E. Gariepy
Sales Mgr.: R. C. Neiswander **MS, G, CT, TT**

HESS, GOLDSMITH & CO., INC.
1400 Broadway, New York 18, N. Y. (Tel. WIsconsin 7-8900)
Exec. V. P.: R. F. Clark **M**

HEVI-DUTY ELECTRIC CO., DIV.-BASIC PRODUCTS CORP.
3002 W. Burleigh St., Milwaukee, Wis. (Tel. UPtown 1-9100)
Purch. Agent: G. J. Bethke
V. P.-Sales: A. W. Frank **RD**

HEWLETT-PACKARD CO.
275 Page Mill Rd., Palo Alto, Calif. (Tel. DAvenport 5-4451)
Purch. Mgr.: O. B. Sundberg
Purch. Agents: D. W. Anderson & Shell Trask
Sales Mgr.: Cort Van Rensselaer **CT, RD**

HEXACON ELECTRIC CO.
627 W. Clay Ave., Roselle Park, N. J. (Tel. CHestnut 5-6200)
Purch. Agent: L. J. Wenzel
Sales Mgr.: J. L. Grindrod

HEXCEL PRODUCTS INC.
2332 Fourth St., Berkeley 10, Calif. (Tel. THornwall 3-4664)
Purch. Agent: R. J. Wedemyer
Buyer: M. V. Hess
Gen. Sales Mgr., Engineered Prod.: A. C. Marshall **S, M**

HEYMAN MFG. CO.
Kenilworth, N. J. (Tel. CHestnut 5-2345)
Purch. Agent: K. E. Fohnestock
Sales Mgr.: J. L. Holder **M**

HICKOK ELECTRICAL INSTRUMENT CO., THE
10544 Du Pont Ave., Cleveland 8, Ohio (Tel. LI 1-8060)
Purch. Agent: Donald Cross
Buyers: James Donovan & James Sheil
Dir.-Mktg.: David Hughes **CT, TT**

HICKS CORP., THE
872 Riverside Dr., Asheville, N. C. (Tel. ALpine 3-5335)
Purch. Agents: John B. Sullivan & James Lipe
Exec. V. P.: Maurice Porter **PS, RD**

HI-G, INC.
Bradley Field, Windsor Locks, Conn. (Tel. NAtional 3-2481)
V. P.-Purch.: A. Mulava
Asst. Purch. Mgr.: S. Ptasznick
V. P.-Sales: R. H. Wood

HIGH SPEED HAMMER CO., INC., THE
313 Norton St., Rochester 21, N. Y. (Tel. COngress 6-6740)
Purch. Agent: G. W. Texter

HIGH VACUUM EQUIPMENT CORP., SUB.-ROBINSON TECHNICAL PRODUCTS, INC.
2 Churchill Rd., Hingham, Mass. (Tel. Riverview 9-2430)
Purch. Agent: Neil Reyngouat
Sales Admin.: William B. White **M**

HIGH VOLTAGE ENGRG. CORP.
S. Bedford St., Burlington, Mass. (Tel. BR 2-1313)
Purch. Agent: Richard Chase
V. P. & Sales Mgr.: E. Alfred Burrill **PS, RD**

HIGHLAND ENGRG. CO.
1736 Berkeley St., Santa Monica, Calif. (Tel. UP 0-2541)
Asst. Gen. Mgr.: B. E. Alvey
Mgr., Purch.: W. Van Benschoten
Sales Mgr.: William Stratton **MS, CT**

HIGHWAY TRAILER CO.
250 Park Ave., New York 17, N. Y. (Tel. YUkon 6-9570); Edgerton, Wis. (Tel. EDgerton 194)
Purch. Agent: J. W. Shellnut
V. P.-Sales: C. A. Venske

E. VERNON HILL & CO.
P. O. Box 189, Lake Geneva, Wisc. (Tel. CHestnut 8-3729)
Pres.: N. Peterson **M, CT**

HILL ELECTRONICS, INC.
300 N. Chestnut St., Mechanicsburg, Pa. (Tel. POplar 6-7611)

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Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
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Research & Development	RD
Human Space Engineering	HSE

Purch. Agent: Donald Gross
Sales Mgr.: James A. Nickerson **G, TT**

HILLBURN ELECTRONIC PRODS. CO.
55 Nassau Ave., Brooklyn 22, N. Y. (Tel. STagg 2-3875)
Purch.: B. S. Gilman
Sales: S. A. Shaw

HILLIARD CORP., THE
100 W. 4th St., Elmira, N. Y. (Tel. REgent 3-7121)
Purch. Agent: Carl Bauer
V. P.-Sales, Purifier Div.: T. A. Labrecque
V. P.-Sales, Clutch Div.: J. H. Fassett

HILLS-McCANNA CO.
4600 W. Touhy Ave., Chicago 40, Ill. (Tel. ORchard 4-7080)
Purch. Agent: R. Schmidt
V. P.-Sales: R. I. Allen **PS, MS, M, G, RD**

HI-LO MANUFACTURING CORP.
1122-26 W. Newport Ave., Chicago 13, Ill. (Tel. GRaceland 7-1890)
Pres.: F. J. Klancnik
Gen. Mgr.-Sales: E. A. Goncoe

HINDE & DAUCH DIV.-WEST VIRGINIA PULP & PAPER
407 Decatur St., Sandusky, Ohio (Tel. MA 5-6610)
Purch. Agent: Jay M. McGookey
Asst. Purch. Agent: Harold Sartorius
Regional Sales Mgrs.: Paul Roberts, Sandusky; Ralph Jaret, New York; Joseph Piemonte, Richmond, Va.; Calvin Race, Chicago **M**

HI Q DIV., AEROVOX CORP.
Myrtle Beach, S. C. (Tel. HI 8-3191)
Purch. Agent: D. L. Gilbert
Asst. Purch. Agent: John French
Sales Mgr.: James Krampf **M**

CARL HIRSCHMANN CO., INC.
30 Park Ave., Manhasset, L. I., N. Y. (Tel. MA 7-5300)
Purch. Agent: Fred Johnson
Purch. & Sales: M. H. Kaefer

HI-SHEAR RIVET TOOL CO.
2600 W. 247th St., Torrance, Calif. (Tel. SPruce 5-3181)
Purch. Agent: Stirling Souder **S**
V. P.-Sales: Guy Nash

HI-SPEC ELECTRONICS CORP.
7328 Ethel Ave., North Hollywood, Calif. (Tel. POplar 5-5075)
Pres.: John H. Mattson
Acting Purch. Agent: W. F. Ziegler (Tel. TRiangle 7-6519) **MS, G, CT, TT**

HI-SPEED EQUIPMENT, INC.
63 Pond St., Waltham, Mass. (Tel. TWinbrook 3-6800)
Dir.-Sales: H. J. Cedrone

HITCHINER MFG. CO. INC.
P. O. Box 320, Milford, N. H. (Tel. MIlford 635)
Purch. Agent: Ralph Bodwell
Plant Engr.: L. Guertin
Gen. Mgr.: David Hoadley
Sales Mgr.: Edwin G. Chapman **S**

HITEMP WIRES, INC.
1200 Shames Dr., Westbury, L. I., N. Y. (Tel. EDgewood 3-4600)
Purch. Agent: Patrick Hoade
Buyer: Robert Straus
V. P.-Sales: Christopher F. Wyer **MS, M**

HOBART BROTHERS CO.
Hobart Sq., Troy, Ohio (Tel. FEderal 2-1223)
Dir.-Purch.: B. A. Lutz
Sales Mgr.: E. C. Galbreath **PS, MS**

JOHN W. HOBBS CORP., DIV.-STEWART-WARNER CORP.
P. O. Box 358, Springfield, Ill. (Tel. 8-7533)
Purch. Agent: P. W. Redieske
Gen. Sales Mgr.: B. D. Booth

HOBBS MFG. CO.
26 Salisbury St., Worcester 5, Mass. (Tel. PLeasant 6-8361)
Purch. Agent: F. J. Woodberry
V. P. & Gen. Mgr.: Stewart F. Oakes
Gen. Sales Mgr.: H. K. Lambert **M, RD**

HOBSON BROTHERS, INC.
4940 W. Lawrence Ave., Chicago 30, Ill. (Tel. Avenue 3-3600)
Purch. Agent: H. L. Behm
Sales: Roy L. Hobson **M**

HOCKS LABS.
935 N. E. Couch St., Portland 14, Ore. (Tel. BE 4-1388)
Dir.-Purch.: Art Austin
Sales Mgr.: W. G. Hocks **CT**

HOEFNER CORP.
9720 Rush St., El Monte, Calif. (Tel. CUmberland 3-4138)
Purch. Agent: Arnold E. Tapie
V. P.-Sales: Grant W. Fredericks **PS, MS, G, RD**

P. R. HOFFMAN CO.
321 Cherry St., Carlisle, Pa. (Tel. CHapel 3-2011)
Purch. Agent: Ralph J. Laury
Chemist: Warren J. Hunt
V. P.-Sales: Leon W. McGinnes **G**

HOFFMAN ELECTRONICS CO.
1001 Arden Dr., El Monte, Calif. (Tel. CUmberland 3-7191)
Purch. Agent: Earl Schultz
Dir.-Sales: William De Sousa **G, TT**

HOFFMAN ELECTRONICS CORP., MILITARY PRODUCTS DIV.
3761 S. Hill St., Los Angeles 7, Calif. (Tel. RIchmond 7-4488)
Dir.-Materiel: R. A. Gingrich
Purch. Agent: Keith Douglas
Buying Supvr.: Burl Strong **MS, G, RD**

HOFFMAN ELECTRONICS CORP., SEMICONDUCTOR DIV.
Solar & Transistor Products; 1001 N. Arden Dr., El Monte, Calif. (Tel. CUmberland 3-7191)
Diode & Rectifier Products; 930 Pitner Ave., Evanston, Ill. (Tel. UNiversity 9-2400)
Dir.-Purch.: Mrs. Dorothy Perkins
V. P.-Mktg.: G. W. DeSousa **G, CT, TT**

HOFFMAN ENGRG. CORP.
9th & Tyler, Anoka, Minn. (Tel. HA 1-2240)
Supt.: Philip DeJarlais
Sales Mgr.: L. Bell **MS**

HOFMAN LABS., INC.
5 Evans Terminal, Hillside, N. J. (Tel. ELizabeth 4-4016)
Pres.: G. F. Sulfrian
Purch. Agent: Kay Krausse **MS, RD**

C. G. HOKANSON CO., INC.
2140 Pontius Ave., Los Angeles 25, Calif. (Tel. GRanite 7-4231)
Exec. V. P.: R. H. Hilmer
Purch. Agent: H. L. Cooper **MS, CT, RD**

HOKE INC.
#1 Tenakill Park, Cresskill, N. J. (Tel. LOwell 8-9100)
Dir.-Purch.: R. MacLallen
Sales Mgr.: R. J. Moody **S, MS**

A. F. HOLDEN CO., THE
14341 Schaefer Hwy., Detroit 27, Mich. (Tel. BRoadway 3-5405)
Purch. Dept.: L. P. Atkins
Pres.: A. F. Holden

***HOLEX, INC.**
2751 San Juan Rd., Hollister, Calif. (Tel. MErcury 7-5306)
V. P.-Operations: George H. Anderson
Dir.-Sales: J. W. Jones **PS, RD**
*(See advertisement this issue)

HOL-GAR MFG. CORP.
Clifton Heights, Pa. (Tel. MAdison 6-6300)
Dir.-Purch.: H. Kessler
Purch. Dept.: M. Mandzick
Dir.-Sales: K. H. Hartz **MS**

HOLLEY CARBURETOR CO.
11955 E. Nine Mile Rd., Warren, Mich. (Tel. JEfferson 6-1900)
Dir.-Purch.: Robert W. Carbary
Sr. Buyer: E. J. Masar
V. P. & Dir.-Sales: J. C. Holley **PS, RD**

R. M. HOLLINGSHEAD CORP.
840 Cooper St., Camden 2, N. J. (Tel. WOodlawn 4-7000)
Purch. Agent: Orville Timms
Mgr., Govt-Aviation Div.: Charles W. Griffiths **M, RD**

HOLLINGSWORTH CO., SOLDERLESS TERMINAL DIV.
Nutt & French Creek Rds., Phoenixville, Pa. (Tel. WEllington 3-8947)
Purch. Agent: John J. Gress
Sales Mgr.: J. C. Ludwick **M**

HOLOPHANE CO., INC.
342 Madison Ave., New York 17, N. Y. (Tel. MUrray Hill 2-5320)
Mgr., Customer Service: W. E. Horton
Sales Mgr.: Gene G. Rae **S**

HOLTZER-CABOT DIV., NATIONAL PNEUMATIC CO., INC.
125 Amory St., Boston 19, Mass. (Tel. JAmaica 4-7000)
Purch. Agent: S. Coven
Sales Mgr.: E. B. Selig **MS, M**

HOLUB INDUSTRIES, INC.
413 DeKalb Ave., Sycamore, Ill. (Tel. 2161)
Secy.-Treas.: A. R. Linden
V. P. & Sales Mgr.: Gordon W. Wetzel

HOLYOKE WIRE & CABLE CORP.
720 Main St., Holyoke, Mass. (Tel. JEfferson 3-3961)
Purch. Agent: Robert J. O'Connor
Mgr.-Sales: G. T. Miles

HOMALITE CORP., THE
11-13 Brookside Dr., Wilmington, Del. (Tel. OL 2-6641)
Pres.: W. R. Hoover
Shop Foreman: Lawrence Rose
Dir.-Sales: Thomas J. Christeson **M**

HOMELITE, DIV.-TEXTRON INC.
Riverdale Ave., Port Chester, N. Y. (Tel. WEstmore 9-3400)
Purch. Agent: John Clark
Sales Mgr.: R. P. Straetz **MS**

O. HOMMEL CO., THE
P. O. Box 475, Pittsburgh 30, Pa. (Tel. WA 1-1194)
Purch. Agent: W. E. Stairs
Pres.: E. M. Hommel **M**

HONEYCOMB CO. OF AMERICA, INC.
1225 Connecticut Ave., Bridgeport 7, Conn. (Tel. EDison 4-3155)
Purch. Agent: John Martin
V. P.-Sales: F. J. Quinlan **S, M**

LUDWIG HONOLD MFG. CO.
Chester Pike & Folcroft Ave., Folcroft, Pa. (Tel. LUdlow 3-6800)
Purch. Agent: Robert Stabb
Contract Adm.: Nicholas Melnjak
V. P.-Sales: William H. Kerchner

HONTI ENGRG. & MFG. CO.
1410 De Latorre Way, Los Angeles 23, Calif.
Purch. Agent: Walter Walker
Dir.-Sales: Joseph Honti

HOOSIER TARPAULIN & CANVAS GOODS CO., INC.
P. O. Box 574, Indianapolis 6, Ind. (Tel. MElrose 2-9451)
V. P.-Sales: Robert T. Goldberg **S, M**

HOOVER ELECTRIC CO.
2100 S. Stoner Ave., Los Angeles 25, Calif. (Tel. BRadshaw 2-3125)
Purch. Agent: L. Rinnie
Gen. Mgr.: Paul Cedwood **MS, G**

HOOVER ELECTRONICS CO.
110 W. Timonium Rd., Timonium, Md. (Tel. CLearbrook 2-4000)
Purch. Agent: Charles Sigler, Sr.
V. P. & Gen. Mgr.: A. J. W. Novak **MS, G, CT, TT**

HOPKINS ENGRG. CO.
12900 Foothill Blvd., San Fernando, Calif. (Tel. EMpire 1-8691)
Exec. V. P.-Purch.: Langdon Parrill
V. P.-Purch.: Roland Duquette
Pres.: Charles Wieland
Sales Mgr.: John Schlenker

HORIZONS INC.
2905 E. 79th St., Cleveland 4, Ohio (Tel. BRoadway 1-1600)
Dir.-Sales: John Cameron

***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
24660 S. Crenshaw Blvd., Torrance, Calif. (Tel. SP 5-1211)
Chief, Purch. Dept.: L. Henrikson
Purch. Agent: B. Brazel
V. P.-Develop. Planning: R. C. Chilton **S, MS, CT, RD**
*(See advertisement this issue)

WILLIAM I. HORLICK CO., INC.
266 Summer St., Boston 10, Mass. (Tel. HAncock 6-2480)

V. P.-Purch.: Paul H. Horlick
Gen. Mgr.: Robert C. Horlick M

HORSEY, ROBSON & CO. INC.
551 5th Ave., New York 17, N. Y. (Tel. MU 7-1332)
Pres.: D. H. Horsey
Gen. Mgr.: R. K. Robson S, M

HOSKINS MFG. CO.
4445 Lawton Ave., Detroit 8, Mich. (Tel. TYler 5-2860)
Purch. Agent: R. J. Stefanac
V. P.-Mktg.: R. I. Cratch M

HOUDAILLE INDUSTRIES, INC., BUFFALO HYDRAULICS DIV.
537 E. Delavan Ave., Buffalo, N. Y. (Tel. FIllmore 8000)
Purch. Agent: V. E. Lasker
Buyer: W. E. Thompson
Gen. Mgr. & Dir.-Sales: E. L. Spencer

E. F. HOUGHTON & CO.
303 W. Lehigh Ave., Philadelphia 33, Pa. (Tel. RE 9-7100)
Dir.-Purch.: H. B. Fox
Purch. Agent: C. F. Kalmbach
V. P.-Sales: Frank Ross M

HOUSTON FEARLESS CORP.
11801 W. Olympic Blvd., Los Angeles 64, Calif. (Tel. BRadshaw 2-4331)
Dir.-Prod. & Material: William Katona
Purch. Agent: F. J. Garcia
Sales Mgr.: A. J. Kjontvedt MS, RD

HOUSTON INSTRUMENT CORP.
P. O. Box 22234, Houston 27, Texas (Tel. MOhawk 7-7405)
Purch. Agent & Sales Mgr.: George H. More
Pres.: E. V. Hardway, Jr.
V. P. & Chief Engr.: E. E. Crump CT

HOWE SCALE CO., THE
Rutland, Vt. (Tel. PR 5-5541)
Gen. Purch. Agent: R. L. Hendee
Gen. Sales Mgr.: F. E. Pringle, Jr.

HOYT ELECTRICAL INSTRUMENT WORKS, INC., BURTON ROGERS CO.
42 Carleton St., Cambridge 42, Mass. (Tel. ELliot 4-1643)
Mgr.-Purch.: D. A. Hoyt, Penacook, N. H. (Tel. PLaza 3-6321) M, RD

HUBBARD-ANTISDEL, INC.
155 E. Silver Spring Dr., Milwaukee 17, Wis. (Tel. ED 2-7620)
Pres.: A. W. Hubbard
V. P.-Purch.: R. L. Antisdel
Sales Rep.: Art Beck

HUCK MFG. CO.
2480 Bellevue Ave., Detroit 7, Mich. (Tel. WAlnut 3-4500)
Purch. Agent: Leland W. Fox
V. P.-Sales: George Q. Mathews

HUDSON TOOL & DIE CO., INC.
18 Malvern St., Newark 5, N. J. (Tel. MA 4-1802)
Purch. Agent: William Herbert
Sales Mgr.: Ernest Isler M

HUDSON WIRE CO.
62 Water St., Ossining, N. Y. (Tel. WIlson 1-8500)
Plant Mgr.: J. T. Simmons
Gen. Sales Mgr.: W. H. Elliott
Plant Mgr.: H. V. Kovacs, Winsted, Conn. (Tel. FRontier 9-3341)
Plant Mgr.: K. McNagney, Cassopolis, Mich. (Tel. HIckory 5-2424) M

HUFFORD CORP., THE
1700 E. Grand Ave., El Segundo, Calif. (Tel. ORegon 8-6221)
Purch. Agent: A. H. Knight
Buyers: Frank Frazee & Maurice Hagberg

HUGGINS LABS., INC.
999 E. Arques Ave., Sunnyvale, Calif. (Tel. RE 6-9330)
Purch. Agent: H. O. Harting
Sales Mgr.: V. D. Varenhorst RD

HUGHES AIRCRAFT CO.
Culver City, Calif. (Tel. TExas 0-7111)
Missile Mfg. Div.: P. O. Box 5555, Tucson, Ariz. (Tel. MAin 4-2711)

HUGHES ELECTRONICS CO.
5343 Crenshaw Blvd., Los Angeles 43, Calif. (Tel. AX 4-2422)
Dir.-Purch.: Nancy David
Pres.: E. E. Hughes MS, RD

HUGHES PRODUCTS GROUP, HUGHES AIRCRAFT CO., SEMICONDUCTOR DIV.
International Airport Sta., Los Angeles 45, Calif. (Tel. ORchard 2-5011)
Sales Mgr.: H. K. Mann

HUGHES SEMICONDUCTOR DIV., HUGHES AIRCRAFT CO.
500 Superior Ave., Newport Beach, Calif. (Tel. LI 8-0671)
Purch. Agent: Ralph Hoover
Sales Mgr.: W. H. Gray

HUGHES TOOL CO., AIRCRAFT DIV.
Florence & Teale Sts., Culver City, Calif. (Tel. UPton 0-7111); 260 W. Beach Ave., Inglewood 3, Calif. (Tel. ORegon 8-7181)
Dir.-Purch.: Milton E. Taylor
Asst. Dir.-Purch.: H. W. Dominisse
Sr. Buyer, Prod.: J. L. Titmus
Sr. Buyer, Non-Prod.: R. L. Jones
Dir.-Customer Relations & Contracts: A. W. Bayer (Tel. UPton 0-7111) S, PS, MS, M, CT, RD

HUGHEY & PHILLIPS, INC.
3200 N. San Fernando Blvd., Burbank, Calif. (Tel. VIctoria 9-1104)
Purch. Agent: Larry K. Craddock
V. P. & Gen. Mgr.: J. H. Ganzenhuber M

HUMAN SCIENCES RESEARCH, INC.
1408 N. Fillmore St., The Clarendon Bldg., Arlington 1, Va. (Tel. JAckson 4-3606)
Pres.: Dr. M. Dean Havron
Bus. Adminstr.: Mrs. Charlotte L. Brewer HSE

HUMIDIAL CO.
465 Mt. Vernon Ave., Colton, Calif. (Tel. TAlbot 5-1793)
Pres.: W. C. Blinn
V. P.: B. G. Blinn M

HUMMEL CHEMICAL CO., INC.
90 West St., New York 6, N. Y. (Tel. BArclay 7-6630)
Dir.-Purch.: Jos. B. Wiley, Jr.
Sales Mgr.: James M. Vreeland RD

HUMPHREY, INC., ELECTRO MECHANICAL INSTRUMENTS
2808 Canon St., San Diego 6, Calif. (Tel. ACademy 3-1654)
Purch. Agent: D. C. DeVries
V. P.: R. J. Rutherford
Contracts Admin.: R. E. Troxel
Pres.: P. E. Humphrey G, TT, RD

PHILIP A HUNT CO.
Roosevelt Pl., Palisades Park, N. J. (Tel. WIndsor 4-4000)
Purch. Agent: T. L. Collins
Gen. Sales Mgr.: John R. Bonniwell M

HUNT CORP., THE
453 Lincoln St., Carlisle, Pa. (Tel. CHapel 9-2232)
Gen. Mgr.: Samuel Ryesky
Sales Mgr.: Ronald Kearns G, TT

HUNTER MFG. CO.
30525 Aurora Rd., Cleveland 39, (Solon), Ohio (Tel. CHurchill 8-6111)
Purch. Agent: J. C. Wolfe
Sales Mgr.: Warren A. Miller MS, RD

HUNTER SPRING CO., DIV.-AMERICAN MACHINE & METALS, INC.
One Spring Ave., Lansdale, Pa. (Tel. Ulysses 5-6815)
Purch. Agent: Horace Machado
Sales Mgr.: G. D. Bennett M, CT

HUNTER TOOL CO.
9851 Alburtis Ave., Santa Fe Springs, Calif. (Tel. OX 2-7231)
Purch. Agent: D. D. Melstrom
V. P.-Sales: R. N. Hunter, Jr. RD

HUNTER-DOUGLAS ALUMINUM CORP.
3017 Kansas Ave., Riverside, Calif.

HUNTINGTON ALLOY PRODUCTS DIV., THE INTERNATIONAL NICKEL CO., INC.
67 Wall St., New York 5, N. Y. (Tel. WHitehall 4-1000)
V. P.-Sales: J. A. Marsh M

HUNTINGTON RUBBER MILLS
7100 S. W. Macadam Ave., Portland, Ore. (Tel. CHerry 4-7535)
Chief Purch. Agent: Mrs. Agnes Imel
Dir.-Sales: J. S. DuVal

HUPP AVIATION DIV., HUPP CORP.
6633 W. 65th St., Chicago 38, Ill. (Tel. PO 7-2100)
Purch. Agent: James Bovis
Buyers: Charles Rydbert & Robert Zvitkovits
Sales Mgr.: Kenneth M. Spurgeon S, PS, MS

HUPPERT, K. H., CO.
6830-40 Cottage Grove Ave., Chicago 37, Ill. (Tel. Midway 3-4770)
Pres.: K. H. Huppert
V. P.: R. A. Hastings
Sales Mgr.: M. J. Patterson
Plant Mgr.: James Matias

C. G. HUSSEY & CO., DIV.-COPPER RANGE CO.
2850 Second Ave., Pittsburgh 19, Pa. (Tel. GRant 1-3650)
V. P.-Purch.: R. W. Myers
Asst. Purch. Agent: J. F. Pierce
V. P.-Sales: J. G. McNeely M

HUTCHENS & SON METAL PRODUCTS, INC.
1355 S. S. S., Springfield, Mo. (Tel. UN 2-5012)
Purch. Agent: B. G. King
V. P.-Sales: Lewis G. Hutchens

HUYCK SYSTEMS CO.
360 Wolf Hill Rd., Huntington Station, N. Y. (Tel. HAmilton 7-7500)
Purch. Agent: Al Fritz
Subcontract Buyer: Jim Radin
Buyer: Edw. Stockus
Mktg. Mgr.: Louis C. Prisco MS, G, CT, TT, RD, HSE

WALTER J. HYATT CO., THE
P. O. Box 943, Beverly Hills, Calif. (Tel. BRadshaw 2-2844)
Sales: Walter J. Hyatt MS, RD

HYATT BEARINGS DIV., GENERAL MOTORS CORP.
Harrison, N. J. (Tel. HUmboldt 4-4000)
Purch. Agent: L. V. Forrel
Sales Mgr.: J. R. Gilmartin

HYCON EASTERN INC.
75 Cambridge Pkwy., Cambridge 42, Mass. (Tel. UNiversity 4-7200)
Purch. Agent: W. Senior
V. P.-Operations-Sales: J. R. Martin

HYCON MFG. CO.
1030 S. Arroyo Pkwy., Pasadena, Calif. (Tel. SYcamore 9-4171)
Mgr.-Proc.: Al Curry
Mgr.-Customer Rel.: M. J. Leonard
Buyers: F. Sizinski, Chuck Schultz & Harold Held

HYDRA-POWER CORP.
10 Pine Court, New Rochelle, N. Y. (Tel. NE 2-2200)
Purch. Agent: J. Tranos
V. P.-Sales: E. D. Holland S, MS, G, CT, RD

HYDRAULIC PRESS MFG. CO., THE, DIV.-KOEHRING CO.
Marion Rd., Mt. Gilead, O. (Tel. 9351)
Dir.-Purch.: Carl A. Fisher
V. P.-Sales: E. L. Oehling

HYDRAULIC RESEARCH & MFG. CO.
2835 N. Naomi St., Burbank, Calif. (Tel. VIctoria 9-6111)
Purch. Agent: F. T. Arthur
Sales Mgr.: H. H. Koppenhafer MS

HYDRAULICS, INC.
1831 S. Boulevard, Parsons, Kans. (Tel. 674)
Purch. Agent: H. P. Boner
V. P. & Gen. Mgr.: N. W. Brandeberry M

HYDRO MOLDING CO. INC.
100 Sharron Ave., Plattsburgh, N. Y. (Tel. 2598)
V. P.-Purch.: M. A. Rabin S

HYDRO-AIRE CO., DIV.-CRANE CO.
3000 Winona Ave., Burbank, Calif. (Tel. VIctoria 9-1331)
Purch. Agent: C. E. Lenox
V. P.-Sales: Frank Cooper

***HYDRODYNE CORP.**
7350 Coldwater Canyon Ave., North Hollywood, Calif. (Tel. POplar 5-8001)
Purch. Agent: Dick Zabnter
Dir.-Mktg.: G. L. Murphy PS, MS, RD
*(See advertisement this issue)

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Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

HYDROMATICS, INC.
70 Okner Blvd., Livingston, N. J. (Tel. WYman 2-4900)
Pres.: Bernard Moss
V. P.: Hannison Britton
Asst. Sales Mgr.: Austin Platt
Purch Agent: Don Moran, Naylon Ave., Livingston, N. J. (Tel. WYman 2-0556) **PS, MS, CT, RD**

HY-PRO TOOL CO.
461 Mt. Pleasant St., New Bedford, Mass. (Tel. WYman 6-5656)
Dir.-Purch.: Philip J. Morgan
Purch. Agent: Edward Pettengill
V.P. & Sales Mgr.: Robert A. Smith **M**

HYSTER CO.
2902 N. E. Clackamas St., Portland 8, Ore. (Tel. ATlantic 8-5011)
Purch. Agent: Paul Rhodes
Gen. Sales Mgr.: Robert F. Moody **MS**

IERC DIV., INTERNATIONAL ELECTRONIC RESEARCH CORP.
145 W. Magnolia Blvd., Burbank, Calif. (Tel. Victoria 9-2481)
Purch. Agent: Philip T. Solomon
V. P.: John E. Markley, Jr.
Admin., Tech. Sales: Walter R. England

ILG ELECTRIC VENTILATING CO.
2850 N. Pulaski Rd., Chicago 41, Ill. (Tel. KIldare 5-1520)
V. P. I/C Purch.: S. E. Heyerick
Exec. V. P.: J. J. Friedler, Jr.

I-L-S INSTRUMENT DIV., THE MERIAM INSTRUMENT CO.
4525 W. 160th St., Cleveland 35, Ohio (Tel. CLearwater 2-3850)
Purch. Agent: M. E. Saltsgaver
Sales Mgr.: P. W. McRaven **CT**

IMC MAGNETICS CORP.
570 Main St., Westbury, L. I., N. Y. (Tel. EDgewood 4-7070)
Purch. Agent: M. Cuffori
V. P.-Sales: G. Egan

I-T-E CIRCUIT BREAKER CO., SPECIAL PRODUCTS DIV.
601 E. Erie Ave., Philadelphia 34, Pa. (Tel. GArfield 6-5700)
Purch. Agent: W. Manning
Sales Mgr.: R. K. Johnson **S, PS**

ITI ELECTRONICS, INC.
369 Lexington Ave., Clifton, N. J. (Tel. GRegory 3-0900)
Purch. Agent: Joseph Weinberg
Sales Mgr.: R. J. Harrington **CT, TT**

ITT COMPONENTS DIV., INTERNATIONAL TELEPHONE & TELEGRAPH CORP.
100 Kingsland Rd., Clifton, N. J. (Tel. NOrth 7-3600)
Sr. Buyer: R. A. Thomson
Buyer: M. Donovan
Sales Mgr.: R. W. Deutsch **MS**

ITT FEDERAL DIV., INTERNATIONAL TELEPHONE & TELEGRAPH CORP.
100 Kingsland Rd., Clifton, N. J. (Tel. NOrth 7-3600)
Purch. Mgr.: H. E. Giese
Mgrs., Materials: A. A. Kinsey & J. E. Loveless
V. P.-Sales: T. M. Douglas **MS, G, CT, TT**

ITT LABS.
500 Washington Ave., Nutley, N. J. (Tel. NOrth 1-1100)

ITT LABS.
3700 Pontiac St., Fort Wayne, Ind. (Tel. EAstbrook 7571)
Mgr.-Purch.: Walter Pitts
Purch. Agent: Monroe W. Brosius **MS, G, CT, TT, RD**

ICONIX INC.
945 Industrial Ave., Palo Alto, Calif. (Tel. DAvenport 3-1411)
Pres.: Dr. N. L. Pappas **CT, RD**

IDEAL-AEROSMITH, INC., DIV.-ROYAL INDUSTRIES, INC.
3913 Evans Ave., Cheyenne, Wyo. (Tel. 7-7715)
Purch. Agent: F. E. Wheelhouse
Exec. V. P.-Sales: William Lush **MS, G, CT, RD**

IDEAL INDUSTRIES, INC.
1427 Park Ave., Sycamore, Ill. (Tel. 2114)
Purch. Agent: Robert D. Voss
Gen. Sales Mgr.: Gordon B. Koch

IDEAL PRECISION METER CO., INC.
214-218 Franklin St., Brooklyn 22, N. Y. (Tel. EVergreen 3-6904)
V. P.: Charles Bernstein
Pres.: Harry Leiderman **M, RD**

ILLINOIS TESTING LABORATORIES, INC.
420 N. LaSalle St., Chicago 10, Ill. (Tel. WHitehall 3-1331)
Purch. Agent: J. M. Lajka
V. P.-Sales: M. J. Rauscher **MS**

ILLINOIS ZINC CO., DIV.-HYDROMETALS, INC.
2959 W. 47th St., Chicago 32, Ill. (Tel. LAfayette 3-1600)
V. P.-Purch.: L. F. Johnson
Chief Engr.: A. S. Wallin
V. P.-Sales: W. F. Synnott

ILLUMITRONIC ENGRG. CO.
680 E. Taylor, Sunnyvale, Calif. (Tel. REgent 9-2395)
Purch.: Wm. W. Smith
Sales Mgr.: Joe D. Giulie **M**

IMAGE INSTRUMENTS, INC.
2300 Washington St., Newton Lower Falls 62, Mass. (Tel. BI 4-2256)
V. P.-Operations: W. W. Bemis
Dir.-Sales: Lester C. Smith **CT**

IMPACT-O-GRAPH CORP., THE
1900 Euclid Ave., Cleveland, Ohio (Tel. CHerry 1-5838)
Pres.: W. S. Mielziner **MS, CT, RD**

IMPERIAL BRASS MFG. CO., THE
6300 W. Howard St., Chicago 31, Ill. (Tel. SPring 4-1700)
Purch. Agent: W. B. Burnet
V. P. & Dir.-Mktg.: G. J. Duerr **M**

IMPERIAL OIL & GREASE CO., INC.
6505 Wilshire Blvd., Los Angeles 48, Calif. (Tel. OLive 3-2250)
Secy.-Treas.: A. C. Parkinson **M**

IMTRA CORP.
11 University Rd., Cambridge 38, Mass. (Tel. UN 4-4350)
Pres.-Sales: William H. Farnham **M**

INDIANA GEAR WORKS, INC.
1458 E. 19th St., Indianapolis 7, Ind. (Tel. MElrose 8-2331)
Proc. Mgr.: Paul M. Dirks
Mktg. Mgr.: G. R. Shields **PS, MS, CT**

INDIANA STEEL PRODUCTS, DIV.-INDIANA GENERAL CORP.
405 Elm St., Valparaiso, Ind. (Tel. HOward 2-3131)
Purch. Agent: W. F. Eckert
V. P.-Sales: P. M. Wheeler **M**

INDIANA STEEL & WIRE CO., INC.
2200 E. Jackson St., Muncie, Ind. (Tel. AT 8-3601)
Purch. Agent: S. W. Holmes
Mgr.-Sales: James L. Galbraith **M**

INDIUM CORP. OF AMERICA, THE
1676 Lincoln Ave., Utica, N. Y. (Tel. SWift 7-1630)
V. P.-Purch. & Sales: J. R. Dyer, Jr. **M**

INDUCTION HEATING CORP.
181 Wythe Ave., Brooklyn 11, N. Y. (Tel. EVergreen 4-3110)
Dir.-Purch.: Arthur J. Slobin
Sales: Thomas J. Stanton **RD**

INDUSTRIAL ACOUSTICS CO., INC.
341 Jackson Ave., New York, N. Y. (Tel. CYpress 2-0180)
Purch. Agent: Les Braverman
V. P.-Sales: A. C. Hawthorne **PS, CT, RD**

INDUSTRIAL CONTROL CO.
Central Ave. at Pinelawn, Farmingdale, L. I., N. Y. (Tel. MYrtle 4-3000)
Dir.-Purch.: F. Seymour
Chief Engr.: G. M. Attura
Dir.-Sales: E. Vigliotti **MS, G, CT, TT, RD**

INDUSTRIAL DEVICES, INC.
Edgewater, N. J. (Tel. WHitney 3-4084)
Purch. Agent: G. E. Mesnick
Sales Mgr.: N. J. Seiden **M**

INDUSTRIAL ELECTRONIC ENGINEERS, INC.
5528 Vineland Ave., North Hollywood, Calif. (Tel. TRiangle 7-1144)
Purch. Agent: Paul F. Kelly
Gen. Mgr.: John Hendricks
Sales Mgr.: John J. Bylo **CT, RD**

INDUSTRIAL ENGRG. CORP.
525 East Woodbine, Louisville 8, Ky. (Tel. MElrose 4-3601)
Project Engr.: Floyd B. Simpson
V. P.-Purch.: Clyde Walker
Coordinator: Tom Hutson **CT**

INDUSTRIAL ENGRAVERS INC.
2212 McDonald Ave., Brooklyn 23, N. Y. (Tel. HIckory 9-3200)
Pres.: J. Zatzkin **G, TT**

INDUSTRIAL EQUIPMENT DIV., BALDWIN LIMA HAMILTON CORP.
Philadelphia 42, Pa. (Tel. SAratoga 6-9300)
Dir.-Purch.: J. G. Swanberg
Gen. Sales Mgr.: G. H. Lynn **S, MS, RD**

INDUSTRIAL FILTER & PUMP MFG. CO.
5900 Ogden Ave., Cicero 50, Ill. (Tel. OL 2-8700)
Purch. Agent: Charles Prusaitis
Gen. Sales Mgr.: James F. Zieveks **CT**

INDUSTRIAL INSTRUMENTS INC.
89 Commerce Rd., Cedar Grove, N. J. (Tel. CEnter 9-6200)
Purch. Agent: P. Frazza
Sales Mgr., Elec. Test: R. Mac Auley
Sales Mgr., Electro Chemical: J. Williamson **MS, CT**

INDUSTRIAL METAL PROTECTIVES, INC.
401 Homestead Ave., Dayton 8, Ohio (Tel. BAldwin 2-6747)
Dir.-Purch.: Mrs. Nancy Sheets
V. P.-Engrg.: J. R. Fisher, Jr.
Dir.-Sales: J. E. Berman **S, MS, M**

INDUSTRIAL MICA CORP.
223 S. Van Brunt St., Englewood, N. J. (Tel. LOwell 8-7200)
Gen. Mgr.: Norman J. Bottie
Sales Mgr.: Arthur A. Bottie

INDSL. PROD.-DANBURY KNUDSEN DIV.-AMPHENOL-BORG ELECTRONICS CORP.
Danbury, Conn. (Tel. Pioneer 3-9271)
Mgr.-Prod. Control: Albert A. Marvin
Buyers: Walter Loesch, Theodore Davis
Sales Mgr.: Norman Cresci

INDUSTRIAL RETAINING RING CO.
57 Cordier St., Irvington, N. J. (Tel. WAverly 6-5000)
Purch. Agent: V. A. Stabile

INDUSTRIAL SYSTEMS CO.
32 Main St., Matawan, N. J. (Tel. LO 6-4660)
Purch. Agent: J. B. Freiman
Dir.-Sales: H. M. Sadwith

INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th St., New York, N. Y. (Tel. GR 3-4684)
Purch. Agent: Walter Meyer
Sales Mgr.: Melvin Schreibman **MS, RD**

INDUSTRIAL TIMER CORP.
1407 McCarter Hwy., Newark, N. J. (Tel. HUmbolt 4-5600)
Purch. Agent: J. M. Ravelle
Sales Mgr.: Kenneth Kraemer **M**

INDUSTRIAL TOOLS MFG. CORP., SUB.-PENDLETON TOOL INDUSTRIES, INC.
8150 Marbrisa Ave., Huntington Pk., Calif. (Tel. LUdlow 3-4301)
Purch. Agent: H. O. Gross (Tel. LUdlow 3-5655)
Sales Engr.: G. M. Fishering (Tel. LUdlow 3-5655)
Sales Mgr.: H. D. Norton **MS**

INDUSTRIAL TRANSFORMER CORP.
Gouldsboro, Pa. (Tel. VI 2-2111); 1001 N. W. 163rd Dr., Miami 69, Fla.
Purch. Agent: J. B. Smith
Sales Mgr.: S. Lundy

INDUSTRO TRANSISTOR CORP.
35-10 36th Ave., Long Island City 6, N. Y. (Tel. EXeter 2-8000)
Exec. V.P.-Prod. & Mfg.: Archie McDougall
Purch. Agent: Vincent Rossano
Gen. Mgr.: Ira R. Becker **G, CT, RD**

INDUSTRON CORP.
55 Needham St., Newton 61, Mass. (Tel. DE 2-1477)
Purch. Agent: Frank Lanchantin
Dir.-Sales: Harold Gerber **S, MS, RD**

INERTIA SWITCH, INC.
311 West 43rd St., New York 36, N. Y. (Tel. JUdson 6-5880)
Purch. Agent: A. Khederian
Sales Mgr.: J. Grill

INFERNO MFG. CORP.
Box 7067, 115 Ricou, Shreveport, La. (Tel. 2-7498)
V.P.-Purch. & Sales: T. R. Webb

INFRARED INDUSTRIES, INC.
62 Fourth Ave., Waltham 54, Mass. (Tel. TWinbrook 3-5400)
Gen. Sales Mgr.: E. D. Reddan
Purch. Agent: George Howard — MS, G, CT, RD

INGERSOLL KALAMAZOO DIV., BORG-WARNER CORP.
1810 N. Pitcher St., Kalamazoo, Mich. (Tel. FIreside 5-3501)
Dir.-Proc.: Harry E. Morse, 760 E. Vine St., Kalamazoo, Mich. (Tel. FIreside 2-0136)
Purch. Agent: E. M. Anderson, 760 E. Vine St.
Buyers: O. S. McQueen, E. J. Ries & L. D. Payne, 760 E. Vine St.
V. P. & Dir.-Defense Sales: A. S. Mrozek

INGRAHAM CO., THE
392 North Main St., Bristol, Conn. (Tel. LUdlow 2-6321)
Purch. Agent: B. I. Downs
V.P.-Sales: Allen W. Rork

INSCO CO., DIV.-BARRY CONTROLS INC.
Hollis St., Groton, Mass. (Tel. GIlbert 8-6358)
Gen. Mgr.: David L. Ammen — CT, TT, RD

INSO ELECTRONIC PRODUCTS, INC.
1200 Commerce Ave., Union, N. J. (Tel. MUrdock 6-4258) — M

INSTRON ENGRG. CORP.
2500 Washington St., Canton, Mass. (Tel. CAnton 6-2500)
Purch. Agent: Torey Montesi
Buyer: Leo Quintiliani
Sales Mgr.: E. J. Tolle — M, RD

INSTRULAB, INC.
1205 Lamar St., Dayton 4, Ohio (Tel. BA 3-2241)
V.P.: Stanley I. Tekamp — CT

INSTRU-LEC CORP.
520 Homestead Ave., Mt. Vernon, N. Y. (Tel. MOunt Vernon 8-3754)
Pres.: Russell Hobert — MS, G

INSTRUMENT CORP. OF FLA.
P. O. Box 1226, Melbourne, Fla. (Tel. PArkway 3-8112)
Buyer: E. M. Raley
Contract Adm.: Robert Walker

INSTRUMENT DEVELOPMENT LABS., INC.
67 Mechanic St., Attleboro, Mass. (Tel. ATtleboro 1-3880)
Purch. Agent: William Pendergast
Buyer: Robert Comstock
Gen. Sales Mgr.: George P. Bentley — G, TT, RD

INSTRUMENT DIV., THE W. L. MAXSON CORP.
475 Tenth Ave., New York 18, N. Y. (Tel. LOngacre 5-1900)
Purch. Agent: J. N. Tsagaris
Div. Mgr.: J. R. Coleman — G

INSTRUMENT ELECTRONICS CORP.
P. O. Box 830, Port Washington, N. Y. (Tel. PO 7-4242)
Pres.: E. Huckenbeck

INSTRUMENT LABS.
315 W. Walton Place, Chicago 10, Ill. (Tel. MIchigan 2-0123)
Dir.-Purch.: John R. Fouser
Dir.-Sales: H. Taylor — CT, RD

INSTRUMENT RESISTORS CO.
1036 Commerce Ave., Union, N. J. (Tel. MUrdock 6-4363)
Office Mgr.: P. Bargerstock
Plant Mgr.: Howard G. Melick — M

INSTRUMENTATION ASSOCIATES, INC.
17 W. 60th St., New York 23, N. Y. (Tel. CIrcle 5-5590)
Dir.-Purch.: Sol Bernstein
Dir.-Sales: William Gruen — RD, HSE

INSTRUMENTS DIV., THE BUDD CO.
P. O. Box 245, Pheonixville, Pa. (Tel. WE 3-8965)
Plant Mgr.: George Pron
Purch. Agent: A. Abrams
Sales Mgrs.: Henry Cook & A. V. Kelley — CT, RD

INSTRUMENTS FOR INDUSTRY, INC.
101 New South Rd., Hicksville, N. Y. (Tel. OVerbrook 1-7100)
Contracts Admin.: John T. Daley
V. P.-Sales: Robert C. Lockwood — CT, TT, RD

INSULATION MFRS. CORP.
565 W. Washington Blvd., Chicago 6, Ill. (Tel. CEntral 6-7320)
Exec. V. P.: A. S. Gray
Asst. V. P.: J. H. Martin
V. P.: B. F. McNamara — M

INTEGRAL CORP.
100 Frank Road, Hicksville L. I., N. Y. (Tel. WEIls 1-4099)
Purch. Agent: William Shea
V. P.-Sales: J. Kendall — PS, MS, M

INTEGRATED DYNAMICS DIV., GLOBE INDUSTRIES, INC.
711 San Mateo Blvd., S.E., Albuquerque, N.M. (Tel. AM 8-0324)
Purch. Agent: B. Juliette Tolman
Chief Engr.: Kenneth E. Pope
Prod. Control: Bill Maxwell — G, TT

INTERCONTINENTAL DYNAMICS CORP.
170 Coolidge Ave., Englewood, N. J. (Tel. LOwell 7-3600)
Purch. Agent: Harold White
Sales Mgr.: F. M. Winnai — CT, RD

INTERCONTINENTAL ELECTRONICS CORP.
1551 Franklin Ave., Mineola, N. Y. (Tel. Pioneer 6-5010)
Dir.-Mktg.: Leonard Goldman
Purch. Agents: John Lacci & William McBride, 100 Shames Dr., Westbury, N. Y. (Tel. EDgewood 4-2800) — MS, G

INTERCONTINENTAL MFG. CO., INC.
Amundsen Road, P. O. Box 949, Garland, Texas (Tel. BRoadway 6-5131)
Dir.-Purch.: L. D. Barnhill
Mgr., Contract Admin: R. E. Tarpley — S, MS, RD

***INTERELECTRONICS CORP.**
2432 Grand Concourse St., New York 58, N. Y. (Tel. LUdlow 4-6200)
Purch. Agent: M. L. Lewis
Sales Mgr.: M. H. Pintell
*(See advertisement this issue)

INTERFERENCE MEASUREMENT LABORATORY, INC.
907 E. 51st St., Brooklyn 3, N. Y. (Tel. INgersoll 9-1765)
Purch. Agent: E. N. Sands — CT, RD

INTERLAKE STAMPING CORP.
12415 Euclid Ave., Cleveland 6, Ohio (Tel. SWeetbriar 1-7101)
Pres.: Wayne Groenstein — M

INTERNATIONAL BALSA CORP.
86 Boyd Ave., Jersey City 4, N. J. (Tel. HEnderson 4-2044)
V. P.-Purch.: Samuel Greenhouse
Exec. V. P.-Sales: Prem Gary — M

INTERNATIONAL BUSINESS MACHINES CORP., FEDERAL SYSTEMS DIV.
326 E. Montgomery Ave., Rockville, Md. (Tel. GArdner 4-6700)

INTERNATIONAL ELECTRIC INDUSTRIES, INC.
468 Grand Ave., Brooklyn 38, N. Y. (Tel. NEvins 8-0211)
Purch. Agent: William Auslander
Chief Engr.-Purch.: John H. Tanges, Jr.
Sales Mrg.: Leo Margold

INTERNATIONAL ELECTRONIC INDUSTRIES, INC.
Corner Berry & Fessey Roads, P. O. Box 9036, Nashville, Tennessee (Tel. CYpress 8-4411)
Purch. Agent: W. W. Dick
National Sales Mgr.: A. M. Rowley

INTERNATIONAL ELECTRONIC RESEARCH CORP.
145 W. Magnolia Blvd., Burbank, Calif. (Tel. VIctoria 9-2481)
Purch. Agent: Philip Solomon
Exec. V. P.: John E. Markley, Jr.
Sales Mgr.: John Foster — MS, CT, TT

INTERNATIONAL ELECTRONICS CORP., MULLARD PRODUCTS
81 Spring St., New York 12, N. Y. (Tel. WO 6-0790)
Purch. Agent: I. Letrztman
V. P.-Sales: E. J. Porto — TT, RD

INTERNATIONAL EQUIPMENT CO.
1284 Soldiers Field Rd., Boston, Mass. (Tel. STadium 2-7900)
Purch. Agent: Walter Morrison
V. P.-Sales: R. W. Schmader — CT

INTERNATIONAL FERMONT MACHINERY CO., INC.
Ramapo, N. Y. (Tel. SLoatsburg 3-2791)
V. P.-Purch.: D. Rohr
Dir.-Sales: C. Sugarman — MS, CT

INTERNATIONAL INSTRUMENTS INC.
Box 2954, New Haven 15, Conn. (Tel. FUlton 7-2515)
Sales Mgr.: R. C. Livingston — CT

INTERNATIONAL RADIO & ELECTRONICS
S. 17th St. & Mishawake Rd., Elkart, Ind. (Tel. JA 2-8583)
Purch. Mgr.: Jason Bemus
Sales Mgr.: Edwin Moore — M, RD

INTERNATIONAL RECTIFIER CORP.
233 Kansas St., El Segundo, Calif. (Tel. ORegon 8-6281)
Dir.-Purch.: Claire Behar
Purch. Agent: Larry Dudley
Mktg. Mgr.: W. H. Atkinson — M

INTERNATIONAL RESISTANCE CO.
401 N. Broad St., Philadelphia 8, Pa. (Tel. WAlnut 2-8900)
Mgr. Purch.: Henry Zaccaria
Buyers: Irene Smith & John H. Cummings
Dir.-Sales: George D. Butler

INTERNATIONAL STEEL CO.
1321 Edgar St., Evansville 7, Ind. (Tel. HArrison 5-3311)
Chief Purch. Agent: Elmer Will
V.P.-Sales: Frank W. Schroeder
Sales Mgr.-Metal Products: Robert Chapman
Sales Mgr.-Lindsay Structure: William Beastall — S, MS

INTERNATIONAL TELEPHONE & TELEGRAPH CORP., INDUSTRIAL PRODUCTS DIV.
15191 Bledsoe St., San Fernando, Calif. (Tel. EMpire 7-6161)
Purch. Agent: Edward Radley
Buyers: H. Reis & C. Jones
Dir.-Mktg.: Robert T. Diehl — MS

INTERNATIONAL WAX REFINING CO.
99 E. Hawthorne Ave., Valley Stream, N. Y. (Tel. LOcust 1-2500)
Purch. Dept.: Frank W. Clarke & Frank J. Clarke

INTERSTATE ELECTRONICS CORP.
707 E. Vermont Ave., Anaheim, Calif. (Tel. PRospect 2-2222)
Purch. Dir.: Joseph Kacura
Sales Mgr.: Hugh M. Griffin — CT, TT, RD

INTERSTATE ELECTRONICS INC.
227 Fulton St., New York 7, N. Y. (Tel. BEekman 3-8780)
Purch. Agent: D. DiPadova
V.P.-Sales: Irving M. Robbins — M

INTERSTATE ENGRG. CORP.
600 East Vermont Ave., Anaheim, Calif. (Tel. PRospect 2-2222)
Prod. Mgr.: G. McMaster
Buyers: M. Hodkin & P. Rutledge
Sales Mgr.: E. J. Norman — MS, RD

INVESTMENT CASTING CO.
60 Brown Ave., Springfield, N. J. (Tel. DRexel 6-6260)
Purch. Agent: Edwin Schoffman
Sales Mgr.: E. H. Parris — M

INVINCIBLE VACUUM CLEANER MFG. CO.
14th & Davis Streets, Dover, Ohio (Tel. 42191)
Purch. Agent: Charles Wenger
V.P.-Sales: L. M. Thomas

IRON FIREMAN MFG. CO., AIRCRAFT DIV.
4784 S. E. 17th Ave., Portland, Ore. (Tel. BE 2-2121)
Purch. Agent: R. Werth
Plant Mgr.: K. S. Wright — S

IRON FIREMAN MFG. CO., ELECTRONICS DIV.
2838 S. E. 9th Ave., Portland 2, Ore. (Tel. BElmont 4-6551)
Purch. Agent: A. D. Rolfe
Asst. Purch. Agent: Harold Walker
Mil. Sales Coordinator: Henry Des Georges — G, CT, TT

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Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

IRVING AIR CHUTE CO., INC.
1315 Versailles Rd., Lexington, Ky. (Tel. 4-6910)
Exec. V. P.: C. H. Pulley
Purch. Agent: B. F. Phares **MS, RD, HSE**

ISOCYANATE PRODUCTS, INC.
900 Wilmington Rd., New Castle, Del. (Tel. EAst 8-5661)
Products Mgr.: John G. Keffer
Sales Mgr.: Jerold B. Smith **M**

ISOLANTITE MFG. CORP.
337 Warren Ave., Stirling, N. J. (Tel. MIllington 7-0385)
Pres. & Dir.-Sales: Frank J. Stevens **G**

ISOTOPES SPECIALITIES CO., DIV.-NUCLEAR CORP. OF AMERICA
170 W. Providencia, Burbank, Calif. (Tel. VIctoria 9-2273)
Purch. Agent: S. W. Lamb
Operations Mgr.: A. J. Moses
V.P.-Sales: A. A. Michaud **M, RD**

ITEK CORP.
1566 Trapelo Road, Waltham, Mass. (Tel. TWinbrook 3-8700)
Purch. Agent: J. J. Kistner
Prod. Sales Mgr.: B. J. Warren

***ITEMCO, INC.**
18 Beechwood Ave., Port Washington, N. Y. (Tel. POrt Washington 7-8330)
Purch. Agent: Julius Rosen
Chief Engr.: Raymond Dzelzkalns
Asst. Chief Engr.: Edward Migliore
Sales Mgr.: Albert J. Deeb **CT, RD**
*(See advertisement this issue)

JEM ELECTRONICS CORP.
743 Circle Ave., Forest Park, Ill. (Tel. PResident 1-8242)
Purch. Agent: C. F. Amberg **CT, RD**

J.F.D. ELECTRONICS CORP.
6101 16th Ave., Brooklyn 4, N. Y. (Tel. DEwey 1-1000)
Purch. Agent: Bob Kuttner
Sales Mgr.: Jack Goodman
Sales Mgr., Western Div.: Bill Bellenkes, Van Nuys, Calif. (Tel. STate 1-3530)

J-V-M MICROWAVE CO.
9300 W. 47th St., Brookfield, Ill. (Tel. HUnter 5-2000)
Buyer: L. Rzeminski
Sales Mgr.: R. E. Morgan **MS, G, TT**

JACK & HEINTZ, INC.
17600 Broadway, Cleveland 1, Ohio (Tel. MOntrose 2-1000)
Purch. Agent: Hugh W. Lloyd
V. P.-Sales: R. J. Eschborn
V. P.-Operations: C. F. Herbold **MS, CT, RD**

JACOBSON NUT MFG. CORP.
Box 177, Mark Rd., Kenilworth, N. J. (Tel. MUrdock 6-0200)
Purch. Agent: J. C. Marrone
Sales Mgr.: C. W. Aagaard **M**

B. JADOW INC.
860 Broadway, New York 3, N. Y. (Tel. GR 5-4450)
Dir.-Purch.: Milton Berman
Dir.-Sales: Henry C. Jadow **M, RD**

JALBERT AEROLOGY LAB. INC.
40 N. W. 20th St., Boca Raton, Fla. (Tel. 9094)
Dir.-Purch.: Domina C. Jalbert **RD**

JAMES ELECTRONICS INC.
4050 N. Rockwell St., Chicago 18, Ill. (Tel. CO 7-6333)
V. P.-Purch.: Robert C. Canning
Pres.: John A. Kennedy **G**

JAMES, POND & CLARK, INC.
2181 E. Foothill Blvd., Pasadena, Calif. (Tel. SYcamore 3-9195)
Purch. Agent: William Olsen
Sales Mgr.: P. F. Shepherd

JAMESBURY CORP.
45 New St., Worcester, Mass. (Tel. SW 9-4166)
Purch. Agent: Domenic J. Bucca
Sales Mgr.: Julian S. Freeman
Asst. Sales Mgr.: Maxwell H. Reck **PS, MS**

JAMISON COLD STORAGE DOOR CO.
Box 70, Hagerstown, Md. (Tel. RE 3-3100)
Gen. Sales Mgr.: P. J. Duffy **CT, RD**

JAN HARDWARE MFG. CO., INC.
38-01 Queens Blvd., Long Island City 1, N. Y. (Tel. EMpire 1-0800)
Chief Purch. Agent: M. Weiss
Dir.-Sales & Gen. Mgr.: Arthur Z. Rowe

JANCO CORP.
3111 Winona Ave., Burbank, Calif. (Tel. THornwall 8-5792)
Purch. Agent: Lester Jones
V. P.-Sales: J. T. Peterson, Jr. **MS, G, CT, RD**

JANITROL AIRCRAFT DIV., MIDLAND-ROSS CORP.
4200 Surface Rd., Columbus 4, Ohio (Tel. BRoadway 6-3561)
Dir.-Proc.: R. H. Rupp
Buyers: John Huntley, Jerry Roberts, William Higgins
Gen. Mgr.: J. W. Ashby
Sales Mgr.: F. H. Scott **MS, RD**

JANKE & CO. INC.
38-44 Railroad Ave., Hackensack, N. J. (Tel. DIamond 3-4674)
Chief Engr.: W. C. Jackson
Chief Draftsman: N. E. Seche **MS, CT, RD**

JARDUR AVIATION CO.
874 Broadway, New York 3, N. Y. (Tel. ALgonquin 4-2238)
Dir.-Purch.: Samuel Klepper
Dir.-Sales: Herman H. Klepper

JARDUR IMPORT CO.
874 Broadway, New York 3, N. Y. (Tel. ALgonquin 4-2239)
Dir.-Purch.: Samuel Klepper
Dir.-Sales: Herman H. Klepper

WALTER K. JAROS AIRCRAFTERS
48-00 Astoria Blvd., Astoria, L.I. 3, N. Y. (Tel. YEllowstone 2-1400)
Purch. Agent: Josephine K. Jaros
Sales Mgr.: Walter K. Jaros **M, RD**

JARRELL-ASH CO.
26 Farwell St., Newtonville 60, Mass. (Tel. DEcatur 2-2130)
Purch. Agent: W. Jokinen
V. P.-Sales: John Schuch **M, RD**

JARVIS CORP.
10 Glastonbury Tpke., Portland, Conn. (Tel. DIamond 7-3381)
Purch. Agent: John Harvey
Gen. Mgr.: Edward G. Sharp
Chief Engr.: R. Stewart **PS**

JAVEX ELECTRONICS
P. O. Box 646, Redlands, Calif. (Tel. PYramid 3-5752)
V. P.-Purch. & Sales: C. J. Reimuller

JEFFERS ELECTRONICS DIV., SPEER CARBON CO.
Hoover Ave., DuBois, Pa. (Tel. 2100)
Purch. Agent: A. P. Kokoska
Sales Mgr.: J. S. Speer II
V.P.-Mktg.: E. W. Butler **M, G, TT**

JEFFERSON ELECTRONIC PRODUCTS
322 State St., Santa Barbara, Calif. (Tel. WOodland 5-8505)
Purch. Agent: William Bedford
Sr. Buyer: Frank E. Brackett
Mgr., Customer Relations Div.: Donald F. Barr **MS**

JEFFERSON WIRE & CABLE CORP.
Pleasant Valley Rd., Sutton, Mass. (Tel. UNion 5-4447)
V.P.-Purch.: Michael Friedman
Gen. Mgr.: Leo Boosahoa
Plant Mgr.: Donald Faraday

JEFFREY MFG. CO., THE
843 N. 4th St., Columbus 16, Ohio (Tel. AX 4-3331)
Dir.-Purch.: H. J. Halliday
V. P.-Sales: J. E. M. Wilson

JENNINGS MACHINE CORP.
3452 Ludlow St., Philadelphia 4, Pa. (Tel. EV 6-2420)
Purch. Agent: J. P. McIntyre
Asst. Purch. Agent: M. A. Russo
Sales Engr.: J. Robert Peace **M, RD**

JENNINGS RADIO MFG. CORP.
970 McLaughlin Ave., San Jose, Calif. (Tel. CYpress 2-4025)
Purch. Agent: Howard A. Coon
Asst. Purch. Agent: Oliver A. Weiss
Sales Mgr.: Roderick Neibaur **M, CT**

JENSEN MFG. CO., DIV.-THE MUTER CO.
6601 S. Laramie Ave., Chicago 38, Ill. (Tel. POrtsmouth 7-7600)
Purch. Agent: Edmund B. McGuckin
Indsl. Sales Mgr.: Horace L. White
Asst. Sales Mgr., Distributor Div.: Frank D. Lintern

JERGUSON GAGE & VALVE CO.
Adams St., Burlington, Mass. (Tel. BRowning 2-3600)
Purch. Agent: Alfred G. Mugford
Buyer: Leo Tripodi
V. P.-Sales: James A. Ford **PS, RD**

JESSOP STEEL CO.
500 Green St., Washington, Pa. (Tel. BAldwin 2-4000)
Dir.-Purch.: George W. Mawhinney
Purch. Agent: Ross Herron
V. P.'s-Commercial: Thomas W. Gabriel & Samuel J. Clokey **M**

JET PULVERIZER CO., THE
Rte. #73 & O'Donnell's Lane, Palmyra, N. J. (Tel. NOrmandy 2-0703)
Dir.-Purch. & Sales: Edwin F. Fay **M**

JET TOOL CORP.
7952 North Ave., Box 547, Lemon Grove, Calif. (Tel. HOpkins 6-0471)
Pres.: Grant Hadley

JETA, INC.
957 Saw Mill River Rd., Yonkers 2, N. Y. (Tel. YOnkers 9-4400)
Mgr.: Howard C. Beyer
Sales Mgr., Metal Fabrication: Raymond E. Calhoun
Asst. Sales Mgr., Power Equip.: Frank P. Monaco **S, MS**

JET-HEET, INC.
152 S. Van Brunt St., Englewood, N. J. (Tel. LOwell 9-0420)
Purch. Agent: Jack White
Sales Engr.: H. Appleton
Sales Mrg.: Robert Barr **RD**

JETTRON PRODUCTS, INC.
56 Route 10, P. O. Box 274, Hanover, N. J. (Tel. TUcker 7-0571)
Pres.: Kenneth Johnson
V. P.: Carlton P. Werner
Elec. Engr.: Frank J. Strassner **RD**

JOCLIN MFG. CO. THE
Lufbery Ave., Wallingford, Conn. (Tel. COlony 9-8708)
Purch. Agent: S. F. DiGiorgi
Sales Mgr.: R. M. Clarke **PS, M**

JOHNS-MANVILLE SALES CORP.
22 E. 40th St., New York 16, N. Y. (Tel. LExington 2-7600)
Mgr.-Purch. Dept.: D. H. Lyons
V. P.-Sales: J. A. O'Brien **M, RD**

CORYDON M. JOHNSON CO., INC.
Bethpage, N. Y. (Tel. WElls 8-4600)
Purch. Agent: Thomas Cassino
V. P.-Sales: Wallace A. Haeberle **RD**

E. F. JOHNSON CO.
206 2nd Ave., S. W., Waseca, Minn. (Tel. 990)
Purch. Agent: M. L. Johnson
Gen. Sales Mgr.: E. T. Herbig, Jr. **M**

K. W. JOHNSON & CO., INC.
1825 Webster St., Dayton 4, Ohio (Tel. BA 4-1078)
Dir.-Purch.: Richard M. Wilcox
Sales Mgr.: R. D. Tobey
Pres.: K. W. Johnson **S, MS, G, CT, TT, RD**

JOHNSON ELECTRONICS INC.
Hwy. 17-92, P. O. Box 1675, Casselberry, Fla. (Tel. MIdway 4-3311)
Chief Purch. Agent: Merlin Baudino
Purch. Agent: Lona Whistler
V. P.-Sales: E. C. Johnson **G, RD**

JOHNSON MFG. CO., INC.
616 First Ave., N., Mt. Vernon, Iowa (Tel. 3651)
Mgr.-Sales: R. H. Thompson
Asst. Mgr.-Sales: D. F. Jones **M**

JOHNSON METAL HOSE, INC.
10 Sperry St., Waterbury 20, Conn. (Tel. PL 6-4612) **M**

JOHNSON-WILLIAMS, INC.
2625 Park Blvd., Palo Alto, Calif. (Tel. DAvenport 3-4131)
Mgr.: P. L. Williams
Chief Engr.: K. W. Johnson **MS**

JOHNSTON & FUNK METALLURGICAL CORP.
W. Decatur Hwy., Huntsville, Ala. (Tel. JE 6-3374)
Purch. Agent: Don Good
Sales Coordinator: Ernie Thiemonge **M**

JO-LINE TOOLS, INC.
8442 Otis St., South Gate, Calif. (Tel. LOrain 7-1489)
Purch. Agent: Roy Moore
V. P.-Purch.: William S. Woods **MS**

JOMA INC.
Town Line Rd., Wolcott, Conn. (Tel. PLaza 7-0040)
Pres.: Joseph M. Macary

JONCO AIRCRAFT CORP., SUB.-FAIRCHILD ENGINE & AIRPLANE CORP.
P. O. Box 549, Shawnee, Okla. (Tel. 6230)
Mgr.-Materials: W. W. Drake
Mgr.-Purch.: P. F. Willis
Mgr.-Sales: H. A. Crouch **S, MS**

HOWARD B. JONES DIV.-CINCH MFG. CO.
1026 S. Homan Ave., Chicago 24, Ill. (Tel. NEvada 2-2000)
Purch. Agent: Tom Hopkins
Gen. Sales Mgr.: S. Pfannstiehl

JONES & LAMSON MACHINE CO.
160 Rocket St., Springfield, Vt. (Tel. TUrner 5-2121)
Purch. Agent: E. F. St. Mary
Asst. Purch. Agent: Frank Barter
Mgr.-Marketing: H. A. Finch

JONES & LAUGHLIN STEEL CORP., STAINLESS AND STRIP DIV.
P. O. Box 4606, Detroit 34, Mich. (Tel. JEfferson 6-7200)
Purch. Agent: H. W. Arnold
Asst. Purch. Agent: C. A. Kiesgen
Purch. Clerk: H. C. Geiger
V. P.-Sales: J. H. Abbott **M**

JONES MOTOROLA CORP.
432 Fairfield Ave., Stamford, Conn. (Tel. DAvis 4-7381)
Mgr.-Purch. & Sales: C. E. Rees
Purch. Agent: S. E. Jacobs **CT**

JONESVILLE PAPER TUBE CORP.
474 Beck Rd., Jonesville, Mich. (Tel. VI 9-2951)
Dir.-Purch.: A. G. Schaerer
Dir.-Sales: W. W. Schray **M**

JORDAN CONTROLS INC.
3235 W. Hampton Ave., Milwaukee 9, Wis. (Tel. UPtown 1-9240)
Dir.-Purch.: Arthur Scammell
Chief Engr.: Fred Gruner
Dir.-Sales: Charles Jordan **MS**

JORDAN ELECTRONICS, DIV.-VICTOREEN INSTRUMENT CO.
3025 W. Mission Rd., Alhambra, Calif. (Tel. CUmberland 3-6425)
Purch. Agent: Darrell Johnston
Sales Mgr.: George W. Egan

EARLE M. JORGENSEN CO.
10650 S. Alameda St., Los Angeles 54, Calif. (Tel. LOrain 7-1122)
Purch. Agent: James Nassir
Mdse. Mgr.: W. R. Lindman
Mgr.-Sales: Charles Schriber **M**

JOY MFG. CO.
Henry W. Oliver Bldg., Pittsburgh 22, Pa. (Tel. GRant 1-2140)
Dir.-Purch.: K. Warmbein
Purch. Agent, Elec. Prod. Div.: H. C. Brown
V. P.-Elec. Prod. Div.: W. C. Russell
V. P., Ind. Div.: J. P. Cartwright **MS**

JUALL GEAR CO., INC.
1108 Goffle Rd., Hawthorne, N. J. (Tel. HA 7-4220)
Pres.: C. Juall **TT**

K-W ENGRG. WORKS
N50 W16328 Pin Oak Ct., (P.O.) Butler, Wisc. (Tel. (Milwaukee) SUnset 1-8616)
Purch. Agent: H. Charles Kaetel

GEO. E. KAERCHER CO.
4911 36th Ave., S., Minneapolis 17, Minn. (Tel. PArkway 4-4986)
Purch.: Don Kaercher & Geo. Kaercher **M**

KAHN & CO., INC.
885 Wells Rd., Wethersfield, Hartford, Conn. (Tel. JAckson 9-8643)
Mail: P. O. Box 516, Hartford 1, Conn.
V. P.-Purch.: Kenneth O. Jacobs
Asst. Purch. Agent: James Melo
Expediter: Richard Metcalf
Sales Mgr.: Edward D. Kane **MS, CT, RD**

KAHN RESEARCH LABS. INC.
81 S. Bergen Pl., Freeport, N. Y. (Tel. FReeport 9-8800)
Purch. Agent: Ernest Howard
V. P.-Sales: Kenneth B. Boothe **TT, RD**

KAISER AIRCRAFT & ELECTRONICS, DIV.-KAISER INDUSTRIES CORP.
P. O. Box 1828, Oakland 4, Calif. (Tel. San Leandro, Calif.—LOckhaven 2-2456)
Material Mgr.-Richmond Machining Plt.: James Tallman (Tel. Richmond, Calif.—LAndscape 6-4688)
Purch. Agent-Richmond & San Leandro Plts.: J. R. Anderson (Tel. Richmond, Calif.—LAndscape 6-4688)
Purch. Agent-Toledo Electronics Plt.: R. W. Gibson (Tel. Toledo, Ohio—RAndolph 6-1591)
Purch. Agent-Phoenix Electronics Plt.: Ralph Musbach (Tel. Phoenix, Ariz.—WIndsor 3-3431)
Sr. Sales & Contract Rep.-Phoenix Electronics Plt.: Robert N. O'Hara (Tel. Phoenix, Ariz.—WIndsor 3-3431)
Gen. Sales Mgr.-Weapons Systems Mktg. Dept.: A. L. Mapes (Tel. San Leandro, Calif.—LOckhaven 2-2456)

KAISER ALUMINUM & CHEMICAL SALES, INC.
919 N. Michigan Ave., Chicago 11, Ill. (Tel. MOhawk 4-6900); 300 Lakeside Dr., Oakland 12, Calif. (Tel. CRestview 1-2211) **S, MS, M, RD**

KAISER FLEETWINGS, INC.
Bristol, Pa. (Tel. STillwell 8-8431)
Proc. Mgr.: W. C. Heilbrun
V. P. & Gen. Mgr.: S. D. Hackley
Div. Mgr.: W. K. Palmer
Contracts Mgr.: E. J. Raymond
Sales Mgr.: D. E. Egan **S, PS, MS, M, RD**

KAISER STEEL CORP., FABRICATING DIV.
7301 Telegraph Rd., Los Angeles 22, Calif. (Tel. RAymond 3-5411)
Purch. Agent: Frank E. Cooper
V. P.-Gen. Mgr.: Jack J. Carlson **CT**

KALART CO., INC., THE
Hulteneus St., Plainville, Conn. (Tel. SHerwood 7-1663)
Plant Mgr.: L. J. Quartin
Buyers: Harry Schwartz & Harry G. Searles
Gen. Sales Mgr.: Hy Schwartz **S, CT, RD**

KANAAR CORP.
447 Market St., Kingston, Penna. (Tel. BUtler 7-2151)
Purch. Agent: Clinton D. Smith
Sales Mgr.: John H. Uhl **S, MS**

KANO LABS.
1000 S. Thompson Lane, Nashville, Tenn. (Tel. ALpine 4-3519)
Purch.: Thomas J. O'Kane
Sales Mgr.: C. G. Montgomery

KANTHAL CORP., THE
Amelia Place, Stamford, Conn. (Tel. DAvis 5-2206)
Treas.: Lennart Haha
Sales Mgr.: G. W. Eisenbeis

A. LAWRENCE KARP
Sawmill Rd., Stamford, Conn. (Tel. DA 2-2280)
Pres.: A. L. Karp **M**

KATO ENGRG. CO.
1415 First Ave., Mankato, Minn. (Tel. 8-2941)
V. P.-Sales: William Cliff **MS, CT**

KATOLIGHT CORP.
First Ave. & Chestnut St., Mankato, Minn. (Tel. 7966)
Sales Engr.: Norval Biggs
Pres.: C. W. Pennington
Sales Mgr.: Stan F. Neubert

C. B. KAUPP & SONS, INC.
6-10 & 32 Newark Way, Maplewood, N. J. (Tel. SOuth Orange 3-2490)
Pres.: Carl B. Kaupp, Jr.
Secy.-Treas.: Clem N. Kaupp
Sales Rep.: John M. Hogan

KAUSTINE FURNACE & TANK CORP.
1937 Thomas St., Perry, N. Y.

KAY ELECTRIC CO.
Maple Ave., Pine Brook, N. J. (Tel. CApital 6-4000)
Purch. Agent: Marsden Shaw
Gen. Sales Mgr.: John Gilmore **CT, TT, RD**

KAYDON ENGRG. CORP., THE
McCracken St., Muskegon, Mich. (Tel. PLaza 5-3741)
Dir.-Purch.: W. J. Pierre
Buyers: John Peterson & O. Lee Mitchell
Gen. Sales Mgr.: D. C. Maxwell **RD**

JOSEPH KAYE & CO., INC.
49 Hampshire St., Cambridge 39, Mass. (Tel. UNiversity 8-7080)
Joseph Kaye **PS, RD**

KAYNAR MFG. CO., INC., KAYLOCK DIV.
Box 2001, Terminal Annex, Los Angeles 54, Calif. (Tel. SPruce 3-3070)
Purch. Agent: George Mooers
Gen. Mgr.: R. H. Randall
Sales Mgr.: K. D. Davis

***KEARFOTT DIV., GENERAL PRECISION, INC.**
Little Falls, N. J. (Tel. CL 6-4000) **MS, G, CT, RD**
*(See advertisement this issue)

***KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS**
14844 Oxnard St., Van Nuys, Calif. (Tel. STate 6-1760)
Purch. Agent: J. E. Hachtel
Sales Mgr.: W. K. Dau, Jr. **G, CT, RD**
*(See advertisement this issue)

KEIL ENGRG. PRODUCTS, INC.
4356 Duncan St., St. Louis 10, Mo. (Tel. OLive 2-7005)
Gen. Mgr.: J. S. Keil, 6833 Manchester (Tel. STerling 1-3209)
Sales Mgr.: Norman W. Kathrinus **M**

KEITHLEY INSTRUMENTS, INC.
12415 Euclid Ave., Cleveland 6, Ohio (Tel. SWeetbriar 5-2666)
Works Mgr.: G. L. Pfromm
V. P.-Engrg.: Dr. Julius Praglin **CT, RD**

KELITE CORP.
1250 N. Main St., Los Angeles 12, Calif. (Tel. CApitol 2-0201)
V. P., and Tech. Dir.: Louis McDonald
V. P.-Sales: W. Sorensen **M, RD**

HUGO P. KELLER, JR.
50 East 42nd St., New York 17, N. Y. (Tel. MUrrayhill 2-8450)
Pres.: Hugo P. Keller, Jr.
Sales Mgr.: R. M. Wolff **M**

KELLETT AIRCRAFT CORP.
P. O. Box 35, Willow Grove, Pa. (Tel. OS 5-2930)
Purch. Agent: H. A. Harner
Asst. Purch. Agent: R. Nevin
V. P.-Sales: I. Medgebow **S, MS, CT, RD**

KELLOGG SWITCHBOARD & SUPPLY CO., COMMUNICATIONS DIV.-INTERNATIONAL TELEPHONE & TELEGRAPH CORP.
6650 S. Cicero Ave., Chicago 38, Ill. (Tel. POrtsmouth 7-6900)
Dir.-Purch.: H. O. Nordberg
V. P.-Mktg.: C. J. Trees
V. P.-Sales: R. Griebel

KELSEY HAYES CO.
3600 N. Military, Detroit 32, Mich. (Tel. TA 5-5500)
Purch. Mgr.: E. Kern
Gen. Mgr., Sales & Engrg.: L. G. Taylor **MS, M, RD**

KELSEY HAYES CO., UTICA DROP FORGE & TOOL DIV.
2415 Whitesboro, Utica 4, N. Y. (Tel. RE 5-6411)
Purch. Agent: Edward Kern
Sales Mgr.: Walter Hart **MS, M, RD**

KEMET CO., DIV.-UNION CARBIDE CORP.
11901 Madison Ave., P. O. Box 6087, Cleveland 1, Ohio (Tel. ACademy 6-3330)
Purch. Agent: P. R. Hostacky
Dir.-Sales: W. H. Fritz **M**

KEMLITE LABORATORIES, INC.
1819 W. Grand Ave., Chicago 22, Ill. (Tel. TAylor 9-6050)
Purch. Agent: J. V. Daniels

KEMP AERO PRODUCTS
Marshall Hill Rd. West Milford, N. J. (Tel. PArkway 8-3149)

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Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

Dir.-Purch.: J. L. Bishop
Buyer: L. Cocks
Chief Engr.: N. Kling
V. P.-Sales: J. Harrington S, PS, MS, G, RD

KENDALL CO., THE
111 West 40th St., New York 18, N. Y. (Tel. LOngacre 3-7600) M

KENDALL CO., THE, POLYKEN SALES DIV.
309 W. Jackson Blvd., Chicago 6, Ill. (Tel. WEbster 9-7100)
Dir.-Purch.: J. F. Karl
Dir.-Sales: J. T. Doyle

KENNAMETAL INC.
Lloyd Ave., Latrobe, Penna. (Tel. KEystone 7-3311)
Purch. Agent: Dale R. Versaw
Sales Mgr.: Bennett Burgoon, Jr.

D. S. KENNEDY & CO.
Cohasset, Mass. (Tel. EVergreen 3-1200)
Purch. Agent: Robert Fisher
Buyer: E. W. Anderson
V. P.-Sales: R. J. Grenzeback TT, RD

KENNEDY AIRCRAFT SUPPLY CO.
43-10, 162 St., Flushing 58, N. Y. (Tel. HIckory 5-3500)
Gen. Mgr.: Chris Kennedy
Supvr.-Sales: K. D. Shanley M, CT

KENSICO TUBE CO., DIV.-ROBINSON TECHNICAL PRODUCTS, INC.
Hubbell's Dr., Mount Kisco, N. Y. (Tel. Mount Kisco 6-8046)
Dir.-Purch.: Philip P. Genussa
Plant Engr.: Arthur L. Mortensen
Gen. Sales Mgr.: Frederic F. Moore, Jr. M, RD

KENTUCKY METAL PRODUCTS CO.
3104 S. Preston St., Louisville 13, Ky. (Tel. MElrose 4-9421)
Dir.-Purch.: R. E. Morrison, Sr.
Dir.-Sales: J. L. Covert
Sales Mgr.: S. S. Emison

KEPCO, INC.
131-38 Sanford Ave., Flushing 55, N. Y. (Tel. INdependence 1-7000)
Purch. Agent: Jack Kupferberg
Dir.-Engrg.: Ken Kupferberg
Sales Mgr.: Max Kupferberg

KERNS MFG. CORP.
45-18 Court Sq., Long Island City 1, N. Y. (Tel. STillwell 6-2550)
Purch. Agent: Arnold Novak
Gen. Mgr.: R. J. Auman
Mgr.: L. M. Cirami S, PS, MS

WAYNE KERR CORP.
1633 Race St., Philadelphia 3, Pa. (Tel. LOcust 8-6820)
Gen. Mgr.: Boyce M. Adams
Purch. Agent: Frank Scott CT

KERRCO
Box 4178, 4335 N. 61st St., Lincoln 7, Nebr. (Tel. IV 6-5105)
Dir.-Sales: D. W. Hemphill
Prod. Mgr.: M. Kerr, Box 727, Hastings, Nebr. (Tel. 2-2812)

KESTER SOLDER CO.
4201 Wrightwood Ave., Chicago 39, Ill. (Tel. BElmont 5-1601)
Purch. Agent: G. E. Fischer
Gen. Sales Mgr.: J. H. Humble

KETAY DEPT., NORDEN DIV., UNITED AIRCRAFT CORP.
Jericho Turnpike, Commack, N. Y. (Tel FOrest 8-5500)
Purch. Agent: S. Schiener
Buyers: M. Gibber, D. Harkins, S. Leto
Sales Mgr.: N. Pell RD

KEYSTONE BOLT & NUT CORP.
125 Church St., New York 7, N. Y. (Tel. WOrth 4-4600)
Sales Mgr.: Kenneth Fischer

KEYSTONE CARBON CO.
1935 State St., St. Marys, Penna. (Tel. TE 41-591)
Purch. Agent: L. H. Schaut
Thermistor Sales: F. A. Brennan M

KEYSTONE ELECTRONICS CO., THE
65 Seventh Ave., Newark 4, N. J. (Tel. HUmbolt 2-0630)
Purch. Agent: S. Spector
V. P.-Sales: A. B. III, Jr. CT, TT, RD

KEYSTONE ELECTRONICS CORP.
49 Bleecker St., New York 12, N. Y. (Tel. GRamercy 5-4600)
Purch.: I. Rosen M

KEYSTONE PRODUCTS CO.
904-6 23rd St., Union City, N. J. (Tel. UNion 6-5400)
Purch. Agent: F. W. Harth
Sales Coordinator: E. Holewski

KICKHAEFER MFG. CO.
901 S. Second St., Milwaukee 4, Wisc. (Tel. MItchell 5-1630)
Pres.: Edward A. Kickhaefer
V. P.-Purch.: Ernest Davis

KIDCO INC.
P. O. Box 583, Somerset, Ky. (Tel. 1440)
Purch. Agent: Donald Carter
Plant Supt.: Caudie Redmond
Gen. Mgr.-Sales: Murray Rogers PS, MS

KIDDE AERO-SPACE DIV., WALTER KIDDE & CO., INC.
1320 Main St., Belleville 9, N. J. (Tel. PLymouth 9-5000)
Purch. Agent: J. P. Blake
V. P. & Dir.-Sales: V. J. Hill S, PS, MS, M, G, CT, RD

KIELEY & MUELLER, INC.
64 Genung St., Middletown, N. Y. (Tel. DIamond 2-2526)
Dir.-Purch.: Rex Palmer
Dir.-Sales: Joseph P. O'Conner, Jr. MS

KILGORE, INC., INTERNATIONAL FLARE-SIGNAL DIV.
200 E. Broadway, Westerville, Ohio (Tel. TUxedo 2-2341)
Sales Mgr.: G. J. Bishop
Tech. Dir.: Hugh McManus

KILO ENGRG. CO.
2011 Third St., LaVerne, Calif. (Tel. LYcoming 3-4626)
Purch. Agent: J. B. Gach
Gen. Mgr.-Sales: R. L. Gach G, CT, TT, RD

KIN TEL DIV.-COHU ELECTRONICS, INC.
5725 Kearny Villa Rd., San Diego 12, Calif. (Tel. BRowning 7-6700)
Purch. Agent: Robert J. Just
Sales Mgr.: E. C. Titcomb
Pres.: L. T. Cohu CT

ALFRED B. KING CO., THE
Devine St., North Haven, Conn. (Tel. CHestnut 8-5561)
Purch. Agent: Frank P. Forte
Sales Mgr., Fabrication Div.: Louis A. Carloni S

KING FIFTH WHEEL CO.
P. O. Box 759, Wilkes-Barre, Pa. (Tel. GRanite 4-6371)
Purch. Agent: J. J. Gatti
V. P.-Sales: J. E. Gibbons S, PS

KING LABS., INC.
127 Solar St., Syracuse 3, N. Y. (Tel. GRanite 4-3359)
Exec. V. P.-Purch. & Sales: W. R. MacLeod M

KINGS ELECTRONICS CO., INC.
40 Marbledale Rd., Tuckahoe, N. Y. (Tel. SWiftwater 3-5000)
Purch. Agent: Jack Zinaman
Buyer: Claire Straus
Asst. Buyer: Alma Verrigni
Sales Mgr.: Willard Lavers MS, G, CT, TT

KINGSTON ELECTRONICS, DIV.-KINGSTON INDUSTRIES INC.
North St., Medfield, Mass. (Tel. FLeetwood 9-4347)
Purch. Agent: N. H. Peterson
Sales Mgr.: R. W. Moulton

KINNEY VACUUM DIV., THE NEW YORK AIR BRAKE CO.
3529 Washington St., Boston 30, Mass. (Tel. JAmaica 4-3220)
Purch. Agent: W. Botts
Sales Mgr.: W. B. Mills M

KIP ELECTRONICS CORP.
29 Holly Place, Stamford, Conn. (Tel. DAvis 5-1551)
Purch. Agent: Vincent Engdall
V. P.-Sales: John N. Higgins RD

M. KIRCHBERGER & CO., INC.
250 Humphry St., Englewood, N. J. (Tel. LOwell 8-4555)
Purch. Agent: A. Kent
Sales Mgr.: T. H. Church M

MORRIS P. KIRK & SON, INC.
2700 S. Indiana, Los Angeles 23, Calif. (Tel. ANgelus 2-1101)
Purch. Agent: E. Gullette
Gen. Sales Mgr.: F. A. Eichorn M

KIRK & BLUM MFG. CO., THE
3239 Forrer St., Cincinnati 9, Ohio (Tel. ELmhurst 1-1400)
Purch. Agent: F. G. Weber
Asst. Purch. Agent: Fred Herrle
Dir.-Sales: W. R. Meuttmen S

KIRKHILL RUBBER CO.
300 E. Cypress St., Brea, Calif. (Tel. JAsper 9-2161)
Purch. Agent: Sterling Atkinson
V. P. & Sales Mgr.: Dan E. Budnick M

H. R. KIRKLAND CO., THE
10 King St., Morristown, N. J. (Tel. JE 8-2777)
Dept. Mgrs.: Bruce A. Kirkland & Harry P. Anson
Dir.-Sales: H. R. Kirkland

KISH INDUSTRIES, INC.
1301 N. Turner St., Lansing, Mich. (Tel. IV 2-1181)
Secy. & Treas.: Daniel I. Lessens
Purch. Agent: Ewald Schrader
Pres.: Charles A. Chambers M

KISTLER INSTRUMENT CORP.
15 Webster St., N. Tonawanda, N. Y. (Tel. JAckson 2099)
Dir.-Purch.: J. F. Lally
Prod. Mgr.: W. C. Waytena
Sales Mgr.: R. W. Lally G, CT

KITTELL-LACY, INC.
10816 E. Fawcett Ave., El Monte, Calif. (Tel. GIlbert 4-9567)
Purch. Agent: W. Keith Clow
Mgr.-Sales: Walter S. Martin MS, RD

LEO KLEIN ELECTRONICS CO.
2404 S. LaBrea Ave., Los Angeles 16, Calif. (Tel. WEbster 5-3119)
Purch. & Prod. Expediter: A. Klein
Sales Mgr.: H. Navis CT

KLINCHER LOCKNUT CORP.
2153 Hillside Ave., Indianapolis 18, Ind. (Tel. WAlnut 5-9284)
Pres.: E. W. Pummill
Quality Control: H. Henley
Sales Mgr.: I. J. Deinhart PS, MS, G

KLING METAL SPINNING & STAMPING CO.
247 Centre St., New York, N. Y. (Tel. CAnal 6-5580)
Owner: Philip Kling
Engr.: Peter Miller
Metallurgist: Sol Gross S, M, RD

JAMES KNIGHTS CO., THE
Sandwich, Ill. (Tel. 2141)
Purch. Agent: Russell Walgren
Sales Mgr.: Glenn Munro MS, G, TT, RD

KNOPP INC.
1307 66th St., Oakland 8, Calif. (Tel. OLympic 3-1661)
Sales Mgr.: Henry N. Muller

KOBE INC.
3040 East Slauson Ave., Huntington Park, Calif. (Tel. LUdlow 8-1271)
Purch. Agent: R. W. Warfield
Aircraft Sales Mgr.: P. H. Jamison CT

H. KOCH & SONS
P. O. Box 125, Corte Madera, Calif. (Tel. WAbash 4-3510)
Purch. Agent: H. Salkin
Gen. Mgr.: M. P. Koch S, MS

KOEHLER AIRCRAFT PRODUCTS CO., INC.
409 Leo St., Dayton 59, Ohio (Tel. BAldwin 6-1821)
Purch. Agent: John H. Rininger
Gen. Sales Mgr.: R. T. McCauley

KOH-I-NOOR PENCIL CO., THE
North St., Bloomsbury, N. J. (Tel. GReenwood 9-4124)
Purch. Agent: Orville Henderson
Sales Dept.: Richard LaBarre

KOHLER CO.
Kohler, Wisc. (Tel. GLencourt 7-4441)
V. P. & Sales Mgr.: A. G. Zibell
Sales Rep.: W. C. Voigt MS

KOLCAST INDUSTRIES—DIV. THOMPSON RAMO WOOLDRIDGE INC.
P. O. Box 250, Minerva, Ohio (Tel. 725)
Purch. Agent: A. M. Pelley
Sales Mgr.: R. C. Kramer M, RD

KOLLMORGEN OPTICAL CORP.
347 King St., Northampton, Mass. (Tel. JUstice 4-0280)
Purch. Agent: Richard G. Walsh
Asst. Purch. Agent: George Dudley
V. P.-Sales: J. C. Milligan **MS, CT, TT, RD**

KOLLSMAN INSTRUMENT CORP., SUB.-STANDARD COIL PRODUCTS CO. INC.
80-08 45th Ave., Elmhurst 73, N. Y. (Tel. TWining 9-5600)
Purch. Agent: J. Goodrich
Asst. Purch. Agent: W. Kelly
Dir.-Mktg.: H. Droge **MS, G, RD**

KOLTON ELECTRIC MFG. CO.
123 New Jersey Railroad Ave., Newark 5, N. J. (Tel. MItchell 2-4622)
Purch. Agent: Charles Kolton
Chief Engr.: Barrett D. Kolton
Dir.-Sales: Heyman Kolton **M**

E. KONIGSLOW STAMPING & TOOL CO.
450-1-N, 9th St., Elwood, Indiana (Tel. FE 2-5342)

KOONTZ-WAGNER ELECTRIC CO., INC.
516 N. Michigan St., South Bend 1, Ind. (Tel. CEntral 3-8251)
Procurement Mgr.: A. W. Koehnke
Gen. Mgr.: C. D. Hills
Production Mgr.: C. H. Bill
V. P.-Sales: B. Kumm **PS, MS, G, CT**

KOPP GLASS, INC.
Swissvale, Pittsburgh 18, Pa. (Tel. BRandywine 1-0190) **M**
Purch. Agent: Charles Rudek
V. P.-Sales: J. L. Newton

KOPPERS CO., INC., METAL PRODUCTS DIV.
200 Scott St., Baltimore 30, Md. (Tel. SAratoga 7-2500)
Dir.-Procurement: B. K. Shaner
Buyers: D. A. Koerin & E. C. Reid
Sales Mgr.: T. F. Naylor **M, CT, RD**

KRAMER FABRICATING CO., THE
920 Fisher Bldg., Detroit 2, Mich. (Tel. TRinity 1-1800)
Sales Mgr.: Charles R. Sterritt **S, MS**

HERB KRECKMAN CO.
Cresco, Pa. (Tel. LYndhurst 5-2212)
Herb Kreckman

KRYLON, INC.
Ford & Washington Sts., Norristown, Pa. (Tel. BRoadway 9-1950)
Dir.-Purch.: William Sansalone
V. P.-Sales: Richard C. Newbold

KULKA ELECTRIC CORP.
633-643 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. Mt. Vernon 4-4024)
Treas.: William Kulka
Purch. Agent: Harry Meltzer
Sales Mgr.: Elliott Edelman **M**

KURMAN ELECTRIC CO., SUB.-CRESCENT PETROLEUM CORP.
191 Newel St., Brooklyn 22, N. Y. (Tel. EVergreen 3-8000)
Purch. Agent: Jim Barry
Sales Mgr.: Wallace Green **RD**

KURZ-KASCH, INC.
1421 S. Broadway, Dayton, Ohio. (Tel. BAldwin 3-8161)
Purch. Agent: I. H. Naas
V. P.-Sales: R. L. Davidson **M**

KUTHE LABS., INC.
730 S. 13th St., Newark 3, N. J. (Tel. BIgelow 2-6000)
Works Mgr.: J. J. Myers
Staff Engr.: H. M. Brady **G, TT**

KWIKSET POWDERED METAL PRODUCTS
516 E. Santa Ana St., Anaheim, Calif. (Tel. KEystone 5-8111)
Purch. Agent: E. M. Scott
Sales Mgr.: John Mikitka

L. A. B. CORP.
Skaneateles 1, N. Y. (Tel. OV 5-5781)
Purch. Agent: H. B. Mantz
Sales Mgr.: J. T. Hubbard

L. O. F. GLASS FIBERS CO.
3116 Van Owen Blvd., Burbank, Calif. (Tel. Victoria 9-2331)
Purch. Agent: Robert O. Eiseld
Sales Mgr.: Wm. Worcester

L & R MFG. CO.
577 Elm St., Kearny, N. J. (Tel. WY 1-5330)
Purch. Agent: A. L. Hendler
V. P.-Purch.: Saul Goldfarb
V. P.-Sales: Jim Lazarus

L S M MFG. CO.
Waterville 14, Conn. (Tel. Plaza 4-4136)
Dir.-Purch. & Sales Mgr.: P. J. Ciarleglio

LABELON TAPE CO., INC.
450 Atlantic Ave., Rochester 9, N. Y. (Tel. HUbbard 2-3460)
Purch. Mgr.: Kurt Baum
Gen. Sales Mgr.: D. L. Allen **M**

LABLINE, INC.
3070-82 W. Grand Ave., Chicago 22, Ill. (Tel. SAcramento 2-5151)
Purch. Agent: George A. Parsons
Asst. Sales Mgr.: Charles V. Kelly **RD**

LAB. FOR ELECTRONICS, INC.
1079 Commonwealth Ave., Boston 15, Mass. (Tel. ALgonquin 4-4235)
Dir.-Purch.: C. R. Skinner
Mgr., Purch.: H. H. Neilson
Mgr., Subcontracting: M. R. Anderson
V. P.-Mktg.: J. V. Holdam **G, CT, TT, RD**

LAB-TRONICS, INC.
3656 N. Lincoln Ave., Chicago 13, Ill. (Tel. GRaceland 7-7900)
Purch. Agent: J. McNurney
Sales Mgr.: G. I. Lovitt **M**

LADISH CO.
5481 S. Packard Ave., Cudahy, Wisc. (Tel. HUmboldt 1-1500)
Purch. Agent: J. F. Wachs
Sales Mgr.-Forging Div.: R. F. Starz **S, PS, MS, M, RD**

LAMB ELECTRIC CO., THE., DIV.-AMERICAN MACHINE & METALS, INC.
Lake St., Kent, Ohio (Tel. ORchard 3-3451)
Purch. Agent: S. E. Campbell
Gen. Sales Mgr.: E. L. McIntyre **M**

LAMBDA ELECTRONICS CORP.
11-11 131st St., College Point, 56, N. Y. (Tel. INdependence 1-8500)
Purch. Agent: E. Botuck
Sales Mgr.: Merrill Simon

LAMINATED SHIM CO., INC.
9304 Union St., Glenbrook, Conn. (Tel. DAvis 5-2631)
Purch. Agent: Frederick J. Thomas
Sales Dept.: M. Errico
V. P.-Sales: M. L. Lockwood

LAMPKIN LABS., INC., MR DIV.
Bradenton, Fla. (Tel. 6-1906)
Purch. Agent & Sales Mrg.: George C. Craig **PS, G, CT, TT**

LAM-PLY, INC.
16 Railroad Sq., Nashua 10, N. H. (Tel. TUxedo 2-5871)
Purch. Agent: Donald Cummings
Pres.: Edwin W. Zetterberg **M**
Sales Mgr.: Robert V. Weston

LAMSON CORP., THE
500 Lamson St., Syracuse, N. Y. (Tel. HOward 3-0221)
Purch. Agent: C. S. Estabrook
V. P.-Sales: C. Hennessy **S**

LAMSON & SESSIONS CO., THE
5000 Tiedeman Rd., Cleveland 9, Ohio (Tel. CLearwater 2-3700)
Dir.-Purch.: Frank J. DeCrane
Asst. Mgr.-Aircraft Sales: Don H. Kluth
V. P.-Sales: J. G. Rayburn

LAMTEX INDUSTRIES INC.
Motor Ave., Farmingdale, N. Y. (Tel. MYrtle 4-2000)
Buyer: Irving Griman
V. P.-Sales: Hsing Liu **M, RD**

LANCASTER GLASS CORP.
Lancaster, Ohio (Tel. OLive 3-0311)
Purch. Agent: Homer Echard
Sales Mgr.: M. R. Hoover **M**

LAND-AIR INC., SUB.-CALIFORNIA EASTERN AVIATION, INC.
7444 W. Wilson Ave., Chicago 31, Ill. (Tel. UNderhill 7-7550)
Purch. Agent: C. D. Mitchell
Mgr.-Field Mktg.: Rodney A. Stevens
Dir.-Comm. Sales: A. W. Crampton **MS, G, CT, TT, RD**

LANDIS & GYR, INC.
45 W. 45th St., New York 36, N. Y. (Tel. JUdson 6-4644)
Exec. V. P.: M. Wiesendanger
Sales Mgr.: John J. McNiff

LANE ELECTRONICS MFG. CORP.
7254 Atoll Ave., North Hollywood, Calif. (Tel. TR 7-3267)
Purch. Agent: Philip A. Mottola
Sales Mgr.: Arden J. Lane **RD**

LANGEVIN DIV.-THE W. L. MAXSON CORP.
475 Tenth Ave., New York 18, N. Y. (Tel. LOngacre 5-1900)
Purch. Agent: John Tsagaris
Sales Mgr.: Robert A. Lombard **MS, M, TT**

LANGLEY CORP.
310 Euclid Ave., San Diego 12, Calif. (Tel. COngress 4-3181)
Purch. Agent: R. H. Keeyes
Mgr., Aircraft Sales: C. L. Phelps **S, PS, MS, RD**

LANTZ MFG. CO., INC.
902 Calumet Ave., Valparaiso, Ind. (Tel. HOward 2-1168)
Secy.: Wilford N. Ugland

LAPHAM HICKEY STEEL CORP.
3333 W. 47th Pl., Chicago 32, Ill. (Tel. VI 7-0822)
Dir.-Sales: J. W. Davis **M**

ARTHUR S. LA PINE & CO.
6001 S. Knox Ave., Chicago 29, Ill. (Tel. REliance 5-4700)
Purch. Agent: John Boros
Asst. Purch. Agents: Ernest Rodrigue & John Olenke
Sales Mgr.: Donald Miller

LA POINTE INDUSTRIES INC.
155 W. Main St., Rockville, Conn. (Tel. TRemont 5-3351)
Purch.: E. Evans
Pres.: Y. H. Stillbach **MS, G, TT, RD**

LA POINTE MACHINE TOOL CO., THE
34 Tower St., Hudson, Mass. (Tel. JOrdan 2-3444)
Purch. Agent: Ira J. Habeshian
V. P.-Sales: Joseph P. Crosby **M, RD**

LAPP INSULATOR CO., INC., RADIO SPECIALTIES DIV.
42 Gilbert St., LeRoy, N. Y. (Tel. 385)
Purch. Mgr.: Dean H. Lapp
Sales Mgr.: Sumner P. Lapp **M**

CHARLES E. LARSON & SONS, INC.
2645-65 N. Keeler Ave., Chicago 39, Ill. (Tel. SP 2-9700)
Purch. & Sales: Charles M. Larson **M**

***LAVELLE AIRCRAFT CORP.**
Sterling St., Newtown, Bucks County, Pa. (Tel. WOrth 8-3838)
V. P. & Purch. Agent: H. A. Liese
Contracts Mgr.: Frank V. Kiefer
Chief Engr.: Adolph Herzog **S, PS, MS**
*(See advertisement this issue)

LA VEZZI MACHINE WORKS
4635 W. Lake St., Chicago 44, Ill. (Tel. ESterbrook 8-1636)
Purch. Agent: Jerome J. Kremer
Sales Mgr.: Worth Baird **MS, CT, TT**

LAVOIE LABS., INC.
Matawan-Freehold Rd., Morganville, N. J. (Tel. LOwell 6-2600)
Purch. Agent: G. F. Craddick
Buyers: N. Robinson & J. Higgins
Sales Admin.: A. P. Buckley **MS, CT, RD**

LAWRENCE PUMPS INC.
371 Market St., Lawrence, Mass. (Tel. MUrdock 2-5249)
V. J. Mill, Jr.

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

LEA MFG. CO., THE
16 Cherry Ave., Waterbury 20, Conn. (Tel. PLaza 3-5116)
Dir.-Purch.: William D. Starr
V. P.-Sales: Richard P. Crane

LEACH CORP.
18435 Susana, Compton, Calif. (Tel. NE 6-1061)
Purch. Agent, Spec. Prod. Div.: Robert Burns
Purch. Agent, Relay Div.: Al Rose
Purch. Agent, Inst Div.: Rudy Jantz
V. P.-Sales: James Dysart **MS, CT, TT, RD**

LEACH & GARNER CO., INDUSTRIAL DIV.
School St., Attleboro, Mass. (Tel. ATtleboro 1-1155)
Purch. Agent: Preston Stevenson, Jr.
Gen. Mgr.-Sales: Gerald F. Tucci **M**

LEAK DIV.-BRITISH INDUSTRIES CORP.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Sales Mgr.: Roger Daniel

LEAR, INC.
3171 S. Bundy Dr., Santa Monica, Calif. (Tel. EX 1-7211)
Chm.-Bd.: W. P. Lear, Sr.
Pres.: A. G. Handschumacher
Exec. V. P.: K. R. Hahn
Sr. V. P. & Secy: P. E. Golde
Group V. P.'s: A. F. Haiduck & Roy J. Benecchi
Astronics Div.: 3171 S. Bundy Dr., Santa Monica, Calif. (Tel. EX 1-7211)
V. P. & Div. Gen. Mgr.: J. P. Brown
Contracts: E. J. Petterson
Purch. Agent: R. H. Loomis
Electro-Mechanical Div.: 110 Ionia Ave., N. W., Grand Rapids, Mich. (Tel. GLendale 1-1542)
V. P. & Div. Gen. Mgr.: T. K. Greenlee
Contracts: J. B. Harmon
Purch. Agent: O. Werts
Instrument Div.: 110 Ionia Ave., N. W., Grand Rapids, Mich. (Tel. GLendale 1-1542)
V. P. & Div. Gen. Mgr.: J. M. Walsh
Contracts: R. W. Richardson
Purch. Agent: R. S. Thies
Lear-Romec Div.: Abbe Rd., Elyria, Ohio (Tel. FAirfax 3-3211)
V. P. & Div. Gen. Mgr.: H. C. Andrus
Contracts: J. E. McKeighan
Purch. Agent: W. W. Wilbur
Service Div.: 110 Ionia Ave., N. W., Grand Rapids, Mich. (Tel. GLendale 1-1542)
Div. Gen. Mgr.: R. W. Harbison
Asst. Div. Gen. Mgr.: C. J. Hafner
S, MS, M, G, CT, TT, RD, HSE

LEBANON STEEL FOUNDRY
1st Ave. & E. Lehman St., Lebanon, Pa. (Tel. CR 3-1611)
Dir.-Purch.: C. R. Mease
Gen. Sales Mgr.: W. H. Flynn **M**

LEBEC CHEMICAL CORP.
14066 S. Garfield Blvd., Paramount, Calif. (Tel. NEvada 6-3381)
Purch. Agent: George Wolf
Pres.: John C. Plummer **M, RD**

R. K. LEBLOND MACHINE TOOL CO.
Madison & Edwards Rds., Cincinnati, Ohio (Tel. JEfferson 1-0910)
Purch. Agent: Wm. McK. Reis
V. P.-Sales: B. N. Brockman

LECTROHM, INC.
5560 Northwest Hwy., Chicago 30, Ill. (Tel. ROdney 3-1700)
Head-Purch. Dept.: Mrs. E. Newman
Head-Sales: J. Rinaldi

LEDEEN INC.
3350 N. Gilman Rd., El Monte, Calif. (Tel. CUmberland 3-3163)
Purch. Agent: E. J. Hoy
Sales Mgr.: Harold Rosoff **CT**

LEE CO., THE
523 Boston Post Rd., Old Saybrook, Conn. (Tel. EVergreen 8-3564)
Dir.-Purch.: E. Shields
Sales Mgr.: Albert B. Stevens **RD**

LEE ELECTRIC & MFG. CO.
2806 Clearwater St., Los Angeles 39, Calif. (Tel. NO 3-1295) **MS**

LEECE-NEVILLE CO., THE
1374 E. 51st St., Cleveland 14, Ohio (Tel. HEnderson 1-0740)
Gen. Purch. Agent: James D. Barlow
V. P.-Sales: Harold J. Zuske **RD**

LEECRAFT MFG. CO., INC.
58-60 Greene St., New York 12, N. Y. (Tel. WOrth 6-2855)
Dir.-Purch.: N. R. Sherwin
Dir.-Sales: R. S. Nelson

LEEDS & NORTHRUP CO.
4970 Stenton Ave., Philadelphia 44, Pa. (Tel. DAvenport 9-4900)
Mgr.-Purch. Dept.: J. E. Jennings
Chief Buyer: C. E. Totoritis
Sales Mgr.: H. L. Scutt **CT**

LEEMATH INC.
Oak Dr., Syosset, N. Y. (Tel. WAlnut 1-3080)
Purch. Agent: Jean Z. Lebkuecher
Mgr.-Customer Relations: M. G. Gosselink, Jr. **G, CT**

LEETRONICS, INC.
30 Main St., Brooklyn 1, N. Y. (Tel. ULster 5-7163)
Purch. Agent: T. Dalton
Gen. Mgr.-Sales: O. M. Lerz, Jr. **M, RD**

LEFFINGWELL CHEMICAL CO.
P. O. Box 1187, Perry Annex, Whittier, Calif. (Tel. OWen 7-1716)
Purch. Agent: J. W. Kinsman
Sales Mgr., Indsl. Div.: A. J. Frieling **M**

LE FIELL MFG. CO.
3359 Packers Ave., Los Angeles 58, Calif. (Tel. LUdlow 8-8266)
Purch. Agent: Frank Brink
Sales Prom.: R. B. Whitfield **S, PS, MS, M, RD**

LEGRIS RESISTOR CORP.
391 Riverdale Ave., Yonkers 5, N. Y. (Tel. YOnkers 9-600)
Dir.-Sales: George Saderman **MS, RD**

LEHIGH STRUCTURAL STEEL CO.
17 Battery Pl., New York 4, N. Y. (Tel. WHitehall 4-1424)
Gen. Sales Mgr.: E. A. Murphy
Purch. Agent: T. C. Neil, Foot of Allen St., Allentown, Pa. (Tel. HEmlock 4-5221) **S**

LEIMAN BROTHERS, INC.
P. O. Box 1339, 146-181 Christie St., Newark 1, N. J.
Purch. Agent: Frank Cristo
Sales Mgr.: J. R. Whipp

L E L, INC.
380 Oak St., Copiague, L. I., N. Y. (Tel. AM 4-2200)
Purch. Agent: Charles Lupo
Sales: C. A. Nuebling **G, TT, RD**

LELAND AIRBORNE PRODUCTS, DIV.-AMERICAN MACHINE & FOUNDRY CO.
P. O. Box 128, 740 E. National Hwy., Vandalia, Ohio (Tel. TWin Oaks 8-5881)
Purch. Agent: Walter Stump
Buyers: D. Bechtol & M. Booher
Sales Mgr.: E. C. Johns **MS**

G. H. LELAND, INC.
123 Webster St., Dayton 2, Ohio (Tel. BAldwin 4-9891)
Purch. Agent: Morris M. Wright
Sales Mgr.: Hans G. Belitz
Mgr., Materials: K. Woolley
Buyer: Leo Watkins **G, CT, RD**

LEMERT ENGRG. CO., INC.
1313 Western Ave., Plymouth, Ind. (Tel. WEbster 6-3430)
Head-Purch. Dept.: E. R. Lemert
Head-Sales: J. F. Sherrill **S, RD**

LENKURT ELECTRIC CO., INC.
1105 County Rd., San Carlos, Calif. (Tel. LYtell 1-8461)
Mgr., Purch. & Materials: David Steinberg
Buyers: William Palmer & Gordon R. Mead
Mgr., Govt. Relations: Joseph R. Sherman
MS, TT, RD

LENNOX TOOL & MACHINE BUILDERS
651 N. Baxter St., Lima, Ohio (Tel. CApitol 6-5015)
Purch. Agent: Louis Kundert
Gen. Mgr.: L. W. Nichols
Sales Mgr.: W. V. Trask

LENOX INSTRUMENT CO.
2010 Chancellor St., Philadelphia 3, Pa. (Tel. LOcust 6-6653)
Dir.-Purch.: John W. Lang **CT, RD**

LENZ ELECTRIC MFG. CO.
1751 N. Western Ave., Chicago 47, Ill. (Tel. ARmitage 6-4454)
Purch. Agent: Charles M. Wilkins
Exec. V. P.: R. G. Zender **M**

***WALLACE O. LEONARD, INC.**
373 S. Fair Oaks Ave., Pasadena 1, Calif. (Tel. MUrray 1-4446)
Purch. Agent: Robert L. Todd
Contract & Sales Admin.: Kenneth I. Stubbs
Sales Mgr.: Harry D. Dickinson
Chief Engr.: R. V. Henry
Chief Test Engr.: L. D. Lyon **MS, G, CT**
*(See advertisement this issue)

LEPEL HIGH FREQUENCY LABS. INC.
54-18 37th Ave., Woodside 77, N. Y. (Tel. HAvemeyer 6-4580)
Purch. Agent: Samuel Naiman
Mgrs.-Sales & Service: H. H. Watjen & C. L. Jennings

LERCO ELECTRONICS, INC.
501 S. Varney St., Burbank, Calif. (Tel. VIctoria 9-5556)
Purch. Agent: Sylvia Garmong
V. P.-Sales: Harold J. Wittmeyer **MS, G, CT, TT**

LESLIE CO.
321 Delafield Ave., Lyndhurst, N. J. (Tel. GEneva 8-8000)
Purch. Agent: T. Warcholik
Dir.-Sales: R. W. Boettiger **MS**

R. G. LETOURNEAU, INC.
2399 S. MacArthur, Longview, Texas (Tel. PLaza 3-4411)
Dir.-Purch.: John Williamson
Defense Proj. Section: H. V. Anderson
V. P.-Sales: R. L. LeTourneau **MS**

LOUIS LEVIN & SON, INC.
3610 S. Broadway, Los Angeles 7, Calif. (Tel. ADams 3-7169)
Mgr.-Purch. & Sales: Samuel Levin

LEVINTHAL ELECTRONIC PRODUCTS, INC.
3180 Hanover St., Palo Alto, Calif. (Tel. DAvenport 6-1640)
Purch. Agent: Robert H. Shimer
Mgr., Applications Engrg.: Robert V. Johnson

LEVITON MFG. CO., INC.
236 Greenpoint Ave., Brooklyn 22, N. Y. (Tel. EV 3-4500)
Purch. Mgr.: Joe Wolfson
Sales Mgr.: Jack Amsterdam

***LEWIS ENGRG. CO., THE**
339 Church St., Naugatuck, Conn. (Tel. PArk 9-5253)
Purch. Agent: M. N. Forde
Chief Field Engr.: H. D. Alexander **M**
*(See advertisement this issue)

WARNER LEWIS CO., DIV.-FRAM CORP.
817 N. Lewis Pl., Tulsa, Okla. (Tel. WEbster 9-6386)
Purch. Agent: R. P. Leedy
Asst. Purch. Agent: Jesse L. Bailey
V. P.-Sales: T. R. Bradley **MS**

LEWIS & KAUFMAN
Box 337, Los Gatos, Calif. (Tel. EL 4-3540)
Purch. Agent: C. W. Streeter
Gen. Mgr.: A. J. Thompson **RD**

LEWIS & SAUNDERS, INC.
20 Bayside St., Lakeport, N. H. (Tel. LAkeside 4-2064)
Gen. Mgr.-Purch.: W. W. Saunders **PS**

LIBBEY-OWENS-FORD GLASS CO.
811 Madison Ave., Toledo 3, Ohio (Tel. CHerry 2-5781)
Dir.-Purch.: J. C. Diehl
V. P.-Sales: Clinton F. Hegg

LIBERTY MIRROR DIV., LIBBEY-OWENS-FORD GLASS CO.
851 Third Ave., Brackenridge, Pa. (Tel. ACademy 4-1800)
Purch. Agent: C. R. MacDonald
Gen. Mgr.: J. C. Ogle, Jr.

LIBRASCOPE DIV., GENERAL PRECISION, INC.
808 Western Ave., Glendale, Calif. (Tel. CItrus 4-6541)
Mgr., Material Dept.: M. L. Cowan
Asst. Purch. Agent: C. M. Brown
PS, MS, M, G, TT, RD

LICON SWITCH & CONTROL DIV., ILLINOIS TOOL WORKS
6606 W. Dakin St., Chicago 34, Ill. (Tel. AVenue 2-4040)
Buyer: R. J. Salners
Dir.-Sales & Engrg.: J. O. Roeser **M**

LIECO, INC.
Syosset Industrial Park, Syosset, L. I., N. Y. (Tel. WAlnut 1-6300)
Dir.-Purch.: James Mackey
Dir.-Sales: William McHugh **MS, G**

A. LIETZ CO., THE
840 Post St., San Francisco 9, Calif. (Tel. PRospect 6-0740)
Merchandising Mgr.: C. W. Crocker
Asst. Merchandising Mgr.: R. E. Hartman
Gen. Sales Mgr.: Paul Princelau **M**

LIGHT METALS, INC.
1100 E. 24th St., Indianapolis 5, Ind. (Tel. WAlnut 6-4591)
Purch. Agent: Kenneth R. Goodwin
V. P.-Sales: Thomas H. Hargitt **S, PS, MS, M, G, CT, TT, RD**

LINCOLN ELECTRIC CO., THE
22801 St. Clair Ave., Cleveland 17, Ohio (Tel. IVanhoe 1-8100)
Dir.-Purch.: H. A. Burnip
Exec. V. P.-Sales: J. S. Roscoe

LINDBERG ENGRG. CO.
2450 W. Hubbard St., Chicago 12, Ill. (Tel. MOnroe 6-3443)
Purch. Agent: E. A. Griebe
Sales Mgr.: C. F. Burling

LINDE CO., DIV.-UNION CARBIDE CORP.
30 E. 42nd St., New York 17, N. Y. (Tel. MU 7-8000) **M**

LINDGREN FOUNDRY CO.
717 Main St., Batavia, Ill. (Tel. TRemont 9-1800)
Purch. Agent: E. N. Boyd
Works Mgr.: H. W. Miner **M**

LINE MATERIAL INDUSTRIES, McGRAW-EDISON CO.
700 W. Michigan, Milwaukee 1, Wis. (Tel. BR 2-8777)
Purch. Agent: Robert Olson, 12th & Madison Sts., S. Milwaukee, Wis. (Tel. SO 2-2500)

LINEAR, INC.
State Rd. & Levick St., Philadelphia 35, Pa. (Tel. MA 4-4700)
Purch. Agent: H. Wolfe, Dallas, Pa. (Tel. ORchard 4-1541)
V. P.-Sales: F. A. Lewis **PS, MS, M, G, RD**

LING ELECTRONICS DIV.-LING-ALTEC ELECTRONICS, INC.
1515 S. Manchester Ave., Anaheim, Calif. (Tel. PRospect 4-2900)
Dir.-Purch.: H. D. Copeland
V. P.-Sales: Charles Theodore **CT, RD**

LINK DIV., GENERAL PRECISION, INC.
Hillcrest, Binghamton, N. Y. (Tel. RA 3-9311)
Purch. Agent: M. B. Bird
Asst. Purch. Agent: N. Tatich
V. P.-Sales: L. L. Kelly

LINK-BELT CO.
1700 Prudential Plaza, Chicago 1, Ill. (Tel. RAndolph 6-7790)
V. P.-Sales: David E. Davidson
Purch. Agent: Dan E. Cobb, Los Angeles 22, Calif. (Mail Address, Box 22056, 1200 Sycamore St., Montebello, Calif.)
Purch. Agent: George Somps, 400 Paul Ave., San Francisco 24, Calif.
Purch. Agent: James T. McDonald, Box 10514, Sta. A., 1116 Murphy Ave., S. W., Atlanta 10, Ga.
Purch. Agent: Andrew K. Kolar, (Pershing Rd. Plt.) 300 W. Pershing Rd., Chicago 9, Ill.
Purch. Agent: Albert W. Weldon, (Caldwell Plt.) 2410 W. 18th St., Chicago 8, Ill.
Purch. Agent: Richard J. Joyce, 220 S. Belmont Ave., Indianapolis, Ind.
Purch. Agent: Marvin H. Cramer, 200 Lyndale Ave., N., Minneapolis 5, Minn.
Purch. Agent: Albert W. Boegner, Colmar, Pa.
Purch. Agent: F. Walter Skerrett, 2045 W. Hunting Park Ave., Philadelphia 40, Pa.
Purch. Agent: John H. Canada, Box 2563, 3203 South Wayside, Houston 1, Texas
Purch. Agent: Charles Percich, 3405 Sixth Ave., S., Seattle 4, Wash. **MS, M**

LION FASTENER CO., INC.
c/o Southco, Lester, Pa. (Tel. LEhigh 4-1800)
Purch. Agent: C. R. Hirzel
Sales: T. R. Dunlevy **M**

EDWIN A. LIPPS ENGRG.
1511 Colorado Ave., Santa Monica, Calif. (Tel. EX 3-0449)
Prod. Supvr.: Vernon Geier
Gen. Mgr.: B. D. Lipps **CT, TT**

LIQUID CARBONIC DIV.-GENERAL DYNAMICS CORP.
135 S. LaSalle St., Chicago 3, Ill. (Tel. FInancial 6-8181)
Purch. Agent: Owen Mathews
Gen. Sales Mgr., Carbon Dioxide: E. N. Batchelor
Gen. Sales Mgr., Indsl. Gases: Edward Elliott, Jr.
V. P.-Sales: H. C. Mathey **MS, M, CT, RD**

LIQUIDOMETER CORP., THE
41-03 36th St., Long Island City 1, N. Y. (Tel. STillwell 4-1440)
Purch. Agent: Richard H. Hogan
V. P.-Sales: Harry T. Cullinan

G. W. LISK CO., INC.
Clifton Springs, N. Y. (Tel. HOward 2-2611)
Dir.-Sales: I. A. Morris **PS, MS, G, CT, TT, RD**

LITHIUM CORP. OF AMERICA, INC.
1100 Title Ins. Bldg., Minneapolis 1, Minn. (Tel. FEderal 2-7451)
Mgr., Chemical Sales Dept.: J. D. Campbell, 60 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-5865)
Mgr., Mech. Products Dept., Fulton-Irgon Div.: N. David Fulton, P. O. Box 591, Dover, N. J. (Tel. FOxcroft 6-7474) **PS, M, RD**

LITHIUM CORP. OF AMERICA, INC., FULTON-IRGON DIV.
P. O. Box 591, Dover, N. J. (Tel. FOxcroft 6-7474)
Div. Mgr.: David Fulton
Purch. Agent: John Byrne
Sales Mgr.: A. Schellman **PS, RD, HSE**

LITHO-ETCH METAL NAME PLATE CO.
323 Sound View Ave., New York 72, N. Y. (Tel. TYrone 3-7350)
Dir.-Purch.: Michael Erra
Foreman: Pat Erra
Mgr.: Al-Conti

LITTELFUSE, INC.
1865 Miner St., Des Plaines, Ill. (Tel. VAnderbilt 4-1188)
V. P.-Dist. Sales: W. A. Clements
V. P.-Mfg. Sales: H. A. Cornelius

ARTHUR D. LITTLE, INC.
35 Acorn Park, Cambridge 40, Mass. (Tel. UNiversity 4-5770)
Chief Purch. Agent: Daniel Leone
Dir.-Sales, Engrg. Div.: John Harvell **RD**

LITTON ENGRG. LABS.
P. O. Box 949, Grass Valley, Calif. (Tel. Grass Valley 1730)
Purch. Agent: Mrs. Grace Martz
Gen. Mgr.: F. L. Towne **M**

LITTON INDUSTRIES
336 N. Foothill Rd., Beverly Hills, Calif. (Tel. CRestview 4-7411)
Public Relations: C. V. Meconis **G, TT, RD, HSE**

LITTON INDUSTRIES, MARYLAND DIV.
4900 Calvert Rd., College Park, Md. (Tel. UNion 4-5678)
Dir.-Purch.: Jack Limozaine
Buyers: Bruce Bayliss & Thomas McNamara **MS, G, CT, TT, RD**

LITTON INDUSTRIES, U. S. ENGRG. CO. DIV.
13536 Saticoy St., Van Nuys, Calif. (Tel. ST 6-9381)
Purch. Agent: Richard J. Lee
Sales Mgr., Electronic Hardware: Paul J. Robichaud
Sales Mgr., Printed Circuits: Richard J. Kuri

LIVERMONT, INC.
Myrtle & Maple Aves., Monrovia, Calif. (Tel. ELliott 9-2555)
Purch. Agent: J. F. Hubbard
V. P.-Purch.: J. R. Ewell
Dir.-Mktg.: H. B. Banta, Jr.

LIVINGSTON ELECTRONIC CORP.
27 Runnymede Rd., Essex Fells, N. J. (Tel. CApital 6-3333)
Prod.: Charles L. Nolte
Pres.: Charles E. Smiley **MS, RD**

LOCKHEED AIRCRAFT CORP., MISSILES & SPACE DIV.
1122 Jagels Rd., P. O. Box 504, Sunnyvale, Calif. (Tel. REgent 9-3421)
Gen. Purch. Agent: L. G. Sinning
Dir.-Market Dev.: Wilbur D. Snow **S, PS, MS, G, CT, TT, RD, HSE**

LOCKHEED ELECTRONICS CO., STAVID DIV.
U.S. Hwy. 22, Plainfield, N. J. (Tel. PL 7-1600)
Purch. Agent: J. H. Tehorni
Dir.-Contracts & Sales: H. J. Bradfield **G, CT, TT, RD**

LOCKREY CO., THE, LUBRICANTS DIV.
P. O. Box J, Southampton, N. Y. (Tel. SOuthampton 1-0278)
Purch. Agent: John Anderson
Sales Mgr.: D. I. McMeekan **M**

LODGE & SHIPLEY CO., THE
3055 Colerain Ave., Cincinnati 25, Ohio (Tel. KIrby 1-4774)
Purch. Agent: John Bates
Gen. Sales Mgr.: Donald O. Edwards
Sales Prom. Mgr.: Walter N. Foster **S**

LOEWY-HYDROPRESS INDUSTRIAL EQUIPMENT DIV., BALDWIN-LIMA-HAMILTON CORP.
111 Fifth Ave., New York 3, N. Y. (Tel. OREgon 7-5030)
Gen. Mgr.: Frederick F. Fielder
Sales: Paul Mayer
Purch. Mgr.: John Swanberg

LOFSTRAND CO., THE
Southlawn Lane, Rockville, Md. (Tel. HAzlewood 7-7280)
Purch. Agent: G. M. Chadwick
V. P.-Sales: Henry Clark **S, MS**

J. M. LOGE, SOUND ENGINEERS
2171 W. Washington Blvd., Los Angeles 18, Calif. (Tel. REpublic 4-9178)
Purch. Agent: Merle Adkins
Dir.-Sales: J. M. Loge

LOGETRONICS INC.
500 E. Monroe Ave., Alexandria, Va. (Tel. TE 6-5180)
Purch. Agent: William F. Hamilton
Dir.-Sales: Gordon O. F. Johnson **G**

LONDON CHEMICAL CO., INC.
1535 N. 31st Ave., Melrose Park, Ill. (Tel. AUstin 7-9495)
Purch. Agent: R. I. Schub
Sales Mgr.: K. W. Anderson **M**

LONE STAR PLASTICS CO. INC.
124 Roberts Cut Off Rd., P. O. Box 12007, Fort Worth, Texas (Tel. PE 2-1437)
Purch. Agent: Mrs. Catherine Hare
Dir.-Operations: Creston Perrin
Sales Mgr.: W. P. Fralia **PS, M**

THOMAS J. LONG, INC.
215 Stonehinge Lane, Carle Place, L. I., N. Y. (Tel. EDgewood 4-2300)
Asst. to V. P.: John J. Skelly
Sales Mgr.: Norman A. Terry **M, G, CT, RD**

W. D. LONG PACKAGING CO.
157 Santa Clara St., Arcadia, Calif. (Tel. HIllcrest 7-1237)
Dir.-Purch.: W. D. Long

LORAL ELECTRONICS CORP.
825 Bronx River Ave., New York 72, N. Y. (Tel. TIvoli 2-9500)
Dir.-Material: Seymour Frost
V. P.-Sales: E. M. Siegel **MS, RD**

LORD MFG. CO.
1635 W. 12th St., Erie, Pa. (Tel. GLendale 6-8511)
Purch. Agent: D. P. Cobb
Buyers: H. F. Hultgren & J. E. Prettyman
Mgr., Mktg.: J. C. Mitchell **S, MS, M**

LOVEJOY FLEXIBLE COUPLING CO.
4949 W. Lake St., Chicago 44, Ill. (Tel. ES 9-3010)
V. P.-Purch.: C. P. Hennessy
Purch. Agent: Leslie Cousins
V. P.-Sales: W. B. Briggs

LUBER-FINER INC.
2514 S. Grand Ave., Los Angeles 7, Calif.

LUCIFER FURNACES INC.
374 Easton Rd., Neshaminy, Pa. (Tel. DI 3-0411)
Gen. Mgr.-Purch. & Sales: S. J. Stea
Engr.: J. Shingle
Pres.: C. Dinon **RD**

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

LUKENS STEEL CO.
1st Ave., Coatesville, Pa. (Tel. 2000)
Purch. Agent: Albert Gudal
Dir.-Purch.: Edmund Pfeifer
Supvr.-Stores & Material: Thomas A. O'Hara
Buyers: Wilmer Montgomery, John M. Davis, Donald Davis & Arthur M. Daggett **MS, M**

LUMEN, INC.
Moen Ave., P. O. Box 905, Joliet, Ill. (Tel. SAratoga 3-9324)
Purch. Agent: James T. McGrath
Asst. Purch. Agent: John Voychak
Sales Mgr., Components: Hal Borgen
Sales Mgr., Govt.: Robert H. Johnson **MS, G, TT, RD**

LUNDY MFG. CORP.
Glen Head, L. I., N. Y. (Tel. ORiole 6-1440)
Purch. Agent: Joseph A. Barbado
Buyers: Durell Piersall & John Komst
Pres.: R. C. Barbado **MS, G, RD**

LUNN LAMINATES, INC.
Oakwood Rd. & W. 11th St., Huntington Station, N. Y. (Tel. HAmilton 3-7200)
Purch. Agent: Edward W. Kirchner
Pres.: James S. Lunn
Buyer: Gerard P. Gregor **S, MS**

LUX CLOCK MFG. CO., INC.
95 Johnson St., Waterbury, Conn. (Tel. PL 6-3661)
Purch. Agent: Arthur Kunkel, Jr.
Asst. Purch. Agent: Carl Hungerford
Indsl. Sales Mgr.: Eugene T. Crandall

LUZERNE RUBBER CO.
Muirhead Ave., Trenton, N. J. (Tel. EXport 2-4131)
Purch. Agent: William Gummere
Sales Mgr.: M. J. Kearney, Jr. **M**

LYCOMING DIV., AVCO CORP.
550 S. Main St., Stratford, Conn. (Tel. DRexel 8-8211)
Dir.-Materials: Frank J. Larkins
Purch. Mgr.: George J. Rapuano
Purch. Agent: D. E. Kirby
Sales Mgr.: Stanley R. Brodhead **S, PS, MS, M, CT, TT, RD**

R. H. LYNCH MFG. CO.
7831 E. Arroyo Dr., South San Gabriel, Calif. (Tel. AT 0-3810)
Pres.: R. H. Lynch
V. P.-Sales: J. W. Lynch

LYNCH CARRIER SYSTEMS INC.
695 Bryant St., San Francisco 7, Calif. (Tel. EXbrook 7-1471)
Purch. Agent: J. E. Gilchrist
Sales Mgr.: E. B. Stone

LYNCOACH & TRUCK CO. INC.
440 Chestnut St., Oneonta, N. Y. (Tel. GEneral 2-2900)
Purch. Agent: Royce Strait
Pres.: James Friery
Sales Mgr.: Charles MacLean **MS**

LYON AIRCRAFT SERVICES
2701 N. Ontario St., Burbank, Calif. (Tel. VIctoria 9-3317)
Mgr.-Prod. & Engrg.: W. F. McCann
Gen. Mgr.: Ralph C. Butler **M**

LYON METAL PRODUCTS, INC.
6 Railroad Ave., Aurora, Ill. (Tel. TWinoaks 7-8421)
Dir.-Purch.: S. C. Senyard
Gen. Sales Mgr.: Leo F. Tilly

LYON VAN & STORAGE CO., AIRCRAFT DIV.
2701 N. Ontario St., Burbank, Calif. (Tel. VIctoria 9-3317)
Prod. Mgr.: William F. McCann
Gen. Mgr.: Ralph C. Butler **M**

LYTEL CORP.
1404 San Mateo, S.E., Albuquerque, N.M. (Tel. AMherst 8-3311)
Supvr., Purch. Dept.: Perry Weaver
Exec. Engr.: Julian Prade **M**

LYTLE ENGRG. & MFG. CO.
1404 San Mateo, S.E., Albuquerque, N. Mex. (Tel. ALpine 5-1671)
Purch. Agent: Perry Weaver
Div. Mgr.-Sales: L. V. Julihn **MF, WN, PS, GS, GH, GE, CO, TS, TR**

MB ELECTRONICS
P. O. Box 1825, New Haven 8, Conn. (Tel. FUlton 9-1511)
Purch. Agent: Carl Verderame
Chief Sales Engr.: A. C. Deichmiller **CT**

M. C. MFG. CO.
P. O. Box 126, 118 Indianwood Rd., Lake Orion, Mich. (Tel. MYrtle 2-2711)
Buyer: R. Rhodes
Sales: H. P. Ott **PS, MS**

M-D BLOWERS, INC.
100 Fourth St., Racine, Wis. (Tel. MElrose 4-5521)
Purch. Agent: Parker Thornton
Sales Mgr.: Davis Spencer **MS**

MEG PRODUCTS, DIV., MANDREL INDUSTRIES, INC.
2950 N. Ontario St., Burbank, Calif. (Tel. VIctoria 9-2341)
Purch. Agent: B. E. Roper
Gen. Sales Mgr.: Edward J. Stephens

MPM, INC.
9110 George Ave., Cleveland 5, Ohio (Tel. BRoadway 1-4456)
V. P.-Purch.: A. B. Cook
Sales Engr.: J. M. Van Walshauser

M & Q PLASTIC PRODUCTS
Bannard St., Freehold, N. J. (Tel. FReehold 8-6663)
V. P.-Purch.: William Menges
Pres.: Frank Quinn **M**

MSA RESEARCH CORP.
Callery, Pa. (Tel. EVans City 3510)
Purch. Agent: R. C. Baird
Buyer: E. L. Oviatt
Dir.-Mktg.: C. H. Staub **RD**

M-W LABS., INC.
1824 N. Milwaukee Ave., Chicago, Ill. (Tel. DIckens 2-4020)
Plant Supt.: Norbert Sajdera
Gen. Mgr.: K. A. Dormeyer

MAAS & WALDSTEIN CO.
2121 McCarter Hwy., Newark 4, N. J. (Tel. HUmbolt 4-1600)
Purch. Agent: James Dowd
Sales Mgr., Eastern Div.: Don Volino
Sales Mgr., Mid-West Div.: Charles Berry **M**

MACARR, INC.
4360 Bullard Ave., New York 66, N. Y. (Tel. FA 5-5510)
Purch. Agent: Frank LaMantia
Pres.: Philip P. Bruno

MACHINE PRODUCTS DIV., NEW HAVEN TRAP ROCK CO.
Route 80, N. Branford, Conn. (Tel. HUbbard 4-0444)
Purch. Agent: S. J. Barcsansky
Asst. Purch. Agent: S. E. Engstrom
Chief Buyer: W. C. Dahill
Div. Sales Mgr.: D. A. Briggs **PS, MS**

MACKAY RESEARCH LABS.
P. O. Box 738, Benson, Ariz.
Dir.-Purch.: Diane MacKay
Dir.-Sales: Sanders MacKay **RD**

MACKENZIE WALTON CORP.
478 Pawtucket Ave., Pawtucket, R. I. (Tel. PAwtucket 2-6837)
Purch. Agent: Don M. Cowley
Gen. Mgr. & V. P.: N. W. Fulton
Supt.: J. L. Schaefer
Sales Mgr.: Morris Wuerpel **M**

MACLEOD & HANOPOL, INC.
10 Roland St., Charlestown 29, Mass. (Tel. MO 6-2171)
Pres.: A. D. Macleod

MACWHYTE WIRE ROPE CO.
2906 14th Ave., Kenosha, Wisc. (Tel. OLympic 4-5381)
Purch. Agent: John Goodwin
V. P.-Sales: F. D. Holden **M**

MADIGAN CORP.
200 Stonehinge Lane, Carle Place, L.I., N. Y. (Tel. ED 4-2500)
Exec. V. P.-Purch.: Ciro F. Amodeo
Dir.-Mktg.: Norbert E. Andres **MS, CT, TT, RD**

MAGEE-BRALLA & ASSOCIATES
3361 National Ave., San Diego 13, Calif. (Tel. BE 3-7769)
Partners: Robert L. Bralla & J. Rodgers Magee **MS, RD, HSE**

MAGLINE INC.
1802 Mercer St., Pinconning, Mich. (Tel. TRiangle 9-2411)
Purch. Agent: Roy Schairer
Gen. Sales Mgr.: Stanley R. See **S, M**

MAGNAFLUX CORP., SUB.-GENERAL MILLS, INC.
7328 W. Lawrence Ave., Chicago 31, Ill. (Tel. UNderhill 7-8000)
Purch. Agent: C. D. Ceske
Asst. Purch. Agent: L. Ondacek
V. P.-Sales & Mktg.: R. O. Schiebel **CT, RD**

MAGNASYNC CORP.
5546 Satsuma Ave., N. Hollywood, Calif. (Tel. TRiangle 7-5493)
Electronics Purch.: George Duerr
Mechanical Purch.: Louis Schirm **MS, TT**

***MAGNAVOX CO., THE**
2131 Bueter Rd., Ft. Wayne, Ind. (Tel. E 3967)
Dir.-Purch.: Warren Frebel (Tel. E 9721)
Mgr.-Gov't. Div.-Sales: David W. Martin **G, RD**
*(See advertisement this issue)

MAGNECRAFT ELECTRIC CO.
3352 W. Grand Ave., Chicago 51, Ill. (Tel. EVerglade 4-6868)
Dir.-Purch.: Ray Pettiford
Asst. Sales Mgr.: J. E. Deimel
Dir.-Sales: H. D. Steinback

MAGNE-HEAD DIV., GENERAL TRANSISTOR CORP.
2660 S. La Cienega Blvd., Los Angeles 34, Calif. (Tel. UPton 0-8601)
Purch. Agent: H. Aspinwaic
Buyers: C. Ellis & V. Carver
Dir.-Sales: Martin Braude **G, TT, RD**

MAGNESIUM CO. OF AMERICA
3801 N.W. 36th Ave., Miami 42, Fla. (Tel. NE 4-2672)
Purch. Agent: M. Cochrane
Sales Mgr.: A. L. Leach **S**

MAGNETIC CIRCUIT ELEMENTS, INC.
3722 Park Place, Montrose, Calif. (Tel. CH 8-4040)
Pres.: John S. Conklin
Chief Engr.: Ken Holmes
Mfg. Supvr.: Tom Reid
Sales Mgr.: Arthur Engstrom **M, G, CT, TT**

MAGNETIC CONTROLS CO.
6405 Cambridge St., Minneapolis 26, Minn. (Tel. WE 9-4691)
Dir.-Proc.: G. G. Bezat
Purch. Agent: J. J. Melhoff
Sales Mgr.: M. L. Mullin **G, TT**

MAGNETIC CORE CORP.
John & Lawrence Sts., Newburgh, N. Y. (Tel. NEwburgh 5116)
Purch. Agent: R. G. Burdick
Sales: Robert Webb **M**

MAGNETIC DEVICES, INC.
712 East St., Frederick, Md. (Tel. MO 2-2144)
Purch. & Sales Dept.: F. J. Cook **MS**

MAGNETIC INSTRUMENT CO., INC.
687 Commerce St., Thornwood, N. Y. (Tel. ROgers 9-5312)
Purch. Agent: Richard D. Levine
Sales Mgr.: Robert J. Levine **CT, RD**

MAGNETIC METALS CO.
Hayes Ave. at 21st St., Camden 1, N. J. (Tel. WOodlawn 4-7842)
Plant Engr.: A. F. Fischer
Asst. Plant Engr.: R. L. DuLaney
Purch. Agent: R. L. Stinson
V. P.-Sales: W. J. Miller **M**

MAGNETIC RESEARCH CORP.
3160 W. El Segundo Blvd., Hawthorne, Calif. (Tel. OSborne 5-1171)
Purch. Agent: Richard Hill
Sales Mgr.: H. A. Schmidt **MS, RD**

MAGNETIC SEAL CORP.
166 Bay Spring Ave., West Barrington, R. I. (Tel. CHerry 5-4800)
Purch. Agent: Everett E. Comey
Dir.-Sales: George E. Colby **M**

MAGNETIC SHIELD DIV.-PERFECTION MICA CO.
1322 N. Elston Ave., Chicago 22, Ill. (Tel. EVergläde 4-2122)
Purch. Agent: Henry Hucksold **M**

MAGNETICO, INC.
6 Richter Ct., E. Northport, L. I., N. Y. (Tel. ANdrew 1-4502)
Purch. Agent: Mrs. N. O'Brien
Dir.-Purch.: H. Eicher
Mgr., Amplifier Div.: E. Da Parma
V. P.-Sales: Mark A. Barry **M, G, RD**

MAGNUS CHEMICAL CO., INC.
102 South Ave., Garwood, N. J. (Tel. SUnset 9-0200)
Purch. Agent: George Slaight
Gen. Mgr.-Sales: E. H. Peterson M

MAGTROL, INC.
240 Seneca St., Buffalo 4, N. Y. (Tel. TL 6-7451)
Dir.-Purch.: James F. Duncan
Sales Mgr.: John E. Traise

R. C. MAHON CO., THE
6565 E. 8 Mile Rd., Detroit 34, Mich. (Tel. JE 6-8200)
Purch. Agent: C. D. Tucker S

MAICO ELECTRONICS, INC.
21 N. 3rd St., Minneapolis 1, Minn. (Tel. FEderal 9-7041)
V. P.-Indsl. Sales: J. T. Utne
Purch. Agent: John M. Wheeler
Asst. Purch. Agent: William E. Cunningham RD

MAIDA DEVELOPMENT CO.
214 Academy St., Hampton, Va. (Tel. PArk 3-0785)
Purch. Agent: R. J. Clopton
Pres.: F. X. Maida G, CT, TT

MAJOR TOOL & MACHINE, INC.
1719 N. Cornell Ave., Indianapolis 2, Ind. (Tel. WAlnut 5-9616)
Purch. Agent: Charles Dacoma
Dir.-Sales: J. A. Briere S, MS

MAK INDUSTRIES, INC.
1938 Park Ave., New York 37, N. Y. (Tel. TOmpkins 2-1660)
Dir.-Purch.: Miss M. Devos
Pres.: Mark N. Kert M

MALCO MANUFACTURING CO.
4025 W. Lake St., Chicago 24, Ill. (Tel. Van Buren 6-9300)
Purch. Agent: Walter J. Kulins
Sales Mgr.: Anthony Daidone M

P. R. MALLORY & CO. INC.
3037 E. Washington St., Indianapolis 6, Ind. (Tel. MElrose 6-5353)
Dir.-Purch.: George C. Mercer
Purch. Agent, Capacitor Co.: C. A. Rieman
Purch. Mgr., Metallurgical Co.: W. J. Topmiller
Purch. Mgr., Controls Co.: A. J. Rogers
Purch. Mgr., Elkon Div.: Ralph Meyers
Purch. Mgr., Electronics Div.: A. M. Sheehan
V. P.-Mktg.: H. C. Buell MS, M, RD

MALLORY-SHARON METALS CORP.
980 Warren Ave., Niles, Ohio (Tel. OL 2-9951)
V. P. & Gen. Mgr.: E. J. Cronin, Jr.
Dir.-Purch. & Traffic: B. E. Marquis M

MAMCO CORP.
532-542 Fourth St., Racine, Wis. (Tel. MElrose 4-1923)
Purch. Agent: J. H. Anderson
Buyer: R. Haluska
Sales Mgr.: F. E. Schumacher

MANGER ELECTRIC CO., INC.
N. State St., Stamford, Conn. (Tel. FIreside 8-7761)
Purch. Agent: James Judge
Sales Mgr.: B. L. Manger MS, G, CT, TT, RD

MANHATTAN LIGHTING EQUIPMENT CO., THE
16 Warren St., New York 7, N. Y. (Tel. WO 4-5594)
Mgr., Elec. Dept.: Arthur Cohen
Mgr., Hdwe. Dept.: Leo Bierster
Dir.-Sales: Arnold Denmark M

MANNING & LEWIS ENG. CO.
675 Rahway Ave., Union, N. J.
Purch. Agent: Robert H. Bender
Dir.-Sales: H. G. Gamble

MANSON LABORATORIES, INC.
375 Fairfield Ave., Stamford, Conn. (Tel. DAvis 5-1391)
M. Seroy RD

MARATHON BATTERY CO.
840 Henrietta St., Wausau, Wisc. (Tel. VI 2-2025)
Purch. Agent: C. W. Piehl
Secy.-Treas.: E. D. McEachran

MARBLETTE CORP., THE
37-31 30th St., Long Island City 1, N. Y. (Tel. STillwell 4-8100)
Research Dir.: Max Hilrich M, RD

MARBON CHEMICAL DIV.-BORG-WARNER CORP.
P. O. Box 68, Washington, W. Va. (Tel. GArfield 2-5401)
Dir.-Purch.: Rhoda M. Stewart
V. P. & Sales Mgr.: D. M. Pratt
Sales Mgr., Cycolac: W. A. Suiter

MARCHANT MACHINING CORP.
4704 Rhode Island Ave., Hyattsbille, Md. (Tel. WA 7-6203)
Secy.-Mgr.: John E. Norris M

MARCO INDUSTRIES CO.
207 S. Helena St., Anaheim, Calif. (Tel. KEystone 5-6037)
Purch. Agent & Prod. Supt.: F. C. Loehnig
Sales Mgr.: W. W. Bowles MS, G, CT, TT

MARCONI INSTRUMENTS
111 Cedar Lane, Englewood, N. J. (Tel. LOwell 7-0607)
Mgr.-Purch.: R. J. Bailey
Asst. Sales Mgr.: W. A. Buck TT

MARGINATOR CO.
1121 W. Magnolia Blvd., Burbank, Calif. (Tel. VIctoria 9-2877)
Pres.: Stanley Runyon
V. P.-Sales: Harold R. Foy CT

MARION INSTRUMENT DIV.-MINNEAPOLIS-HONEYWELL REGULATOR CO.
Manchester, N. H. (Tel. National 5-6971)
Purch. Agent: C. Heath
Buyer: R. Mahoney MS, G, CT, TT
V. P.-Sales: E. S. Maury

MARK PRODUCTS CO.
5439 W. Fargo Ave., Skokie, Ill. (Tel. ORchard 5-1500)
Plant Mgr.: A. Mueller
Dir.-Sales: E. Harris CT, TT, RD

MARKEM MACHINE CO.
150 Congress St., Keene, N. H. (Tel. ELmwood 2-1130)
Purch. Agent: C. E. Titcomb
Gen. Sales Mgr.: Robert Mensel

MARKITE CORP.
155 Waverly Pl., New York 14, N. Y. (Tel. ORegon 5-1384)
Purch. Agent: Jules Livingston
V. P.-Sales: Herbert A. Gottschall MS, G, CT, TT, RD

MARLIN-ROCKWELL CORP.
402 Chandler St., Jamestown, N. Y. (Tel. 61-541)
Dir.-Purch.: C. A Berg
Purch. Agent: G. J. Paquin
Asst. Purch. Agent: J. C. Slagle
V. P. & Gen. Sales Mgr.: B. J. Shallow M, RD

MARLO COIL CO.
7100 S. Grand Ave., St. Louis 11, Mo. (Tel. VE 2-5000)
Purch. Agent: K. Guillerming
V. P.-Sales: L. C. Pellegrini MS

MARMAN DIV., AEROQUIP CORP.
11214 Exposition Blvd., Los Angeles 64, Calif. (Tel. GRanite 3-0932)
Purch. Agent: W. E. Flaherty
Gen. Sales Mgr.: T. J. Josalle S, PS, MS, CT, RD

MAROTTA VALVE CORP.
Boonton Ave., Boonton, N. J. (Tel. DEerfield 4-7800)
Purch. Agent: Harold Richards
Sales Mgr.: Del Olson PS, MS, G, CT

MARQUARDT AIRCRAFT CO.
16555 Saticoy St., Van Nuys, Calif. (Tel. STate 1-2121)
Mgr.-Materiel: R. G. Francis
Mgr.-Materiel: P. C. Taylor (Ogden Div., Ogden, Utah, Tel. EXport 4-4511)
Purch. Agent: Wayne Jordan (Pomona Div., Pomona, Calif., Tel. LYcoming 3-1311) PS, GS, CO, TS, RD

MARQUARDT CORP., THE
16555 Saticoy St., Van Nuys, Calif. (Tel. STate 1-2121)
Purch. Agents: G. F. Gregg, J. M. Holloway, P. H. Shank
Dir.-Mktg.: P. J. Papanek S, PS, MS, M, CT, TT, RD

MARSH INSTRUMENT CO., DIV.-COLORADO OIL & GAS CORP.
3501 Howard St., Skokie, Ill. (Tel. ORchard 3-4300)
Purch. Agent: P. Keppeler
V. P.-Sales: R. E. Barnett CT, RD

MARSH STENCIL MACHINE CO.
707 E. B Street, Belleville, Ill. (Tel. ADams 4-1122)
Pres.: Walt Marsh
Secy.: E. J. Marsh
Treas.: John Marsh M

MARTIN CO., THE, BALTIMORE DIV.
Baltimore 3, Md. (Tel. MUrdock 7-3800)
Proc. Dir., Weapons System Engrg. Div.: E. D. Carter
Proc. Dir., Electronics Div.: H. A. Stricker
Dir., Sales Div.: C. H. Welling, Jr.
Dir.-Sales, Electronics Div.: A. H. Green

***MARTIN CO., THE, DENVER DIV.**
P. O. Box 179, Denver 1, Colo. (Tel. PYramid 4-5211)
Dir., Materiel Div.: C. E. Bloomer
Dir., Facilities Div.: H. H. Terry
Dir., Fabrication Div.: R. N. Blakey
Dir., Requirements Div.: O. E. Tibbs
S, PS, MS, M, G, CT, TT, RD, HSE
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MARTIN CO., THE, ORLANDO DIV.
P. O. Box 5837, Orlando, Fla. (Tel. CHerry 1-2411)
Dir.-Procurement: Edward R. McDonald
Dir.-Sales & Weapon System Support: C. O. Wingate

MARTIN MACHINE WORKS, INC.
P. O. Box 230, N. Lindell St., Martin, Tenn. (Tel. 5-1373)
Gen. Mgr.: Murray O. Fussell
Plant Supvr.: Spydell Davidson S

MARTINDALE ELECTRIC CO.
1375 Hird Ave., Cleveland 7, Ohio (Tel. LAkewood 1-8567)
Purch. Agent: C. H. Rueter
V. P.: William N. Osbun, Sr.
Sales Mgr.: J. W. Ackerman M

MARTIN-DECKER CORP.
3431 Cherry Ave., Long Beach 7, Calif. (Tel. GA 4-1696)
Purch. Agent: Frank Carson
Indsl. Sales Mgr.: Clayton Howard MS, CT

MASON ELECTRIC CORP.
3839 Verdugo Rd., Los Angeles 65, Calif. (Tel. CLinton 5-1431)
Purch. Agent: William J. Eagan
Sales Mgr.: William H. Moore MS

MASONITE CORP.
111 W. Washington, Chicago 2, Ill. (Tel. FRanklin 2-5644)
Purch. Agent: W. M. Morrison
Gen. Sales Mgr.: F. O. Marion M

MASON-NEILAN
Nahatan St., Norwood, Mass. (Tel. NOrwood 7-4600)
Purch. Agent: F. J. Kenney
Asst. Purch. Agent: L. Rocheleau
Sales Mgr.: J. M. McAlear
V. P.-Sales: C. W. Gram (Tel. ELdorado 5-1525) New York City MS

MASSA DIV.-COHU ELECTRONICS, INC.
5 Fottler Rd., Hingham, Mass. (Tel. RIverview 9-4800)
Purch. Agent: Robert R. Thomas
V. P. & Gen. Mgr.: Ernest A. Massa
Buyer: Herbert Phillips G, CT

MASSACHUSETTS GEAR DIV.-GEARTRONICS CORP.
918 Main St., W. Concord, Mass. (Tel. TWinoaks 7-2971)
Purch. Agent: G. Reid
Sales Mgr.: F. H. Kean M

MASTER MOBILE MOUNTS, INC.
4125 W. Jefferson Blvd., Los Angeles 16, Calif. (Tel. RE 1-2251)
Pres.: Samuel Goldstein (Tel. RI 7-0638)
Mgr.: Joe Goldfarb (Tel. RI 7-0639)

MASTER SPECIALTIES CO.
956 E. 108th St., Los Angeles 59, Calif. (Tel. LOrain 4-4481)
Purch. Agent: William Smith
Head-Sales: T. W. Hallerberg MS

MASTER TAPE PRINTERS
3400 N. Halsted St., Chicago 13, Ill. (Tel. EAstgate 7-3322)
Gen. Mgr.: Louis J. Dorfmeister
Head-Sales: Ruth G. Dorfmeister

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

MATHIAS KLEIN & SONS, INC.
7200 McCormick Rd., Skokia, Chicago 45, Ill. (Tel. JUniper 8-6820) M

JAS. H. MATTHEWS & CO.
3764 Forbes Ave., Pittsburgh 13, Pa. (Tel. MUseum 1-8500)
Purch. Agent: G. Gray, 3942 Forbes Ave., Pittsburgh 13, Pa.
V. P.-Sales: T. J. Miers

J. A. MAURER, INC.
37-01 31st St., Long Island City 1, N. Y. (Tel. STillwell 4-4600)
Sales Mgr.: Frank J. Kelly
Asst. Secy.: Leon Shaw

MAURER ARTCRAFT CO.
266 Boston Post Rd., Milford, Conn. (Tel. TR 4-7827)
Dir.-Purch.: F. C. Maurer, Sr.
Dir.-Sales: F. C. Maurer, Jr. S

MAUREY INSTRUMENT CORP.
7924 S. Exchange Ave., Chicago 17, Ill. (Tel. RE 1-1717)
Purch. Agent: Thomas F. Morris
Gen. Sales Mgr.: Joseph Popp G, TT, RD

W. L. MAXSON CORP., THE
475 10th Ave., New York 18, N. Y. (Tel. LOngacre 5-1900)
Purch. Mgr.: C. McDowell
Gen. Purch. Supvr.: T. Gordon
Subcontracting Supvr.: G. Richards
Dir.-Mil. Sales: J. W. Stehn MS, G, CT, TT, RD

MAYFLOWER MFG. CO.
Unionville, Conn. (Tel. Farmington, ORchard 3-2626)
Pres.: Nicholas B. Francis
Sales Mgr.: V. Nelson

McCATHRON BOILER WORKS CO., INC.
72 Knowlton St., Bridgeport 8, Conn. (Tel. FOrest 7-8467)
Pres.: Earl H. McCathron
Secy.-Treas.: Wesley F. McCathron S, MS

McCORMICK SELPH ASSOCIATES, INC.
Hollister Airport, Hollister, Calif. (Tel. MErcury 7-3731)
Purch. Agent: Anthony Schneider
Dir.-Applications Engrg.: Hubert I. Bennett PS, MS, RD

MCCOY ELECTRONICS CO.
Mount Holly Springs, Pa. (Tel. HUnter 6-3411)
Purch. Agent: William Shade
Sales Mgr.: David B. Jacoby M, G, TT, RD

JULIAN A. McDERMOTT CORP.
1639 Stephen St., Ridgewood, L. I. 27, N. Y. (Tel. GL 6-3606)
Purch. Agent: R. Wilke
Head-Sales: R. Stevens MS, RD

McDONNELL AIRCRAFT CORP.
Lambert – St. Louis Airport, Box 516, St. Louis 66, Mo. (Tel. PErshing 1-2121)
V. P.-Procurement & Quality Control: Lloyd Harrison
Mgr.-Purch.: W. J. Gamewell
Mgr.-Subcontracts: W. P. Becker
V. P.-Customer Service: J. F. Aldridge S, PS, MS, G, CT, RD, HSE

McDOWELL MFG. CO.
301 Stanton Ave., Pittsburgh 9, Pa. (Tel. TAylor 1-1333)
Purch. Agent: F. R. Knauss
Sales Mgr.: Rodger S. Nestor, Jr. S

McDOWELL-WELLMAN COMPANIES, THE
113 St. Clair Ave., N. E., Cleveland 14, Ohio (Tel. MAin 1-9934)
Dir.-Purch.: S. R. McKinnon
V. P.: J. R. Perkins S, MS

McGILL MFG., CO., INC., BEARING DIV.
600 N. Lafayette St., Valparaiso, Ind. (Tel. HO 2-2161)
Purch. Agent: George A. Walsh
Sales Mgr.: M. L. Brody

McGREGOR MFG. CORP.
2785 W. Maple Rd., Troy, Mich. (Tel. MIdwest 4-3540)
Purch. Agent: Charles Dillon
V. P. & Sales Mgr.: Robert Clapham S, PS, RD

McKAY CO., THE
1005 Liberty Ave., Pittsburgh 22, Pa. (ATlantic 1-5380)
Purch. Agent: John A. Lehr
Sales Mgr., Chain Div.: Rowland Erving M

McKENNA LABS.
2503 Main St., Santa Monica, Calif. (Tel. EXbrook 9-8846)
Pres.: A. G. McKenna
Sales Engr.: Walt McHenry S, RD

McLEAN DEVELOPMENT LABS., INC.
P. O. Box 206, Strong Ave., Copiague, L. I., N. Y. (Tel. Pioneer 7-7555)
Pres.: H. P. Dolan

McLEAN ENGRG. LABORATORIES
P. O. Box 228, 70 Washington Rd., Princeton, N. J. (Tel. WAlnut 4-4440)
Dir.-Proc.: James G. Robinson
V. P.-Sales: W. B. Eckenhoff M, RD

McLOUTH STEEL CORP.
300 S. Livernois Ave., Detroit 17, Mich. (Tel. VInewood 3-3000)
V. P.-Sales: L. E. Moultane M

McMILLAN COMPANIES, THE
Brownville Ave., Ipswich, Mass. (Tel. ELmwood 6-2926)
V. P.-Purch.: N. Janus
Absorber Mgr.: W. H. Davis, III
Plastics Mgr.: R. L. Overholt
Dir.-Mktg.: E. B. McMillan S, M, G, CT, RD

McMILLAN LAB., INC.
Brownville Ave., Ipswich, Mass. (Tel. ELmwood 6-2926)
Purch. Agent: Brian Abbott
V. P.-Sales: Arthur M. Brink

McPHERSON CORP.
1361 S. Broadway St., Denver, Colo. (Tel. PE 3-2481)
V. P.-Purch.: E. Bryon McPherson
Sales Mgr.: D. N. Stevens S

MEAD SPECIALITIES CO., INC.
4114 N. Knox, Chicago 41, Ill. (Tel. MU 5-6800)
V. P.-Purch.: E. W. Malek
Chief Engr.: Robert Bingel
V. P.-Prod.: M. J. Lieser
Sales Mgr.-Air Div.: R. L. Thorsen M, CT, RD

MEALPACK CORP.
2220 Sherman Ave., Evanston, Ill. (Tel. UN 4-9322)
Exec. V. P.-Sales: H. W. Clarke

MECHANICAL AIR CONTROLS, INC.
10030 Capital Ave., (Oak Park) Detroit 37, Mich. (Tel. JOrdan 4-6858)
V. P. & Gen. Mgr.: James A. Neff
Purch. Agent: James M. Rowland M

MECHANICAL FELT & TEXTILES CO.
50 W. 18th St., Weehawken, N. J. (Tel. UN 5-1879)
Prop.: Howard R. Dederick M

MECHANICAL HANDLING SYSTEMS INC.
4600 Nancy Ave., Detroit 12, Mich. (Tel. TWinbrook 2-1210)
V. P.-Engrg.: L. J. Bishop
Gen. Sales Mgr.: J. F. O'Hora
Purch. Agent: D. C. Kilgus, 12755 E. 9-Mile Rd., Van Dyke, Mich. (Tel. JEfferson 9-2210)
Asst. Purch. Agent: R. Statzula (Tel. JE 9-2210) S, M

MECHANICAL PRODUCTS, INC.
1824 River St., Jackson, Mich. (Tel. STate 2-0391)
Purch. Agent: C. C. Frost
Sales Engr.: P. R. Watson MS

MECHANICS RESEARCH DIV., AMERICAN MACHINE & FOUNDRY CO.
7501 N. Natchez, Niles, Ill. (Tel. NIles 7-7000)
Gen. Mgr.: P. Rosenberg S, PS, MS, RD, HSE

MECHANICAL RUBBER PRODUCTS CO.
Box 287, Warwick, N. Y. (Tel. YUkon 6-2271)
Dir.-Sales: Frank S. Puccio M

MECHATROL, DIV.-SERVOMECHANISMS, INC.
1200 Prospect Ave., Westbury, N. Y. (Tel. EDgewood 3-6000)
Purch. Agent: James Owens
Buyer: Louis Addazio
Sales Mgr.: Victor See MS, G, CT, TT, RD

MEDICAL SUPPLY CO.
1027 W. State St., Rockford, Ill. (Tel. WOodland 3-9697)
Purch. Agent: C. Fred Avery
V. P.-Sales: Richard G. Babbitt

MELETRON CORP.
950 N. Highland Ave., Los Angeles 38, Calif. (Tel. HOllywood 3-4841)
Purch. Agent: Milt Loy
Gen. Sales Mgr.: Jack Nelson PS, MS, M, CT, RD

MELODY MASTER MFG. CO.
2149-51 W. Roscoe St., Chicago 18, Ill. (Tel. LAkeview 5-5559)
Pres.: J. M. Trittenbach

MENASCO MFG. CO.
805 S. San Fernando Blvd., Burbank, Calif. (Tel. VIctoria 9-3261)
Dir.-Materiel Div.: Thomas E. Merrick
Mgr., Purch. Dept.: Carl E. Marshall
Purch. Dept. (Tex. Div.): Edward Gibson, Box 7397 Sylvania Sta., Ft. Worth (Tel. ATlas 4-3471)
V. P.-Sales: Jack I. Hamilton (Burbank) S, PS, RD

J. E. MENAUGH CO.
4555 N. Broadway, Chicago 40, Ill. (Tel. UPtown 8-2343)
Purch.: M. M. Maher
Sales: D. A. MacIntyre

MENLO RESEARCH LAB.
595 N. Mathilda Ave., Sunnyvale, Calif. (Tel. REgent 9-6700)
Dir.-Purch. & Sales: Charles Weeks MS, RD

MEPCO, INC.
37 Abbett Ave., Morristown, N. J. (Tel. JEfferson 9-2000)
Purch. Agent: J. Brozek
Sales Mgr.: E. L. Beaudry, Jr. M

MERCK & CO., INC., ELECTRONIC CHEMICALS DIV.
Rahway, N. J. (Tel. FUlton 1-5000)
Purch. Agent: F. G. Schmitt
Sales Mgr.: C. A. Graf M

MERCURY AIR PARTS CO., INC.
9310 W. Jefferson Blvd., Culver City, Calif. (Tel. UPton 0-5923)
Purch. Agent: I. A. Cole (Tel. VErmont 9-2813)
Sales Mgr.: Ralph Cohen M

MERCURY MFG. CO.
4710 W. Division St., Chicago 51, Ill. (Tel. SP 2-9300)
Purch. Agent: Werner Hinz
V. P.-Sales: P. K. McCullough

MERGENTHALER LINOTYPE CO.
29 Ryerson St., Brooklyn 5, N. Y. (Tel. Ulster 5-0300)
Purch. Dept.: C. Aiosa, A. Cuneo & W. Postrion
Mgr., Systems Engrg.: W. O. Grube RD

MERIDIAN METALCRAFT, INC.
8739 S. Millergrove Dr., Whittier, Calif. (Tel. OXford 2-3761)
Purch. Agent: D. W. Willis
Sales Mgr.: Lawrence H. Shipley MS, M, G, RD

MERIT COIL & TRANSFORMER CORP.
2027 Sherman St., Hollywood, Fla. (Tel. WAbash 3-1536)
Purch. Agent: Walter Hendrickson (Tel. WAbash 3-4651)
Sales Mgr.: K. B. Price M, RD

MERIT PRODUCTS INC.
3691 Lenowee Ave., Los Angeles 16, Calif.
Gen. Sales Mgr.: A. Block

MERIX CHEMICAL CO.
2234 E. 75th St., Chicago 49, Ill. (Tel. BAyport 1-8242)
Gen. Mgr.-Purch.: Eric O. Sonneman
Sales Mgr.: E. Arshack M, RD

MESA PLASTICS CO.
12270 Nebraska, Los Angeles 25, Calif. (Tel. BR 2-0259)
Plant Mgr.: K. G. Wolverton
Sales Mgr.: F. C. Karas M, RD

METAL ALLOYS CO.
335 Jelliff Ave., Newark 8, N. J. (Tel. BI 8-3020) (New York Tel. CO 7-7593)
Dir.-Purch.: Robert Kolodin
Dir.-Sales: Stanley W. Werner M

***METAL BELLOWS CORP.**
P. O. Box 35, Newton Lower Falls, Mass.
*(See advertisement this issue)

METAL CARBIDES CORP.
6001 Southern Blvd., Youngstown 12, Ohio (Tel. STerling 8-6541)
Purch. Agent: H. L. Sprinkel
V. P.-Sales: R. T. Beeghly S, M, RD

METAL EDGE INDUSTRIES
Gloucester Pike, Barrington, N. J. (Tel. LIncoln 7-9000)
Dir.-Sales: A. E. Wolf

METAL FABRICATORS CORP.
63 Pond St., Waltham 54, Mass. (Tel. TWinbrook 3-6800)
Dir.-Sales: Harry Ferguson **MS**

METAL FORMING CORP., DIV.-VANADIUM-ALLOYS STEEL CO.
1937 Sterling Ave., Elkhart, Ind. (Tel. JAckson 3-3660)
Purch. Agent: C. H. Schmalzried
V. P.-Gen. Sales Mgr.: C. W. Kelly **S**

METAL HYDRIDES, INC.
12-24 Congress St., Beverly, Mass. (Tel. WAlker 2-1875)
Purch. Agent: J. A. Crowell
Buyer: Sylvia Burke
Mgr.-Tech. Service: H. W. Kruschwitz, Jr. **M**

METAL TEXTILE CORP., DIV.-GENERAL CABLE CORP.
647 E. First Ave., Roselle, N. J. (Tel. CHestnut 5-3000)
Purch. Agent: Minford S. Smith
Sales Mgr.: William Luke, Jr. **M, RD**

METAL & THERMIT CORP.
Rahway, N. J. (Tel. FUlton 1-3000)
Gen. Purch. Agent: G. B. Lederer
Sales Mgr.: H. W. Buchanan (Tel. LExington 2-6300) **M, RD**

METAL TREATING INSTITUTE
271 North Ave., New Rochelle, N. Y. (Tel. NEw Rochelle 6-6382)
C. E. Herington

METALLIZING CO. OF LOS ANGELES INC.
1233 S. Boyle Ave., Los Angeles 23, Calif. (Tel. ANgelus 8-7108)
Mgr.-Purch: Ray White
Pres.: Richard S. Jensen
Sales Engr.: Larry Hemmel **M**

METALLIZING ENGRG. CO., INC.
1101 Prospect Ave., Westbury, N. Y.
Purch. Agent: R. M. Dwyer
Sales Mgr.: R. J. McWaters

METALLO GASKET CO.
16 Bethany St., New Brunswick, N. J. (Tel. KIlmer 5-7223)
Purch. Agent: S. S. Geipel
Asst. Purch. Agent: S. W. Geipel
Sales Mgr.-Secy.: G. K. Mordas **PS, MS**

METALLURGICAL, INC.
900 E. Hennepin Ave., Minneapolis 14, Minn. (Tel. FEderal 3-4581)
Controller: M. P. Paulson
Dir.-Sales: Ralph E. Mueller **S, PS, MS, M**

METALPHOTO CORP.
6811 Superior Ave., Cleveland 3, Ohio (Tel. UToh 1-7575)
Purch. Agent: Mrs. D. J. Weston
V. P.-Sales: Roger Ferryman **M**

METALS DIV., KELSEY-HAYES CO.
New Hartford, N. Y. (Tel. REdwood 5-6411)
Purch. Agent: R. J. Goodman
Mgr., Sales & Mktg.: H. D. Stone **M**

METAPLAST CO., INC.
34-51 56th St., Woodside 77, L. I., N. Y. (Tel. HA 6-9843)
Pres.: James Stein
Plant Engr.: George J. Frankel
Mgr.: J. Lester **M, RD**

METERS INC.
5353 N. Keystone Ave., Indianapolis 20, Ind. (Tel. CLifford 5-3570)
Purch. & Sales: F. R. Finehout

MET-L-WOOD CORP.
6755 W. 65th St., Chicago 38, Ill. (Tel. LUdlow 5-7575)
Purch. Agent: Don L. Janes
Sales Mgr.: Dwight O. Williamson **M**

R. I. METPRO, INC.
230 Toronto Ave., Providence 5, R. I. (Tel. STuart 1-3050)
Pres.: James C. Murphy

METRON INSTRUMENT CO.
432 Lincoln St., Denver 3, Colo. (Tel. PEarl 3-3764)
Purch. Agent: A. N. Jankowski
Sales Mgr.: Edward Pike **MS, CT**

METRONIX, INC., SUB.-ASSEMBLY PRODUCTS, INC.
75 Wilson Mills Rd., Chesterland, Ohio (Tel. HAmilton 3-4440)
Sales Mgr. & V. P.: Ivan Bezugloff, Jr.
Purch. Agent: Robert Foltz
Pres.: John Saint-Amour **CT**

METZ REFINING CO.
369 Mulberry St., Newark 2, N. J. (Tel. MA 0-8667)
Purch. Agent: W. C. Sink
Treas.: W. Peter Metz **M**

MEYERCORD CO., THE
5323 W. Lake St., Chicago 44, Ill. (Tel. ESterbrook 8-3700)
Purch. Agent: William A. Ortlep
Sales Mgr.: R. A. Knopf

MEYERCORD CO., THE, AMC DIV.
2915 S. Vail Ave., Los Angeles, Calif. (Tel. RAymond 3-8661)
Purch.: Robert Bell
Div. Mgr.-Sales: John A. Cargill

MEYERCORD CO., THE, PACIFIC COAST DIV.
2915 S. Vail Ave., Los Angeles, Calif. (Tel. RAymond 3-8661)
Dir.-Purch.: Robert Bell
Div. Sales Mgr.: George D. Kolbe

MICA CORP.
4031 Elenda St., Culver City, Calif. (Tel. UPton 0-6861)
Purch. Agent: William A. Morcumb, 11501 W. Jefferson Blvd., Culver City, Calif. (Tel. UPton 0-5557)
Mgr., Natl. Sales: B. Kessler
V. P. & Dir.-Sales: R. T. Toppin **M**

MIAMI ENGRG., DIV.-MIAMI SHIPBUILDING CORP.
615 S.W. 2nd Ave., Miami 36, Fla. (Tel. FR 9-2611)
Purch. Agent: T. C. Buhler
Pres. & Gen. Mgr.: Robert J. Johnston
Chief Engr.: A. W. Hainlin
Div. Mgr.: Jack R. Davis **S, MS, RD**

MICA FABRICATING CO.
53 Central Ave., Rochelle Park, N. J. (Tel. HUbbard 7-5717)
Purch.: M. H. Cymberg
Sales: J. W. Canter **M**

MICA INDUSTRY ASSOCIATION, INC.
420 Lexington Ave., New York 17, N. Y. (Tel. LExington 2-3988)

MICA INSULATOR DIV.-MINNESOAT MINING & MFG. CO.
797 Broadway, Schenectady 1, N. Y. (Tel. FRanklin 4-4191)
Purch. Agent: Q. F. Jardine
Asst. Purch. Agent: H. Culp
Gen. Mgr.: D. E. Horsford
Sales Mgr.: D. R. Coleman, Jr. **M**

MICACRAFT PRODUCTS INC.
701 McCarter Hwy., Newark, N. J. (Tel. MArket 3-6921)
Purch. Agent: N. A. Pomar (Tel. MArket 3-4074)
Sales: C. E. Garneau, Jr. **M**

MICAMOLD ELECTRONICS MFG. CORP.
65 Gouverneur St., Newark 4, N. J. (Tel. HU 5-2100)
Purch. Agent: A. Leepson
V. P.-Sales: A. S. Gartner

MICHIGAN CHROME & CHEMICAL CO.
8615 Grinnell, Detroit 13, Mich. (WAlnut 1-3711)
Purch. Agent: Frank Lennebacker
Sales Mgr.: Robert E. Sudz

MICO INSTRUMENT CO.
80 Trowbridge St., Cambridge 38, Mass. (Tel. Kirkland 7-8660)
Purch. Agent: Miss F. E. Beede
Sales Mgr.: R. F. Walker **M**

MICRO BALANCING, INC.
191 Herricks Rd., Garden City Park, L. I., N. Y. (Tel. Pioneer 6-0851)
Dir.-Purch: Leon Santora
V. P.-Sales: D. A. Francis **MS**

MICRO GEE PRODUCTS, INC.
6319 W. Slauson Ave., P. O. Box 1005, Culver City, Calif. (Tel. EXmont 1-6719)
Pres.: Walter E. Peterson
V. P. & Chief Mech. Engr.: David S. York
Chief Elec. Engr.: Bela J. Losmandy
V. P. & Chief Engr.: B. W. McFadden **MS, G, CT, RD**

MICRO SWITCH, DIV.-MINNEAPOLIS-HONEYWELL REG. CO.
11 W. Spring St., Freeport, Ill. (Tel. ADams 2-1122)
Purch. Agent: W. L. Young
Sales Mgr.: F. E. Wilsey **M**

MICRO-CIRCUITS CO.
New Buffalo, Mich. (Tel. 1163)
Purch. Agent: M. Bradley
Pres.: R. F. Bradley **M**

MICRODOT INC.
220 Pasadena Ave., South Pasadena, Calif. (Tel. MUrray 2-3351)
Purch. Agent: Robert Batton
Buyer: James Gillis
Asst. Sales Mgr.: Donald T. Mason
V. P.-Sales: Guy M. Martin, Jr. **M, RD**

MICROFLECT CO., INC.
3450 25th S.E., Salem, Oregon (Tel. EMpire 3-1128)
Gen. Mgr.: G. F. Kreitzberg
Pres.: J. S. Kreitzberg **S**

MICROLAB
570 W. Mt. Pleasant Ave., Livingston, N. J. (Tel. WYman 2-5700)
Purch.: Joseph Toma
Sales: Richard C. Hess **G, CT, TT, RD**

MICROMETRICAL MFG. CO.
3621 S. State Rd., Ann Arbor 20, Mich. (Tel. NOrmandy 2-5626)
Purch. Agent: Herman DeMarco
Sales Mgr.: Frank W. Kabat **CT, RD**

MICRON GEAR CO., INC.
73 Rushmore St., Westbury, L. I., N. Y. (Tel. EDgewood 4-8880)
Purch. Agent: Bill Benjamin
Sales Mgr.: Edwin J. Johnson **MS, G, TT, RD**

MICROPHASE CORP.
1 Seneca Place, P. O. Box 1166, Greenwich, Conn. (Tel. NOrmandy 1-6200)
Purch. Agent: Wilbur Thiel
Mgr.-Sales Engrg.: Selim Temel **CT, TT, RD**

MICROTECH DIV., FEDERAL-MOGUL-BOWER BEARINGS, INC.
1201 N. Arden Dr., El Monte, Calif. (Tel. GIlbert 3-3081)
Purch. Agent: Carl H. Sjoberg
Mgr.-Sales: Frank M. Mosier **G**

MICROTRAN CO. INC.
145 E. Mineola Ave., Valley Stream, N. Y. (Tel. LO 1-6050)
Purch. Agent: B. Bell
V. P.-Sales: Albert J. Eisenberg **G, CT, TT, RD**

MICROWAVE ASSOCIATES, INC.
South Ave., Burlington, Mass. (Tel. BRowning 2-3000)
Purch. Agent: Harry Merchant
V. P.-Mktg.: George S. Kariotis **G, TT**

MICROWAVE DEVELOPMENT LABS., INC.
92 Broad St., Babson Park 57, Mass. (Tel. CEdar 5-6252)
Purch. Agent: Abraham Bahm
Buyers: Philip Carson & Harold Lemer
Sales Engr.: John D. Hall

***MICROWAVE & POWER TUBE DIV., RAYTHEON CO.**
Foundry Ave., Waltham, Mass. (Tel. TWinbrook 9-8400)
Purch. Agent: D. Hamant
Sales Mgr.: Palmer Derby **M**
*(See advertisement this issue)

MICRO-WIRE TUNGSTEN & MOLYBDENUM PRODUCTS
301 Crooks Ave., Clifton, N. J. (Tel. PRescott 9-0819)
Stephen H. Meninger

MIDGET LOUVER CO.
6-8 Wall St., Norwalk, Conn. (Tel. VOlunteer 6-2342)
Purch.: Miller Mfg. Co., Stratford, Conn.
Sales: Frank J. Scallon

MIDLAND INDUSTRIAL FINISHES CO.
E. Water St., Waukegan, Ill. (Tel. MAjestic 3-4200)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch. Agent: W. J. Edwards
Buyer: John Whitaker
Pres.: Edwin O. Robson
V. P. & Gen. Mgr.: G. E. Batzel M

MIDLAND INDUSTRIAL DIV., THE HARRISON PAINT & VARNISH CO.
1329 Harrison Ave., S.W., Canton 1, Ohio (Tel. GLendale 5-5125)
Purch. Agent: J. V. Lemmo
Secy.-Treas.: A. F. Chrien
Factory Supt.: Roy Piper M

MIDVALE-HEPPENSTALL CO.
Nicetown, Philadelphia 40, Pa. (Tel. BAldwin 5-5000)
Gen. Sales Mgr.: Derek G. R. Brigg
Asst. Gen. Sales Mgr.: A. T. Richter
Mrg.-Projects & Sales Engr.: H. H. Casey M

MID-WEST COIL & TRANSFORMER CO.
1642 N. Halsted St., Chicago 14, Ill. (Tel. MI 2-4055)
Purch. Agent: Gene Baum
Sales Mgr.: William J. Vance MS, G, TT

MID-WEST GAGE LAB., AFFILIATE-SIZE CONTROL CO.
2500 W. Washington Blvd., Chicago 12, Ill. (Tel. MO 6-6710)
Purch. Mgr.: Ed Olenick
Sales Mgr.: E. E. Olds M, CT, RD

MID-WEST METAL PRODUCTS, INC.
450 E. Donovan Rd., Kansas City 15, Kans. (Tel. MAyfair 1-1980)
Asst. Mgr.-Purch.: H. W. Sanders
Mgr.-Sales: T. H. Minzet

MIDWEST MOLDING & MFG. CO.
Gurnee, Ill. (Tel. ONtario 2-1320)
Purch. Agent: N. Edwards
V. P.-Sales: T. E. Richards

MIDWEST RESEARCH INSTITUTE
425 Volker Blvd., Kansas City 10, Mo. (Tel. LOgan 1-0202)
V. P. & Tech. Dir.: Dr. Max H. Thornton
Admin. Officer: Perry L. Bidstrup
Mgr.-Program Dev.: Richard W. Kunkle
S, PS, MS, M, G, TT, RD, HSE

MID-WEST SPRING MFG. CO.
4632-40 S. Western Ave., Chicago 9, Ill. (Tel. LAfayette 3-1743)
Purch. Agent-Chicago Plant: James J. Dunne, Jr.
Purch. Agent-St. Paul Plant: Cliff Reger (Tel. HU 8-2521)
Purch. Agent-Mentone, Ind., Plant: Richard E. Middleton (Tel. EL 3-2415)
Sales: L. J. Castaldi M

MIDWESTERN INSTRUMENTS, INC.
41st & Sheridan Rd., Tulsa 18, Okla. (Tel. RIverside 7-1331)
Dir.-Purch.: D. M. Kennedy
Purch. Agents: P. B. Wagoner & Pat McKee
V. P.-Sales: D. M. Holloway G, CT, TT, RD

MILBAR CORP.
1900 Euclid Ave., Cleveland 15, Ohio (Tel. SU 1-3113)
Pres.: Jack A. Bares
V. P.: E. M. Smith M

MILGO ELECTRONIC CORP.
7620 N.W. 36th Ave., Miami 47, Fla. (Tel. OXford 1-1220)
Dir.-Purch.: William Kreuter
Buyers: James Kivett & Walter Koth
Gen. Mgr.: William L. Rose MS, RD

MILITARY AIRCRAFT DIV.-CESSNA AIRCRAFT CO.
P. O. Box 1977, K42, West, Wichita 1, Kans. (Tel. WHitehall 3-3211)
Purch. Agent: W. D. Grisamore
Outside Prod. Mgr.: Bob Shirley
Supvr.-Parts, Standards & Raw Mat.: Gene Laudermilk
Contract Admin.: Kenneth W. Whisler MS

JAMES MILLEN MFG. CO. INC.
150 Exchange St., Malden 48, Mass. (Tel. DAvenport 4-4108)
Purch. Agent: George Pike
Gen. Sales Mgr.: E. E. Williams M

MILLEN MFG. CO.
90 Summit Ave., Brookline 46, Mass. (Tel. LOngwood 6-4305)

FRANKLIN P. MILLER & SON, INC.
36 Meadow St., East Orange, N. J. (Tel. ORange 3-4522)
Purch. Agent: H. Preyer
Sales: H. Galanty

J. W. MILLER CO.
5917 S. Main St., Los Angeles 3, Calif. (Tel. ADams 3-4294)
Purch.: L. G. Crawford, Jr.
Buyer: J. E. Stracener
Sales: J. R. Hummes M

SANFORD MILLER CO.
11 Lynch St., Brooklyn 11, N. Y. (Tel. ULster 8-2817)
Purch. Agent: E. Gold
Dir.-Sales: E. Rod CT

MILLER ASSOCIATES
P. O. Box 369, Lakeville, Conn.
Owner: R. R. Miller
Dir.-Sales: H. M. Miller RD

MILLER DIAL & NAME PLATE CO.
4400 N. Temple City Blvd., El Monte, Calif. (Tel. GIlbert 4-4555)
Purch. Agent: Jesse Kuhn
Sales Mgr.: Dom Delorenzis

MILLER ELECTRO-RESEARCH LABS.
5529 S. 5th St., Milwaukee 7, Wisc. (Tel. HUmboldt 3-6303)
A. W. Miller MS

MILLER FALLS CO.
57 Wells St., Greenfield, Mass. (Tel. PRescott 3-5426)
Purch. Agent: Charles W. Parsons
Asst. Purch. Agent: Robert Shortell
Dir.-Sales: Arthur E. Ackerman M

MILLER-ROBINSON CO.
7007 Avalon Blvd., Los Angeles 3, Calif. (Tel. PLeasant 2-6141)
Purch. Agent: J. B. Leavell
Sales Mgr.: Myron B. Adler

D. B. MILLIKEN CO.
131 N. Fifth Ave., Arcadia, Calif. (Tel. ELliott 9-6691)
Purch. Agent: R. R. Meier
Proj. Engr.: W. W. Keddie
V. P.-Photo-Instrument Div.: T. H. Truesdell
CT, TT, RD

MILLIPORE FILTER CORP.
Bedford, Mass. (Tel. CRestview 4-8800)
V. P.-Purch.: Walter W. Kenyon
Sales Mgr.: Kristofer Berg
Office Mgr.: Clifford J. Hughes MS, CT

MILLI-SWITCH CORP.
P. O. Box 67, Mill Creek Rd., Gladwyne, Pa. (Tel. MIdway 2-9222)
Asst. Purch. Agent: R. J. Marchetti
Expediter: M. Ramsdale
Dir.-Purch. & Sales: B. W. Chandler M

MILLITEST CORP.
88 Madison Ave., Hempstead, N. Y. (Tel. IVanhoe 9-9672)
Purch. Dept.: H. Adise & I. Clinton
Sales Mgr.: J. Herman MS, CT, RD

MILMAN ENGRG. CO.
1831 Pontius Ave., Los Angeles 25, Calif. (Tel. GRanite 3-0616)
Pres.: E. I. Druckman
V. P.: Wesley B. Miller

MILMANCO
620 7th Ave., Renton, Wash. (Tel. ALpine 5-8656)
Co-Mgr., Purch. & Sales: Philip B. Lundstrom
Co-Mgr., Purch.: Thomas H. Cooke
Supt.: Robert W. Burman
S, PS, MS, M, G, CT, TT, RD, HSE

MILRO CONTROLS CO. INC.
280 Midland Ave., Saddle Brook, N. J. (Tel. SWarthmore 1-1850)
Dir.-Purch.: M. V. Coronato
Chief Engr.: C. B. Kish
Pres.: Milton Rosen
Dir.-Sales: W. W. Emmerson CT, RD

MINATRON CORP.
61 Cliveden St., Belle Mead, N. J. (Tel. FLanders 9-6400)
Gen. Mgr.: C. W. Pressey CT

MINCO PRODUCTS, INC.
740 Washington Ave., N., Minneapolis 1, Minn. (Tel. FEderal 8-6753)
Purch. Agent: Robert B. Anderson
V. P.-Sales: Karl Schurr

***MINCOM DIV., MINNESOTA MINING & MFG. CO.**
2049 S. Barrington Ave., Los Angeles 25, Calif. (Tel. GRanite 9-3751)
Purch. Agent: Ray Hunt
Sales Mgr.: Robert J. Brown TT, RD
*(See advertisement this issue)

MINE SAFETY APPLIANCES CO.
201 N. Braddock Ave., Pittsburgh 8, Pa. (Tel. CH 1-5900)
Purch. Agent (Safety Prod.): J. P. Curran
Purch. Agent (Tech. Prod.): F. J. Guenther
Sales Mgr. (Safety Prod.): F. A. King
Sales Mgr. (Tech. Prod.): N. W. Hartz M, RD

MINIATURE PRECISION BEARINGS, INC.
Precision Pk., Keene, N. H. (Tel. ELmwood 2-0310)
Purch. Agent: Robert N. Whitney
Sales Mgr.: K. G. Broman M

MINICORD CORP. OF AMERICA
1915 Atlantic Ave., Atlantic City, N. J. (Tel. 2-0488)
Dir.-Purch.: William C. Redding, Jr.
V. P.-Sales: William A. Juhrs, Sr.
Pres.: Maurice J. Ojserkis CT, HSE

MINNEAPOLIS-HONEYWELL REGULATOR CO., AERONAUTICAL DIV.
2600 Ridgway Rd., Minneapolis 13, Minn. (Tel. STerling 1-8011)
Dir.-Proc.: R. B. Foster
Dir.-Proc.: S. E. Puffer, Inertial Guidance Cntr., St. Petersburg, Fla. (Tel. HEmlock 5-1151)
Purch. Mgr.: R. F. Marcy, Missile Dev. Lab., W. Los Angeles, Calif. (Tel. BRadshaw 2-8667)
Dir.-Mktg.: R. E. Clifford RD, HSE

MINNEAPOLIS HONEYWELL REGULATOR CO., BOSTON DIV.
40 Life St., Boston 35, Mass. (Tel. ALgonquin 4-5200)
Purch. Agent: E. L. Hanscom
Mktg. Mgr.: J. W. Rhinesmith G, CT, RD

MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIV.
Wayne & Windrim Aves., Philadelphia 44, Pa. (Tel. DAvenport 9-8300)
Purch. Agent: J. Taws
Sales Mgr.: J. A. Robinson MS, CT, RD

MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL PRODUCT GROUP
Wayne & Windrim Aves., Philadelphia 44, Pa. (Tel. DAvenport 9-8300)
Purch. Agent: J. H. Taws
Sales Mgr.: J. A. Robinson MS, CT, RD

MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL SYSTEMS DIV.
10721 Hanna St., Beltsville, Md. (Tel. GRanite 4-6700)
Dir.-Purch.: John Paszkiet
Sales Mgr.: N. S. Bassett CT, TT

MINNEAPOLIS-HONEYWELL REGULATOR CO., MISSILE EQUIPMENT DIV.
Queen & S. Bailey Sts., Pottstown, Pa. (Tel. FA 3-4000)
Purch. Agent: M. A. Jones
Sales Mgr.: H. A. Lucas MS, CT, TT, RD

MINNEAPOLIS-HONEYWELL REGULATOR CO., ORDNANCE DIV.
600 2nd St., N., Hopkins, Minn. (Tel. WEstport 8-3571)
Mgr.-Proc.: J. F. Barrett
Purch. Agent: Clifford Swisher, Minneapolis-Honeywell Ordnance Missile Engrg. Ctr., Duarte, Calif. (Tel. ELliott 9-5311)
Dir.-Serv. Engrg.: L. E. Sheehan

MINNEAPOLIS-HONEYWELL REGULATOR CO., SEMICONDUCTOR PRODUCTS DIV.
1615 S. Sixth St., Minneapolis 4, Minn. (Tel. FEderal 2-5225)
Mgr.-Purch.: M. E. Knutson
Asst. Purch. Agent-Raw Materials: Wilbur Smisek
Sales Mgr.: R. O. Anderson M

***MINNESOTA MINING & MFG. CO.**
900 Bush Ave., St. Paul 6, Minn. (Tel. PR 6-8511)
V. P.-Purch.: B. B. Countryman
Mgr.-Missile Industry Liaison: W. R. Ludka
V. P.-Sales Admin.: J. C. Duke S, M, TT, RD
*(See advertisement this issue)

***MINNESOTA MINING & MFG. CO. ADHESIVES, COATINGS & SEALERS DIV.**
900 Bush Ave., St. Paul, Minn. (Tel. PRospect 6-8511)
Sales Mgr.-Aircraft Prods.: A. O. Fuhrmann
Gen. Sales Mgr.: C. A. Kelley
Aircraft Products Sales, 6411 Randolph St., Los Angeles 22, Calif. M
*(See advertisement this issue)

***MINNESOTA MINING & MFG. CO., CHEMICAL DIV.**
900 Bush Ave., St. Paul 6, Minn. (Tel. PRospect 6-8511)
Gen. Mgr.-Chemical Div.: J. W. Selden M
*(See advertisement this issue)

MINNESOTA RUBBER CO.
3630 Wooddale Ave., Minneapolis 16, Minn. (Tel. WEst 9-6781)
Purch. Agent: H. L. Stocking
V. P.-Sales: Richard G. Wells M

MIRA CORP., THE
2656 N. Pasadena Ave., Los Angeles 31, Calif. (Tel. CApitol 1-1129)
Pres.: W. A. Douglas
Purch. Agent: I. Burch TT, RD, HSE

MISCO PRECISION CASTING CO.
116 W. Gibbs St., Whitehall, Mich. (Tel. TWin Oaks 3-1515)
Purch. Agent: M. B. Simms
V. P.-Sales: K. J. Yonker

MISKELLA INFRA-RED CO., THE
E. 73rd & Grand Ave., Cleveland 4, Ohio (Tel. HEnderson 1-2210) CT

MISSILE BATTERY DIV., THE ELECTRIC STORAGE BATTERY CO.
2510 Louisburg Rd., Raleigh, N. C. (Tel. TE 4-8465)
Dir.-Purch.: P. W. Morgan
Purch. Dept.: J. W. Barbee & P. Carver
Mgr.-Govt. Sales & Contracts: R. L. Mansfield PS

MISSILE DIV., NORTH AMERICAN AVIATION, INC.
12214 Lakewood Blvd., Downey, Calif. (Tel. SPruce 3-0610)
Dir.-Material: Mark Starr
Gen. Purch. Agent: B. L. Weber S, MS, CT, RD, HSE

MISSILES & SPACE SYSTEMS, DIV.-UNITED AIRCRAFT CORP.
Main St., E. Hartford, Conn. (Tel. JAckson 8-4811)
Sales Mgr.: Boone T. Guyton
Supvr.-Sales Services: Richard T. Allen
Supvr.-Subcontract Admin.: K. Williams

MISSIMERS INC.
3737 San Fernando Rd., Glendale 4, Calif. (Tel. CHapman 5-8471)
V. P.: Dale J. Missimer, Jr.
Engr.-Buyers: H. C. Faris, G. F. Clark, Dave Brown
Parts Buyer: C. Lanphear CT

E. C. MITCHELL CO.
Boston St., Middleton, Mass. (Tel. SPring 4-1191)
Everett W. Mitchell

MITCHELL CAMERA CORP.
666 W. Harvard St., Glendale 4, Calif. (Tel. CHapman 5-1086)
Purch. Agent: M. Kruescher
V. P.-Sales: J. D. McCall

MITCHELL RAND MFG. CORP.
51 Murray St., New York 7, N. Y. (Tel. COrtlandt 7-9264)
Purch. Agent: John Foley
Pres.: J. R. Mitchell, Jr. M

MITRONICS INC.
1290 Central Ave., Hillside, N. J. (Tel. WAverly 6-2250)
Purch. Agent: Allan Davis
Dir.-Sales: R. E. Eaves
Pres.: Harvey M. Pensack

MODEL RECTIFIER CORP.
1675 Utica Ave., Brooklyn 34, N. Y. (Tel. CLoverdale 8-6800)
Purch. Agent: Anthony Iati
Sales Mgr.: Samuel Gelber CT

MODELECTRIC PRODUCTS CORP.
1500 Bangs Ave., Asbury Park, N. J. (Tel. PR 4-2519)
Purch.: Chas. S. Nadler G

MODERN DESIGN DIV.-H. C. SCHLOER, INC.
Vestal Pkwy., Vestal, N. Y. (Tel. STilwell 5-9901)
Electronics Purch.: Mel Schell
Electronics Dept. Mgr.: Morris Shufler
Gen. Mgr.: Henry C. Schloer RD

MODINE MFG. CO.
Racine, Wisc. (Tel. ME 3-2411)
V. P.-Purch.: G. H. Jackson
Purch. Agent: L. W. Floyed
V. P.-Sales: C. C. Wilson MS, G, TT

MOELLER MFG. CO. INC.
2401 Durand Ave., Racine, Wisc. (Tel. MElrose 7-6143)
Purch. Agent: M. Ibsen
Sales Mgr.: W. F. Fisher

MOHAWK WIRE & CABLE CORP.
45 Summer St., Leominster, Mass. (Tel. KE 7-0771)
Sales Mgr.: J. W. Resseguie
Purch. Agent: Robert Marr MS

JOHN MOHR & SONS
3200 E. 96th St., Chicago 17, Ill.
Purch. Agent: A. D. Armstrong
Sales Mgr.: R. C. Mohr MS

MOLDED FIBER GLASS BODY CO.
4601 Benefit Ave., Ashtabula, Ohio (Tel. WYman 3-2177)
Purch. Agent: Harvey Baker
Prod. Control: Dale J. Curtis
Sales Mgr.: Lorin L. Palmer M

MOLDED INSULATION CO.
335 E. Price St., Philadelphia 28, Pa. (Tel. VI 4-2626)
Purch. Agent: Michael Halamar
V. P. & Gen. Mgr.: Russell F. Hurst
Pres.: William T. Bradbury MS, CT, TT, RD

MOLDING CORP. OF AMERICA
40 Church St., Pawtucket, R. I. (Tel. PAwtucket 6-2100)
V. P.: John O. Tate
Design Engr.: James V. Murphy M, RD

MONA INDUSTRIES, INC.
65-75 23rd St., Paterson 17, N. J. (Tel. ARmory 4-8220)
Purch. Agent: Hans Eischen
Dir.-Sales: W. O. Schlimbach M

J. J. MONAGHAN CO., INC.
500 Alcott St., Denver 4, Colo. (Tel. AC 2-3558)
Purch. Agent: J. J. Kramer
V. P.-Sales: W. J. Matsch RD, HSE

MONARCH ELECTRIC CORP.
118 E. First St., Jamestown, N. Y. (Tel. JAmestown 3-1565)
Purch. Agent: Arnold Anderson
V. P.: Alex Sommers
Dir.-Sales: G. L. Williamson CT

MONARCH GOVERNOR CO.
2800 Tyler Rd., Willow Run, Mich. (Tel. HU 3-2411)
V. P.: R. L. McKenna S

MONROVIA AVIATION CORP.
801 Royal Oaks Dr., Monrovia, Calif. (Tel. ELliot 8-3211)
Purch. Agent: C. L. Gallagher
Buyers: Roy Reilly & John Barnes
V. P. & Sales Mgr.: J. L. Payne

MONSANTO CHEMICAL CO.
800 N. Lindbergh Blvd., St. Louis 66, Mo. (Tel. WYdown 3-1000) M

MONTGOMERY CO., THE
60 Canal St., Windsor Locks, Conn. (Tel. NA 3-3336)
Purch. Agent: J. R. Montgomery
Purch. Dept.: G. M. Montgomery M

MOQDY MACHINE PRODUCTS CO., INC.
42-46 Dudley St., Providence 5, R. I. (Tel. GAspee 1-3317)
Dir.-Purch.: W. S. Moody
Sales Mgr.: J. H. Moody

MOOG SERVOCONTROLS, INC.
Proner Airport, East Aurora, N. Y. (Tel. CY 2000)
Purch. Agent: Raymond Howick
Sales Mgr.: Harry White

MOORE ASSOCIATES, INC.
2600 Spring St., Redwood City, Calif. (Tel. EM 9-0204)
Purch. Agent: Dan Sully
Sales Mgr.: James B. Bullock

MORAN CO.
721 E. El Segundo Blvd., El Segundo, Calif. (Tel. OR 8-3444)
Office Mgr.: Karen Kiebert G, RD

MORAN INSTRUMENT CORP.
170 E. Orange Grove Ave., Pasadena 3, Calif. (Tel. SY 6-7158)
Dir.-Purch.: M. Peirce
Prod. Mgr.: A. W. Junkunc
Pres.: R. B. Moran, Jr. CT, TT, RD

MOREHOUSE MACHINE CO.
1742 Sixth Ave., York, Pa. (Tel. 8-1332)
Gen. Mgr.: H. A. Zumbrun CT

MORGANITE, INC.
33-02 48th Ave., Long Island City 1, N. Y. (Tel. STillwell 4-3222)
Gen. Sales Mgr.: W. C. Hass
Dir.-Purch.: M. A. DeRosa

C. A. MORGREN CO.
3400 S. Elati St., Englewood, Colo. (Tel. SU 1-5583)
Dir.-Purch.: James Kyffin
Asst. Dir.-Purch.: William Rubdige
Dir.-Sales: Geoffery Grange MS, CT

MORNINGSTAR-PAISLEY, INC.
630 W. 51st St., New York 19, N. Y. (Tel JUdson 2-3790)
V. P.-Sales: Earl C. Lenz
Purch. Agent: N. Deutschman, 1153 Bloomfield Ave., Clifton, N. J. (Tel. PRescott 3-2500) M

J. I. MORRIS CO.
378 Elm St., Southbridge, Mass. (Tel. POrter 4-4394)
Asst. Mgr.: J. B. Dirlam

ROBERT E. MORRIS CO., THE
5000 Farmington Ave., P. O. Box 41, West Hartford 7, Conn. (Tel. ADams 3-3663)
Pres.: Robert E. Morris S, M

FRANK W. MORSE CO.
354 Congress St., Box 10, Mass. (Tel. HAncock 6-5398)
Purch. Agent: Prescott B. Morse
Sales Mgr.: Richard W. Morse M

MORSE INSTRUMENT CO., THE
21 Clinton St., Hudson, Ohio (Tel. OLympic 3-5141)
Purch. Agent: Edward C. Kenyon
V. P.-Sales: Otis E. Burgess

CHESTER MORTON ELECTRONICS CORP.
10th St., & Morton Ave., Chester, Pa. (Tel. TRemont 4-6363)
Purch. Agent: S. Caine MS, CT

MOSER JEWEL CO.
544 Fayette St., Perth Amboy, N. J. (Tel. HIllcrest 2-3434)
V. P.-Sales: C. H. Kalquist

MOSINEE PAPER MILLS CO.
Mosinee, Wisc. (Tel. OXbow 3-2111)
Purch. Agent: H. L. Voss
Sales Mgr.: Robert T. Seith M

MOSLEY ELECTRONICS, INC.
4610 N. Lindbergh, Bridgeton, Mo. (Tel. St. Louis, PErshing 1-3036)
Dir.-Purch.: Eugene Mosley
V. P.-Sales: George E. Mobus TT

DONALD P. MOSSMAN, INC.
P. O. Box 265, Brewster, N. Y. (Tel. BRewster 9-3725)
Purch. Agent: William Cox
Sales Mgr.: Ben W. Rist MS, G, CT

MOTOR APPLIANCE CORP.
5737 W. Park, St. Louis 10, Mo. (Tel. MIssion 7-1138)
Purch. Agent: Fred O'Day
Gen. Sales Mgr.: A. H. Barrere, Jr.

MOTOR GENERATOR CORP.
Jackson at Water Sts., Troy, Ohio (Tel. FE 2-1227)
Dir.-Purch.: B. A. Lutz
Buyers: Robert Miller & L. D. Isenbarger
V. P.-Sales: D. W. Baker MS

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

MOTORDYNE INC.
2661 S. Myrtle Ave., Monrovia, Calif. (Tel. RYan 1-6132)
Purch. Agent: O. Hartle
Asst. Purch. Agent: Gayle Ross
Dir.-Sales: James Marino **MS, RD**

MOTORESEARCH CO.
1600 Junction Ave., Racine, Wisc. (Tel. MElrose 2-5131)
Purch. Agent: L. J. Novak
Mgr. Govt. Sales: J. G. Hiatt **MS, RD**

MOTOROLA, INC.
8201 E. McDowell Rd., Scottsdale, Ariz. (Tel. WHitney 5-4311)
Purch. Agent: Paul Stancik
Mgr.-Mktg.: Paul Sturm
Riverside Research Lab., 8330 Indiana Ave., Riverside, Calif.
Purch. Agent: J. Williams
Motorola, Inc., 1450 N. Cicero Ave., Chicago 51, Ill.
Purch. Agent: John B. O'Donnell **MS, M, G, CT, TT, RD**

MOTOROLA INC.
Western Military Electronics Center, 8201 E. McDowell Rd., Scottsdale, Ariz. (Tel. WH 5-4311)
Purch. Agent: Paul Stancik
Asst. Purch. Agent: Paul Leinheiser

MOTOROLA, INC., SEMICONDUCTOR PRODUCTS DIV.
5005 E. McDowell Rd., Phoenix, Ariz. (Tel. BRidge 5-4411)
Purch. Agent: Walter S. Gray
Gen. Mgr.: C. Lester Hogan

C. P. MOYEN CO.
8157 Monticello Ave., Skokie, Ill. (Tel. OR 3-6866)
V. P.-Purch.: J. T. Small

MUCKLE MFG. CO.
Box 119, Owatonna, Minn. (Tel. 7249)
Purch. Agent: Robert Doyle
Sales Mgr.: S. A. Muckle

MUCON CORP.
9 St. Francis St., Newark 5, N. J. (Tel. MI 2-1476)
Purch. Agent: B. Berkman
Sales Mgr.: M. A. Prince **G, CT, TT, RD**

HEINZ MUELLER ENG. CO. INC.
4725 Iowa St., Chicago 51, Ill. (Tel. EStebrook 8-4761)
Purch. Agent: Henry Eggert
V. P.: Milton Hoffman **M**

MUELLER ELECTRIC CO.
1583 E. 31st St., Cleveland 14, Ohio (Tel. PRospect 1-5225)
Purch. Agent: E. H. deConingh
Sales: Scott Mueller **CT, RD**

MUIRHEAD INSTRUMENTS INC.
441 Lexington Ave., New York 17, N. Y. (Tel. MUrray Hill 2-8131)
V. P. & Gen. Mgr.: Paul L. Irvine

MULLENBACH DIV.-ELECTRIC MACHINERY MFG. CO.
2100 E. 27th St., Los Angeles 58, Calif. (Tel. LUdlow 2-5331)
Purch. Agent: James F. Lewis
Gen. Mgr.: Wayne M. Bitting **MS, CT**

MULTI-AMP ELECTRONIC CORP.
465 Lehigh Ave., Union, N. J. (Tel. MUrdock 8-7112)
Purch. Agent: G. Pearl
Prod. Mgr.: E. R. Redhammer **CT**

MULTICORE SALES CORP.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Sales Mgr.: Melvin Zalkin

MUNSTON ELECTRONIC MFG. CORP.
Beech St., Islip, N. Y. (Tel. JUniper 1-3900)
Purch. Agent: Charles Leidner
Dir.-Sales: Theodore Whildin **RD**

MURPHY & MILLER, INC.
610 W. Taylor St., Chicago 7, Ill. (Tel. HArrison 7-8900)
Purch. Agent: John Petruska
Gen. Mgr., Mfg. Div.: P. H. Brandt
Sales Supvr., Mfg. Div.: R. W. Farrell

MUTRON CORP.
125 Perkins Ave., Brockton, Mass. (Tel. JUniper 3-0033)
Purch. Agent: Richard F. Anderson
Sales Mgr.: Hilbert T. Forsberg

MYCALEX CORP. OF AMERICA
125 Clifton Blvd., Clifton, N. J. (Tel. PRescott 9-8866)
Purch.: H. C. Westervelt
Sales: E. de Villeroy **M, TT, RD**

MYER'S CORP.
47 Wallace Ave., Wallingford, Conn. (Tel. COlony 9-4738)
V. P.-Purch. & Sales: Ralph Bertini, II

J. E. MYLES, INC.
21315 Woodward Ave., Detroit 20, Mich. (Tel. LI 6-1157)
Mgr.-Purch. & Sales: J. Edgar Myles
Buyer: Roy D. Pageau **MS**

NJE CORP.
20 Boright Ave., Kenilworth, N. J. (Tel. BRidge 2-6000)
Purch. Agent: Robert Schrage
Gen. Sales Mgr.: H. J. Lutz

N. R. K. MFG. & ENGRG. CO.
4601 W. Addison St., Chicago 41, Ill. (Tel. SPring 7-2970)
Dir.-Purch.: Peter Koppenberger
Purch. Agent: M. R. Warren
Dir.-Sales: R. Kirchberger **G**

NUMEC-NUCLEAR MATERIALS & EQUIPMENT CORP.
N. Warren Ave., Apollo, Pa. (Tel. GRover 2-8411)
V. P.-Metallurgy: F. Forscher
V. P.-Chemistry: L. P. Pepkowitz
Dir.-Plutonium Plant: H. Garber (Tel. VIctor 2-0151)
Mgr.-Mktg.: A. M. Weis **M, RD**

NADELLA
66-68 Solothurnstrasse, Biel, Switzerland

NAMEPLATES INC.
421 E. 101st St., Brooklyn 36, N. Y. (Tel. NI 9-2524)
Dir. Purch. & Sales: Vincent Prisco

GEORGE L. NANKERVIS CO.
15300 Fullerton, Detroit 27, Mich. (Tel. VErmont 8-5780)
Purch. Agent: D. Lindh
Mgr., Sales: R. L. Yung

NAPIER ENGINES INC.
1346 Connecticut Ave., N.W., 909 Dupont Circle Bldg., Washington 6, D. C. (Tel. NO 7-9300)
Aviation Mgr.: A. Gualtieri
Mgr.-Sales Engrg.: J. Norton
V. P.-Sales: R. J. Pflum **PS**

NAPOLEON PRODUCTS CO., THE
410 Filmore St., Napoleon, Ohio (Tel. 5361)
Pres. & Gen. Mgr.: G. M. Small
Exec. V. P.-Purch.: E. N. Yeager

NARDA MICROWAVE CORP., THE
118-160 Herricks Rd., Mineola, N. Y. (Tel. Ploneer 6-4650)
Purch. Agent: James Orehosky
Sales Mgr.: William A. Bourke **RD**

NARDA ULTRASONICS CORP., THE
625 Main St., Westbury, N. Y. (Tel. EDgewood 3-5400)
Purch. Agent: Philip McKay
Gen. Sales Mgr.: Paul W. Steen

NARMCO MFG. CO.
5159 Baltimore Dr., La Mesa, Calif. (Tel. HOpkins 9-0171)
Gen. Mgr.: Roy Hughes
Sales Mgr.: Robert Poet
Engrg. Mgr.: D. C. Price **S, TT, RD**

NARMCO MATERIALS DIV., NARMCO INDUSTRIES, INC.
600 Victoria St., Costa Mesa, Calif. (Tel. LIberty 8-1144)
Mgr.-Materials Control: Roy Gill
Mgr.-Product & Process Design: R. J. Reiser
Mgr.-Mktg.: W. D. Rainey **M**

NARMCO MATERIALS DIV.
600 Victoria St., Costa Mesa, Calif. (Tel. LIberty 8-1144)
Purch. Agent: Ray Gill
Asst. Buyer: Marion Edkins
Mktg. Mgr.: William D. Rainey

NARROW FABRIC CO., THE
P. O. Box 742, Reading Pa. (Tel. FRanklin 6-2891)
Dir.-Purch.: C. E. Hoffmaster
Gen. Sales Mgr.: F. S. Pierce **M**

NASHUA CORP., CHART PAPER DIV.
44 Franklin St., Nashua, N. H. (Tel. TUxedo 3-7711)
Purch. Agent: D. V. Lates
Asst. Purch. Agent: F. Richardson
Buyer: E. Toomey
Sales Mgr.-Coating Sales Div.: A. W. Sanborn **CT, TT, HSE**

NATIONAL AUTOMATIC PRODUCTS CO., THE
Washington Ave., Berlin, Conn. (Tel. VA 8-3515)
Purch. Agent: Mrs. Sophia G. Gorban
Pres.: A. F. Kasprow **MS**

NATIONAL BERYLLIA CORP.
4501 Dell Ave., North Bergen, N. J. (Tel. UNion 4-8125)
Pres.: C. E. Nelson
Sales Mgr.: D. C. deGruchy
Dir.-Purch.: Andy Buonpastore, First & Haskell Avenues, Haskell, N. J. (Tel. TEmple 9-1600) **M, RD**

NATIONAL CARBON CO., DIV.-UNION CARBIDE CORP.
30 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-8000)
Dir.-Mktg.: C. E. Ford **S, M**

NATIONAL CERAMIC CO.
500 Southard St., Trenton 2, N. J. (Tel. EXport 4-5373)
Gen. Mgr.: James R. Smith
V. P.-Purch.: Anna B. Hunt
Prod. Mgr.: Joseph Welke **M**

NATIONAL COIL CO.
P. O. Box 1237, Sheridan, Wyo. (Tel. OR 4-7644)
Purch. Agent: Harold Demple
Sales Mgr.: Joe Demple **M**

NATIONAL CO., INC.
61 Sherman, Malden 48, Mass. (Tel. DA 2-7950)
Dir.-Purch.: S. W. Bateman
Dir.-Tech. Liaison: Saul Fast **MS, G, CT, TT, RD**

NATIONAL COPPER & SMELTING CO.
1862 E. 123rd St., Cleveland 6, Ohio (Tel. CE 1-2366)
Purch. Agent: S. O. Smith
Dir.-Sales: Homer B. Smith **M**

NATIONAL CYLINDER GAS, DIV.-CHEMETRON CORP.
840 N. Michigan Ave., Chicago 11, Ill. (Tel. WHitehall 4-3100)
Purch. Agent-Resale Merch. Sect.: R. E. Little
Purch. Agent-Mfg. Gases Sect.: R. Maher
Supvr. Buying, Gen. Stores Sect.: E. J. Rader, (Tel. BIshop 2-1205)
V. P. & Gen. Sales Mgr.: C. D. McGuinn **M**

NATIONAL ELECTRIC COIL, DIV.-McGRAW EDISON CO.
P. O. Box 388, Columbus 16, Ohio (Tel. HUdson 8-1151)
Purch. Agent: F. W. Pearce
Asst. Purch. Agent: W. R. Keesee
Sales Mgr.: B. E. Price **MS**

NATIONAL ELECTRONICS
P. O. Box 1237, Sheridan, Wyo. (Tel. OR 4-7644)
Gen. Mgr. & Purch. Agent: Harold Demple
Sales Mgr.: John Bullinga **CT**

NATIONAL ELECTRONICS, INC.
628 North St., Geneva, Ill. (Tel. CEnter 2-7000)
Purch. Agent: B. Ogden
Sales Mgr.: Joe S. Kirk **M**

NATIONAL ENGRG. PRODUCTS, INC.
435 Washington Bldg., Washington 5, D. C. (Tel. REpublic 7-4473)
V. P.-Purch.: Clinton Rector

NATIONAL FELT CO.
76 Summer St., Boston 10, Mass. (Tel. LIberty 2-6590) **M**

NATIONAL FOAM SYSTEM, INC.
Union & Adams Sts., West Chester, Pa. (Tel. OW 6-3600)
Purch. Agent: A. D. Holmes
V. P.: L. W. Boerner

NATIONAL FORGE CO.
Irvine, Warren Co., Pa. (Tel. Youngsville – LOgan 3-7522)
Purch. Agent: Willis Cooney
Asst. Purch. Agent: Paul Broderick
Dir.-Sales: James H. Kannen **M**

NATIONAL INSTRUMENT LABORATORIES, INC.
834 Evarts St., N. E., Washington, D. C. (Tel. NOrth 7-7582)
Purch. Agent: A. Bloom
Sales & Adv. Mgr.: D. I. Steele **CT**

NATIONAL LOCK CO.
1902 Seventh St., Rockford, Ill. (Tel. WO 2-4455)
Dir.-Purch.: C. M. Oberling
Dir.-Sales: B. A. Grenberg

NATIONAL METALLURGICAL CORP.
P. O. Box 656, Springfield, Ore. (Tel. RIverside 6-3233)
V. P. & Works Mgr.: W. E. Platte
Secy.-Treas.: A. H. Nelson

NATIONAL MOLDITE CO., INC.
250 South St., Newark, N. J. (Tel. Mitchell 2-6860)
V. P.-Purch.: Manuel Miller
Supt.: James Sembrot
Pres.: Sidney Lowenberg **M**

NATIONAL PNEUMATIC CO., INC., HOLTZER-CABOT DIVS.
125 Amory St., Boston, Mass. (Tel. JAmaica 4-7000)
Dir.-Purch.: Sidney Coven
Purch. Agent: Thomas Furlong
Gen. Sales Mgr.: J. J. Anderson **PS, MS**

NATIONAL RESEARCH CORP.
70 Memorial Dr., Cambridge, Mass. (Tel. ELiot 4-5400)
Dir.-Purch.: James R. Caudill
Buyers: R. T. Davis, B. M. Sandock
Contracts Mgr.: J. V. E. Hansen

NATIONAL RESEARCH CORP., METALS DIV.
70 Memorial Dr., Cambridge 42, Mass. (Tel. ELiot 4-5400)
Purch. Agent: James R. Caudill
Sales Mgr.: Kenneth A. Geiger **M, RD**

NATIONAL RESEARCH & DEVELOPMENT CORP.
15 Sixteenth St., N. E., Atlanta, Ga. (Tel. TRinity 3-2536)
Pres.: Carsbie C. Adams

NATIONAL RIVET & MFG. CO.
Waupun, Wisc. (Tel. 780)
Purch. Agent: C. L. Gray
V. P.-Sales: E. J. Maitre **M**

NATIONAL SCIENTIFIC LABS., INC.
2010 Massachusetts Ave., N.W., Washington 6, D. C. (Tel. HUdson 3-4030)
Dir.-Engrg.: William C. Green
Purch. Agent: John F. Hohmann **RD**

NATIONAL SCREW & MFG. CO., THE
2440 E. 75th St., Cleveland 4, Ohio (Tel. ENdicott 1-2650); 3423 S. Garfiel Ave., Los Angeles 22, Calif.
Purch. Agent: William J. O'Neil
Asst. Purch. Agent: Paul Frederick
Gen. Sales Mgr.: R. E. Black **S, MS**

NATIONAL SPECIALTIES CO., INC.
1902 Howell St., Ft. Wayne 7, Ind. (Tel. ANthony 2341)
Asst. Gen. Mgr.: Edward C. Doell

NATIONAL TEL-TRONICS CORP.
52 St. Casimir Ave., Yonkers, N. Y. (Tel. YOnkers 8-6400)
Purch. Agent: Anthony Curriera
Asst. Sales Mgr.: William Jaris
Sales Mgr.: Charles J. Siebert

NATIONAL TUBE DIV.-UNITED STATES STEEL CORP.
525 William Penn Pl., Pittsburgh 30, Pa. (Tel. EXpress 1-2345) **S, MS, M, RD**

NATIONAL ULTRASONIC CORP.
111 Montgomery Ave., Irvington 11, N. J. (Tel. ESsex 1-0550)
V. P.-Purch.: Gilbert Tint
Pres. & Gen. Mgr.: L. R. Jeffrey, Jr. **M, CT, RD**

NATIONAL UNION ELECTRIC CORP.
1201 E. Bell St., Bloomington, Ill. (Tel. 7-6041)
Chief-Purch.: C. Hoover
Sales Mgr.: H. B. Graham **M**

NATIONAL VULCANIZED FIBRE CO.
Maryland Ave. & Beech Sts., Wilmington, Del. (Tel. OL 5-6371)
Dir.-Purch.: L. R. Clinton
Buyer: R. L. Jackson
Sales Mgr.: J. R. Kallaher **M**

NATIONAL WATER LIFT CO., DIV.-CLEVELAND PNEUMATIC INDUSTRIES, INC.
2220 Palmer Ave., Kalamazoo, Mich. (Tel. FIreside 5-8641)
Purch. Agent: Edwin W. Rector
Buyers: Harry Pindell, Joseph Krause
Sales Mgr.: M. E. Schnurr **MS, G, RD**

NATIONAL WELDING EQUIPMENT CO.
218 Fremont St., San Francisco 5, Calif. (Tel. YUkon 6-2868)
Pres.: E. L. Mathy **M**

NATIONAL-STANDARD CO.
Howard & 8th Sts., Niles, Mich. (Tel. MUtual 3-8100)
V. P.-Purch.: J. A. Mogle
V. P.-Sales: R. W. Elder **M**

NATVAR CORP.
211 Randolph Ave., Woodbridge, N. J. (Tel. FUlton 8-8800)
Dir.-Purch.: M. N. Hilseberg
Sales Mgr.: S. Sichermann

NAUGATUCK CHEMICAL DIV.-U. S. RUBBER CO.
Elm St., Naugatuck, Conn. (Tel. PArk 9-5241)
Div. Purch. Agent: R. S. Tobias
Purch. Agent: E. S. Muller
Gen. Sales Mgr.: H. M. Parsekian **PS, M, RD**

NAUGLER ENGRG., INC.
19 Madison Ave., Beverly, Mass. (Tel. WAlker 2-5634)
Purch. Agent: Charles A. Osborn
Sales Mgr.: W. E. Naugler **G**

NAVIGATION COMPUTER CORP.
1621 Snyder Ave., Philadelphia 45, Pa. (Tel. HOward 5-7700)
Purch. Agent: John Newton
Sales Mgr.: D. M. Biberman **CT**

E. V. NAYBOR LABS., INC.
26 Manorhaven Blvd., Port Washington, N. Y. (Tel. Port Washington 7-4300)
Pres.: E. V. Naybor **MS, G, CT, TT**

NAZ-DAR CO.
461 Milwaukee Ave., Chicago 10, Ill. (Tel. CHesapeake 3-1630)
Plant Mgr.: S. Rieger
Dir.-Sales: J. Nickels **M**

NEBEL MACHINE TOOL CORP.
3401 Central Pkwy., Cincinnati 25, Ohio (Tel. LIberty 2-3500)
Purch. Agent: Jack D. Smith
V. P.-Sales: Warren G. Rosendahl

NEFF INSTRUMENT CORP.
2211 E. Foothill Blvd., Pasadena, Calif. (Tel. SY 5-4308)
Buyer: Fred Gahm
Prod. Mgr.: W. P. Shaw
Sales Mgr.: J. B. Schneider **G, CT, TT**

NELCO METALS, INC.
Canaan, Conn. (Tel. TA 4-5437)
Purch. Agent: Richard Palmer
V. P.-Sales: W. J. Ash **M**

NELSON ELECTRIC MFG. CO.
P. O. Box 5385, Tulsa, Okla. (Tel. RI 2-5531)
Purch. Agent: Miss E. Maurer
Mgr.-Engrg.: Dick Ray
Mgr.-Mktg.: D. McDevitt **MS**

NELSON LABS., INC.
4718 Mason Ave., Hyattsville, Md. (Tel. WArfield 7-1116)
Purch. Agent: Charles E. Barker
Dir.-Sales: Ralph S. Baer **MS, RD**

NELSON STUD WELDING, DIV.-GREGORY INDUSTRIES, INC.
Toledo Ave. at E. 28th St., Lorain, Ohio (Tel. CHerry 5-6931)
Dir.-Purch.: Howard P. Nalley
Dir.-Sales: R. E. McGinnis **S**

NELSON VACUUM PUMP CO.
2133 4th St., Berkeley 10, Calif. (Tel. THornwall 8-2277)
Mgr.-Purch.: D. B. Webb
Sales Mgr.: B. J. McClary **CT**

NEMS CLARKE CO., DIV.-VITRO CORP. OF AMERICA
919 Jesup-Blair Dr., Silver Spring, Md. (Tel. JUniper 5-1000)
Purch. Agent: O. E. Lanham
Dir.-Sales: J. F. Whitehead

NETWORKS ELECTRONIC CORP.
14806 Oxnard St., Van Nuys, Calif. (Tel. STate 2-3114)
Purch. Agent: James D. Silianoff
V. P.-Purch.: John A. Shortal
Mktg. Mgr.: Sheldon T. Schreiber **MS, G, TT**

NEUMADE PRODUCTS CORP.
250 W. 57th St., New York 19, N. Y. (Tel. JUdson 6-5810)
Gen. Mgr.: E. T. Neu **M**

NEVADA AIR PRODUCTS CO.
P. O. Box 1090, Reno, Nev. (Tel. FA 2-9421)
Purch. Agent: R. Manaugh
Purch. Mgr.: J. W. Baldecchi
Engrg. Mgr.: S. D. Tout **MS, RD**

NEVILLE CHEMICAL CO.
Neville Island, Pittsburgh 25, Pa. (Tel. FEderal 1-4200)
Purch. Agent: C. H. Brown
Gen. Sales Mgr.: E. Glenn Isenberg

NEW BRITAIN MACHINE CO., THE, PRECISION PRODUCTS DIV.
South St., New Britain, Conn. (Tel. BAldwin 9-1641)
Dir.-Purch.: R. Hulbert
Purch. Agent: J. Devokaitis
Buyer: L. Bourquin
Asst. Purch. Agent: E. Johnson
Sales Mgr.: W. R. Knowles

***NEW DEPARTURE DIV., GENERAL MOTORS CORP.**
269 N. Main St., Bristol, Conn. (Tel. LUdlow 2-6371)
Dir.-Purchases: William J. Ryan
Gen. Sales Mgr.: Leonard F. Swoyer **PS, G, RD**
*(See advertisement this issue)

NEW ENGLAND AIRCRAFT PRODUCTS CO.
105 E. Main St., Plainville, Conn. (Tel. SH 7-2764)
Purch. Agent: Frank Broderick
Supt.: Henry Drescher
Pres.: George Einstein
Gen. Mgr.: Guy C. Shafer **PS, MS, RD**

NEW ENGLAND ELECTRICAL WORKS, INC.
365 Main St., Lisbon, N. H. (Tel. 8-6620)
Treas.: L. H. Dumdey **G**

NEW ENGLAND ETCHING CO., INC.
Spring St., Holyoke, Mass. (Tel. JE 2-9482)
V. P.-Sales: Walter W. Morris

NEW ENGLAND INSTRUMENT CO.
1334 Main St., Waltham, Mass. (Tel. TWinbrook 9-8370)
Asst. to Pres.: Noel Siegel
Sales Mgr.: Melvin Kutchin
V. P.-Purch.: Don McGee, 320 Main St., Woonsocket, R. I. (Tel. POpular 2-6232) **MS, G, CT, TT, RD**

NEW ENGLAND LAMINATES CO., INC.
481 Canal St., Stamford, Conn. (Tel. DAvis 4-4181)
Tech. Dir.: Dr. D. E. Edgar
Sales Mgr.: Bruce B. Greenfield **S, M, RD**

NEW ENGLAND MACHINE & TOOL CO., THE
Berlin, Conn. (Tel. VA 8-3519)
Purch. Agent: A. Herrmann

NEW ENGLAND SCIENTIFIC INSTRUMENTS CO.
238 Main St., Cambridge 42, Mass. (Tel. KI 7-1997)
Gen. Mgr.: Dr. Geoffrey Knight, Jr. **M, CT, RD**

NEW ENGLAND SPRING MFG. CO., INC.
Unionville, Conn. (Tel. Farmington, ORchard 3-2568)
Pres. & Gen. Mgr.: C. J. Daley
Plant Mgr.: L. A. Powers **M**

NEW ENGLAND TAPE CO., DIV.-UNITED-CARR FASTENER CORP.
30 Tower St., Hudson, Mass. (Tel. JOrdan 2-3485)
Purch. Agent: F. A. Keay
Sales: H. M. Wilkoff **M**

NEW ENGLAND TRANSFORMER CO., INC.
47 McGrath Hwy., Somerville 43, Mass. (Tel. SOmerset 6-6100)
Pres.: H. F. S. Morris

NEW HAMPSHIRE BALL BEARINGS, INC.
Peterborough, N. H. (Tel. WAlnut 4-3311)
Purch. Agent: W. R. Reekie
Buyer: Marvin Hammer
Sales Mgr.: George Hampson **MS, G, TT, RD**

NEW JERSEY WOOD FINISHING CO.
Amboy Ave., Woodbridge, N. J. (Tel. MErcury 4-1430)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Dir.-Purch.: Thomas A. Costanza
Sales Mgr.: Frank A. Shoemaker

NEW JERSEY ZINC CO., THE
160 Front St., New York 38, N. Y. (WH 3-5700)
Dir.-Purch.: W. C. Dunlap
Purch. Dept.: W. S. Hutchings & J. Rathjen
Dir.-Sales: R. G. Kenly M

NEW LONDON INSTRUMENT CO. INC.
82 Union St., New London 6, Conn. (Tel. GIbson 3-8451)
Purch. Agent: Anthony Franco
Pres.: Dale Pollack MS, CT, TT, RD

NEW YORK AIR BRAKE CO., THE WATERTOWN DIV.
Starbuck Ave., Watertown, N. Y. (Tel. SUnset 2-7000)
Purch. Mgr.: W. F. Slook
Asst. Purch. Mgr.: H. A. Hardman
Buyer: R. H. Madden
Gen. Sales Mgr.: H. R. Doughty, Jr. PS, MS, G

NEW YORK COIL CO., INC.
48 Second Ave., Phoenixville, Pa. (Tel. WEllington 3-3114)
Purch. Agent: Mrs. J. William Yocum
Pres. & Sales Mgr.: J. R. Zikmund

NEW YORK & NEW JERSEY LUBRICANT CO.
292 Madison Ave., New York, N. Y. (Tel. LExington 2-2851)
Purch. Agent: F. Roettinger
V. P.-Sales: L. L. Hall PS, M

NEW YORK SOLDER CO., INC.
684 E. 133rd St., New York 54, N. Y. (Tel. CYpress 2-3740)
Purch.: B. Gottlieb

NEW YORK TRANSFORMER CO. INC.
3rd Ave., Alpha, N. J. (Tel. GLencourt 4-1143)
Purch. Agent: A. Micci M

NEW YORK TWIST DRILL CO., INC.
276 Lafayette St., New York 12, N. Y. (Tel. WOrth 6-0551)
Purch. Agent: Ernest Lazarus
Exec. V. P.-Sales: Raymond M. Greenfield M

NEWARK CONTROLS CO.
15 Ward St., Bloomfield, N. J. (Tel. PIlgrim 8-2971)
Purch. Agent: D. Hess
Pres.: B. A. Hicks

NEWARK WIRE CLOTH CO.
351 Verona Ave., Newark, N. J. (Tel. HUmboldt 3-7700)
Purch. Agent: E. J. Korn
V. P.-Sales: J. L. Campbell M

NEWAY EQUIPMENT CO.
P. O. Box 425, 1183 E. Laketon Ave., Muskegon, Mich. (Tel. 6-2134)
Purch. Agent: Fred Tuttle
Exec. V. P.: G. W. Bartlett
Sales Mgr.: M. F. Feather S, M

NEWBROOK MACHINE CORP.
16 Mechanic St., Silver Creek, N. Y. (Tel. 44)
Purch. Agent: R. M. Scott
Shop Supt.: J. P. Shaw
Dir.-Sales: Gordon Kurtis

M. M. NEWMAN CORP.
79 Clifton Ave., Marblehead, Mass. (Tel. NEptune 1-0637)
Pres.: M. M. Newman M

NEWTH RUBBER CO.
Country Rd., Barrington, R. I. (Tel. CHerry 5-8050)
Purch. Agent: Charles F. Gladding
Sales Mgr.: Richard T. Shortle M

NEWTON CO., THE
55 Elm St., Manchester, Conn. (Tel. MI 3-1543)
Purch. Agent: Ernest Ehlers
V. P.-Sales: Norman Nelson MS, G, TT

NEWTON HYDRAULIC TOOLING CO.
P. O. Box 278, Auburn, Mass. (Tel. PLeasant 6-4695)
Purch. Agent: A. Pratt
Dir.-Sales: Gerald P. Welman

J. M. NEY CO., THE
Maplewood Ave., Bloomfield, Conn. (Tel. CH 2-2281)
Dir.-Purch.: Ralph Fothergill
Dir.-Sales & Engrg.: Fred I. Kent

NIAGARA MACHINE & TOOL WORKS
683 Northland Ave., Buffalo 11, N. Y. (Tel. TAylor 4070)
Purch. Agent: R. B. DeLisle
V. P.-Sales: F. A. Reed

NICAD DIV., GOULD-NATIONAL BATTERIES, INC.
Pleasant St., Easthampton, Mass. (Tel. EAsthampton 1200)
Purch. Agent: A. R. Duby
Buyer: D. B. Chateauneuf
Gen. Sales Mgr.: L. R. Mannheim MS, G, CT, TT

NICE BALL BEARING CO.
30th & Hunting Park Ave., Philadelphia 40, Pa. (Tel. BAldwin 3-6000)
Purch. Agent: F. P. H. Dimond
V. P.-Sales: Theo E. Spilker M

W. H. NICHOLS CO.
48 Woerd Ave., Waltham 54, Mass. (Tel. TWinbrook 4-0650)
Dir.-Purch.: W. L. Neese
Asst. Dir.-Purch.: R. H. Stearns
Sales Mgr.: John Freeto

NILSEN MFG. CO.
21 N. Church St., Addison, Ill. (Tel. KIngswood 3-6800)
V. P.-Purch. & Sales: T. C. Nilsen M, G, TT

NILSSON ELECTRICAL LAB., INC.
103 Lafayette St., New York 13, N. Y. (Tel. CAnal 6-1648)
V. P.-Purch.: O. Raymond Danielson
Sales Mgr.: Herbert Fransen

NIPPERT ELECTRIC PRODUCTS CO., THE
1759 W. Mound St., Columbus 23, Ohio (Tel. BRoadway 4-1116)
V. P.: J. E. Nippert M

NOBLE & WESTBROOK MFG. CO., THE
Westbrook St., East Hartford 8, Conn. (Tel. BU 9-2717)
Secy.: R. H. Gunther M

NON-LINEAR SYSTEMS, INC.
P. O. Box 728, Del Mar, Calif. (Tel. SKyline 5-1134)
Dir.-Material: William Clemens
V. P.-Mktg.: Richard C. Wynne CT

NOOTER CORP.
1400 S. Third St., St. Louis 66, Mo. (Tel. MAin 1-6000)
Dir.-Purch.: Herbert H. Lurtz
Buyers: Edward Diekmann & Donald Herr
V. P.-Sales: Arthur Schwarz S

NOPCO CHEMICAL CO., PLASTICS DIV.
175 Schuyler Ave., North Arlington, N. J. (Tel. WYman 8-3555)
Dir.-Purch.: Foster Jones
Gen. Sales Mgr.: John Gulick M

NORAIR DIV., NORTHROP CORP.
2031 E. Mariposa Ave., El Segundo, Calif. (Tel. ORegon 8-0411)
Dir.-Materiel: C. W. Hood
V. P. & Mgr.-Mktg.: John R. Alison, 1001 E. Broadway, Hawthorne, Calif. (Tel. OREgon 8-9111)

NORD AVIATION
12 bis, av. Bosquet, Paris (7e)
Factory: 12/18 rue Beranger—CHATILLON—sous—BAGNEUX (Seine)
Pres.: P. Mazer

NORDBERG MFG. CO.
3073 S. Chase Ave., Milwaukee, Wisc. (Tel. SHeridan 4-2345)
Gen. Purch. Agent: F. T. Finley
Mgr.-Sales: W. C. Jackson MS, M

NORDEN DIV., UNITED AIRCRAFT CORP.
58 Commerce Rd., Stamford, Conn. (Tel. DAvis 5-2611)
Gen. Sales Mgr.: Robert M. Adams, Jr.
Purch. Dept.: Carmel Cascio, Wiley St., Milford, Conn. (Tel. TRinity 4-6721) MS, G, TT, RD

NORMANDY ELECTRIC WIRE CORP.
125 Second St., Brooklyn 31, N. Y. (Tel. TRiangle 5-9863)
Mktg. Expediter: Lester W. Goody
Purch. Dept.: Milton Imbey MS, M

NORRICH PLASTICS CORP.
107-109 W. 18th St., New York 11, N. Y. (Tel. WA 4-8360)
Dir.-Purch.: N. Lawrence
Pres.: N. Thaw
Tech. Sales Mgr.: Richard E. Thaw PS, M, CT, TT

NORRICH SCREW MACHINE PRODUCTS
206 Babylon Tpke., Roosevelt, L. I., N. Y. (Tel. MAyfair 3-3100)
Dir.Purch.: Norman L. Thaw
V. P.-Sales: Richard E. Thaw PS, MS, M

NORRIS-THERMADOR CORP.
5215 S. Boyle Ave., Los Angeles 58, Calif. (Tel. LUdlow 8-7111)
Dir.-Purch.: R. R. Stoddard
V. P.-Sales, Military Products: D. P. White

ERNST NORRMAN LABORATORIES
Lake Geneva, Wisc. (Tel. CIrcle 5-5516)
Ernst Norrman G, CT, TT, RD

NORSID MFG. CO., INC., THE
33 Prospect St., Yonkers, N. Y. (Tel. YOnkers 5-8145)
Purch.: Jack Deutsch
Sales: Harold Deutsch

NORTH AMERICAN ELECTRONICS, INC.
71 Linden St., West Lynn, Mass. (Tel. LYnn 8-4800)
Purch. Agent: Mario S. Bruno
Sales Mgr.: Raymond W. Smith

NORTH & JUDD MFG. CO.
500 E. Main St., New Britain, Conn. (Tel. BAldwin 3-3621)
Purch. Agent: M. N. Holmes
Gen. Sales Mgr.: P. W. Brown

NORTH SHORE NAMEPLATE, DIV.-ANODYNE, INC.
214-27 Northern Blvd., Bayside 61, N. Y. (Tel. BAyside 4-4000)
Pres.: E. T. Turney, Jr.
Planning Engr.: A. L. Winter
Purch. Agent: Miss Gladys Dept
Sales Mgr.: Daniel G. Heilpern M

NORTHEAST ELECTRONICS CORP.
P. O. Box 425, Airport Rd., Concord, N. H. (Tel. CApitol 5-6641)
Purch.: R. L. Lincoln
Sales: W. B. Wilkens RD

NORTHEAST METALS INDUSTRIES, INC.
Ridge & Sedgley Avenues, Philadelphia 2, Pa. (Tel. PO 3-5727)
Purch. Agent: Lillian Robbins
Sales Mgr.: T. R. Roberts S, MS, RD

NORTHEAST SCIENTIFIC CORP.
30 Wetherbee St., Acton, Mass. (Tel. COlonial 3-7706)
Pres.: Clement Moritz

NORTHEASTERN ENGRG. INC.
25 S. Bedford St., Manchester, N. H. (Tel. NAtional 2-6485)
Purch. Agent: E. Newhall
Pres.: D. W. Brous
Mgr., Electronics: C. N. Chagaris
Sales Engr.: C. J. Kannair, Jr. MS, CT

NORTHERN ENGRG. LABORATORIES, INC.
372 Wilmot Ave., Burlington, Wisc. (Tel. ROckwell 3-3591)
Pres. & Sales Mgr.: John D. Holmbeck
V. P.-Purch.: E. E. Overbey G, CT, TT

NORTHERN ORDNANCE INC., SUB.-NORTHERN PUMP CO.
Columbia Height, Minneapolis 21, Minn. (Tel. SUnset 8-8601)
Purch. Mgr.: W. H. Bauer
Purchasing: Vern Kinney & Tony Petrangelo
Contract Service Mgr.: A. J. Bryant

NORTHERN PLASTICS CORP.
2nd & Market St., La Crosse, Wisc. (Tel. 4-6070)
Purch. Agent: S. L. Noe
V. P.-Sales: G. C. Kroening M

NORTHROP CORP.
9744 Wilshire Blvd., Beverly Hills, Calif. (Tel. CRestview 4-8061)
Pres.: Thomas V. Jones
S, MS, M, G, CT, TT, RD, HSE

NORTHROP CORP., NORTRONICS DIV.
Electronic Systems & Equipment Dept., 222 N. Prairie Ave., Hawthorne, Calif. (Tel. OREgon 8-9111)
Dir.-Materiel: R. M. Cooper
Chief Applications Engr.: T. J. Venator
Precision Products Dept., The: Norwood, Mass.
V. P. & Gen. Mgr.: Dr. William F. Balthaus
Systems Support Dept.: 500 E. Orangethorpe, Anaheim, Calif. (Tel. LAmbert 5-4771)
Dir.-Materiel: G. A. Johnston
Chief Applications Engr.: E. W. Warnshuis
S, MS, M, G, CT, TT, RD, HSE

NORTHWESTERN ELECTRIC CO.
1750 N. Springfield Ave., Chicago 47, Ill. (Tel. DIckens 2-4400)
Purch. Agent: Paul Christiansen
V. P.-Sales: George D. Craig, Jr. **MS**

NORTON ASSOCIATES, INC.
240 Old Country Rd., Hicksville, N. Y. (Tel. OVerbrook 1-6181)
Purch. Agent: M. Viole
Sales Mgr.: R. S. Norton **G, RD**

NORTON CO.
New Bond St., Worcester 6, Mass. (Tel. SWift 8-2511)
Purch. Dept.: W. L. Hixon
Gen. Purch. Agent: G. D. Seguin
Chief Buyer: H. H. Anderson **M, RD**

NORTON CO., NEW PRODUCTS DEPT.
Worcester 6, Mass. (Tel. SW 8-2511) **M, RD**

NORWALK CUTTER SHARPENING CO.
356 Ely Ave., South Norwalk, Conn. (Tel. VO 6-0560)
Dir.-Sales: Harold W. Nadin

NORWALK THERMOSTAT CO.
100 N. West St., Norwalk, Ohio (Tel. 3-0822)
Dir.-Purch. & Sales: D. H. Callihan
V. P.-Purch.: E. S. Arlin
Plant Mgr.: A. R. Beard

NORWOOD PRODUCTS, DETROIT CONTROLS DIV.
5900 Trumbull St., Norwood, Mass. (Tel. TR 2-0300)
Purch. Agent: J. Moncur
Mgr., Instrumentation Mktg.: H. T. Elliott

NOTHELFER WINDING LABS. INC.
222 Ewingville Rd., Trenton 9, N. J. (Tel. TUxedo 2-2500)
Purch. Agent: Carl W. Zigrano **M**

NOTIFIER CORP.
3700 N. 56th St., Lincoln 4, Nebr. (Tel. 6-2331)
Pres.: Oliver T. Joy

NU STEEL CO.
1714 S. Ashland Ave., Chicago 8, Ill. (Tel. HAymarket 1-5760)
Pres.: Lew W. Cleminson **M**

NUCLEAR CORP. OF AMERICA
2 Richwood Pl., Denville, N. J. (Tel. OAkwood 7-4200)
Purch. Agent: Michael Buff
Sales Mgr., Instrument & Research Div.: David Silverstein
Sales Mgr., Central Electronics Div.: Gene Perry **CT, RD**

NUCLEAR DEVELOPMENT CORP. OF AMERICA
5 New St., White Plains, N. Y. (Tel. WH 8-5800)
Purch. Agent: I. Jacobson
Mgr.-Prod. Operation: K. O. Donevan
Mgr.-Contract Operation: N. Schwartz **M, RD**

NUCLEAR DEVELOPMENT LAB.
P. O. Box 7034, Kansas City 13, Mo. (Tel. DElmar 3-7692)
Mgr.-Purch. & Sales: M. J. Test

NUCLEAR MEASUREMENTS CORP.
2462 N. Arlington Ave., Indianapolis 18, Ind. (Tel. LIberty 6-2415)
Purch. Agent: James L. Sommerville
Chief Engr.: Herbert S. Fall
Gen. Sales Mgr.: Carl L. Kegley **RD**

NUCLEAR-CHICAGO CORP.
333 Howard Ave., Des Plaines, Ill. (Tel. VAnderbilt 7-4456)
Purch. Agent: Robert Young
V. P., Indsl. Div.: O. K. Neville
Chief Engr.: Philip Slevick
Sales Mgr.: Mel Shepherd **RD**

NUCLEONIC PRODUCTS CO.
1601 Grande Vista Ave., Los Angeles 23, Calif. (Tel. AN 2-3503)
Dir.-Purch.: V. Pineda
Dir.-Sales: A. Jolles

NUGENT ELECTRONICS CO., INC.
802 E. Eighth St., New Albany, Ind. (Tel. WHitehall 5-0211)
V. P.-Purch.: J. D. Robinson **G, CT**

NUMBERALL STAMP & TOOL CO.
Huguenot Park, Staten Island 12, N. Y. (Tel. YUkon 4-0822)
Owner: Max Bayerdorffer
Mgr.: William Buechling

PAUL NURCHES CO.
2396 E. Foothill Blvd., Pasadena, Calif. (Tel. SYcamore 6-5844)
Mgr.-Purch. & Sales: Paul Nurches **MS, CT, RD**

NURECO, INC.
1100 Pontiac Ave., Cranston 10, R. I. (Tel. HOpkins 1-4110)
V. P.-Purch.: J. Grana
Pres. & Gen. Mgr.: C. L. Grana
Sales Mgr.: J. J. Jordan **M**

NUTMEG SCREW MACHINE PRODUCTS CO.
Wolcott Rd., Wolcott 16, Conn. (Tel. Waterbury, PLaza 7-1496)
Purch. Agent: Joseph Pagano
Dir.-Sales: Richard H. Sceery **TT**

NUTRON MFG. CO. INC.
67 Monroe Ave., Staten Island 1, N. Y. (Tel. GIbraltar 7-3229)
Secy.-Treas.: Henry Scian

NUTTING TRUCK & CASTER CO.
1201 W. Division St., Faribault, Minn. (Tel. EDison 4-4333)
Purch. Agent: H. E. Hildebrandt
Asst. Purch. Agent: E. W. Erie
Gen. Sales Mgr.: K. F. Heath

NYLOK CORP., THE
611 Industrial Ave., Paramus, N. J. (Tel. COlfax 1-9400)
Purch. Agent: S. J. Roberts
Pres.: R. E. Waldo
V. P.-Sales: T. J. Buckley **S, PS, MS, G, CT, TT**

NYTRONICS, INC., ESSEX ELECTRONICS DIV.
550 Springfield Ave., Berkeley Heights, N. J. (Tel. CRestview 3-9300)
Purch. Agent: William H. Bowman
Purch. Dept.: Jack Gerard
Sales Mgr.: Henry J. Lenox **MS, G, CT, TT**

OPW-JORDAN
6013 Wiehe Rd., Cincinnati 13, Ohio (Tel. EL 1-1352)
Asst. Plant Mgr.: M. H. Hott
Chief Sales Engr.: P. H. Coleman
Sales Engr.: R. J. Peters
Gen. Mgr.: G. B. Richards, Jr.

OFFNER ELECTRONICS INC.
3900 River Rd., Schiller Park, Ill. (Tel. GLadstone 1-0050)
Purch. Agent: H. Lewis
Sales Mgr.: G. W. Little **MS, CT, TT**

OHIO CARBON CO., THE
12508 Berea Rd., Cleveland 11, Ohio (Tel. CL 2-6100)
Purch. Agent: R. Hawrylak
V. P.-Sales: F. C. Aurand **M**

OHIO CHEMICAL & SURGICAL EQUIPMENT CO., DIV.-AIR REDUCTION CO., INC.
1400 E. Washington Ave., Madison 10, Wisc. (Tel. ALpine 6-5421)
Purch. Agent: A. J. Sauer
Asst. Purch. Agent: E. O. McConnell
V. P.-Sales: Charles A. Simpler **M**

OHIO NUT & WASHER CO., THE
P. O. Box 66, Mingo Junction, Ohio (Tel. KE 5-1618)
Dir.-Purch.: Charles B. Lanman
Sales Mgr.: Charles S. Thompson

OHIO PRECISION CASTINGS, INC.
109 Webb St., Dayton 3, Ohio (Tel. CLearwater 3-4183)
Pres.-Treas.: W. J. Prestel
Dir.-Purch.: Mrs. Jeanette Diener **M**

OHIO SEAMLESS TUBE DIV.-COPPERWELD STEEL CO.
Shelby, Ohio (Tel. 3-1010)
Purch. Agent: R. R. Underhill
Asst. Purch. Agent: R. W. Winck
Mgr.-Sales: J. E. Horner

OHIO STEEL FOUNDRY CO., THE
1075 James St., Springfield, Ohio (Tel. FA 5-7631)
Purch. Agent: E. F. Buchanan, P. O. Box "F", Lima, Ohio (Tel. CA 2-2010)
Sales Mgr.: J. D. Hagans **M**

OHLSON EMPIRE INC.
24-16 Bridge Plaza, Long Island City 1, N. Y. (Tel. STillwell 6-0700)
Dir.-Purch.: Donald R. Locke
Dir.-Sales: Philip E. Ohlson **MS, M**

OHMART CORP., THE
2236 Bogen St., Cincinnati 22, Ohio (Tel. PArkway 1-2302)
Purch. Agent: J. Allen
V. P.-Purch.: E. M. Pollock
Pres.: P. E. Ohmart **RD**

OIL-DYNE, INC.
2115 W. Marquette Rd., Chicago 36, Ill. (Tel. HEmlock 4-2300)
Purch. Agent: Andrew Pappas
Buyer: Jack Budakian
Sales Mgr.: George Staat **MS, CT, RD**

OIL-RITE CORP.
2318 Waldo Blvd., Manitowoc, Wisc. (Tel. MUrray 2-2428)
Purch. Agent: Gus Lukas
Sales Mgr.: Frank J. Lyden

OKONITE CO., THE, SUB.-KENNECOTT COPPER CORP.
220 Passaic St., Passaic, N. J. (Tel. PRescott 7-0400)
Purch. Agent: T. B. Woodcock
V. P.-Mktg.: C. M. Kirkland **M**

OLIN MATHIESON CHEMICAL CORP.
10 Light St., Baltimore 3, Md. (Tel. PLaza 2-8300)
Purch. Mgr.-Chemicals Div.: Ralph C. Phillips
Purch. Dept.-Chemicals Div.: Edward W. Genetive
Mgr., Sales Dev.-Spec. Prod., Chemicals Div.: J. G. Chalfant **M**

OLIN MATHIESON CHEMICAL CORP.-METALS DIV.
400 Park Ave., New York 22, N. Y. (Tel. PLaza 1-7227)
Metal Specialist: Jack Forst, 460 Park Ave., New York 22, N. Y. (Tel. MUrray Hill 8-0500) **M**

OLIN MATHIESON CHEMICAL CORP., N. Y.
460 Park Ave., New York 22, N. Y. (Tel. MUrray Hill 8-0500)
V. P.-Defense Products Mktg.: H. A. Sosnoski **PS, M, RD**

OLIN MATHIESON CHEMICAL CORP., WINCHESTER-WESTERN DIV.
275 Winchester Ave., New Haven 4, Conn. (Tel. SPruce 7-7911)
Purch. & Trans. Mgr.: F. E. Plumley
Purch. Agent: M. W. Perrine
Buyer: W. B. Fuller
Mktg. Mgr., Indsl. & Mil. Sales: A. S. Cogan **MS, RD**

OLIVER CORP., THE, A. B. FARQUHAR DIV.
142 N. Duke St., York, Penna. (Tel. 7801)
Spec. Machinery & Ord. Sales Mgr.: J. Kugle
Mech. & Hydraulic Press Sales Mgr.: G. Wright
Conveyor Sales Mgr.: C. W. King
Mgr.-Purch.: Lester B. Hibner **S**

OLYMPIC PLASTICS CO., INC.
3471 S. La Cienega Blvd., P. O. Box 78477, Los Angeles 16, Calif. (Tel. UP 0-1121)
Purch. Agent: J. Borack
Purch. Clerk: A. Aranoff
Sales Mgr.: Herbert Rome **S, PS**

OLYMPIC SCREW & RIVET CORP.
11445 S. Dolan St., Downey, Calif. (Tel. SPruce 3-2060)
Dir.-Purch.: Irving Borg
Purch. Agent: Robert O'Donnell
V. P. & Gen. Mgr.: E. H. Stau **S, MS, M, RD**

OMEGA LABS., INC.
Haverhill St., Rowley, Mass. (Tel. WHitney 8-7757)
Treas.: H. B. Ribbel **MS**

ON MARK COUPLINGS, INC.
4404 York Blvd., Los Angeles 41, Calif. (Tel. CLinton 4-2278)
Purch. Agent: Kenneth Palmer
Pres.: Barry B. Willis
Chief Engr.: H. A. DeCenzo
Sales Mgr.: Howard Sherman **PS, MS, CT, RD**

ON MARK ENGINEERING CO.
7929 Hayvenhurst Ave., Van Nuys, Calif. (Tel. TRiangle 3-1030)
Dir.-Purch.: F. E. Britton
Comm. Sales Mgr.: Harvey D. Adams

D. W. ONAN & SONS INC.
2515 University Ave., S. E., Minneapolis 14, Minn. (Tel. FE 2-1155)

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

Dir.-Procurement: H. P. Richter
Mgr.-Purch. Dept.: L. V. Moen
V. P.-Sales: R. E. Mullin **MS, CT**

ONONDAGA ELECTRONICS DIV., SPEER CARBON CO.
1810 W. Fayette St., Syracuse 1, N. Y. (Tel. HO 8-6261)
Purch. Agent: V. N. Goodrich
Sales Mgr.: P. L. Christensen **M**

ONSRUD CUTTER MFG. CO., INC.
800 E. Broadway, Libertyville, Ill. (Tel. 2-1560)
Gen. Mgr.: Dan Johnstad
Sales Mgr.: Arthur R. Johnson **S, MS**

ONSRUD MACHINE WORKS, INC.
7720 N. Lehigh Ave., Niles 48, Ill. (Tel. Niles 7-8700)
Purch. Agent: Frank Muscarello
Buyer: William Hansen
Exec. V. P.-Sales: G. M. Campbell

OPAD ELECTRIC CO.
43 Walker St., New York 13, N. Y. (Tel. WOrth 6-0380)
Purch. Agent: J. McShay
Dir.-Sales: H. L. Opad

OPELIKA WELDING, MACHINE & SUPPLY INC.
1200 Steel St., Opelika, Ala. (Tel. SHerwood 5-3524)
Pres.: G. C. Mann
Chief Engr.: William S. Harris, II
V. P.-Sales: C. S. Foster **S, MS**

OPTICAL COATING LAB., INC.
2789 Giffen Ave., Santa Rosa, Calif. (Tel. LIberty 5-6440)
Admin. Mgr.: John McCullough
Purch. Agent: L. Vance Fisher
Sales Mgr.: Danforth Joslyn **G, RD**

OPTICAL GAGING PRODUCTS, INC.
26 Forbes St., Rochester 11, N. Y. (Tel. FAirview 8-9090)
Purch. Agent: C. Pat Henry
Dir.-Sales: Wayne G. Norton **CT**

OPTIMIZED DEVICES, INC.
864 Franklin Ave., Thornwood, N. Y. (Tel. ROgers 9-6110)
Prod. Mgr.: J. Murtha
Sales Mgr.: A. Zuch **CT**

OPTOMECHANISMS INC.
216 E. 2nd St., Mineola, N. Y. (Tel. Ploneer 6-5576)
Purch. Agent: John Ferrante
Sales Engrg. Mgr.: Ray T. Smith **RD**

OPTO-METRIC TOOLS, INC.
137 Varick St., New York 13, N. Y. (Tel. ORegon 5-9076)
Secy.: A. A. Crystle

ORBITRAN CO., INC.
11487 Woodside Ave., Lakeside, Calif. (Tel. HI 3-3841)
Gen. Mgr.: E. W. Fischer

ORDNANCE ENGINEERING ASSOCIATES, INC.
407 S. Dearborn St., Chicago 5, Ill. (Tel. HArrison 7-2294)
Purch. Agent: John E. Banko
Dir.-Sales: Ahmed D. Kafadar
V. P.-Engrg.: Ramon L. Olson **RD**

ORDNANCE RESEARCH & DEVELOPMENT CO., DIV.-BERMITE POWDER CO.
6856 Tujunga Ave., North Hollywood, Calif. (Tel. TRiangle 7-5628)
Mgr.-Sales: Joseph B. Tortorici
V. P. & Asst. Gen. Mgr.-Purch.: Hugo Lizza
Mgr.-Sales, Eastern Office: Samuel P. Miller, Alexandria, Va. (Tel. Fleetwood 4-4118)
PS, MS, TT, RD

ORONITE CHEMICAL CO.
200 Bush St., San Francisco 20, Calif. (Tel. SUtter 1-6940)
V. P.-Mktg.: T. M. Welton
Div. Sales Mgr.: J. R. Stitt
Product Specialist: J. S. McClure **M, G**

ORR INDUSTRIES CO., DIV.-AMPEX CORP.
Opelika, Ala. (Tel. SH 5-7643)
Purch. Mgr.: Thad McEachin
Dir.-Sales: J. Reynolds Carey

ORTHO FILTER CORP.
7 Paterson St., Paterson 1, N. J. (Tel. MUlberry 4-5858)
Purch. Agent: George C. Pagonis
Buyer: William McGravey

ORTMAN-MILLER MACHINE CO. INC.
19 143rd St., Hammond, Ind. (Tel. WEstmore 1-1710)
Dir.-Purch.: A. H. Ortman
Dir.-Sales: N. H. Ortman

ORYX CO.
13804 Ventura Blvd., Sherman Oaks, Calif. (Tel. STate 8-1013)
Dir.-Purch. & Sales: C. H. Mitchell

OSBORNE ELECTRONIC SALES CORP.
712 S. E. Hawthorne Blvd., Portland 14, Ore. (Tel. BElmont 2-0161)
Purch. Agent: Charles Pearce
Pres.: G. L. Osborne
V. P.-Mktg.: S. H. Bellue **MS**

R. H. OSBRINK MFG. CO.
6917 McKinley Ave., Los Angeles 1, Calif. (Tel. PLeasant 3-3381)
Purch. Agent: J. R. Elam
Mktg. Mgr.: H. C. Cisco
Chief Engr.: W. C. Brown **S**

JOHN OSTER MFG. CO., AVIONIC DIV.
1 Main St., Racine, Wis. (Tel. MElrose 7-4445)
Purch. Agent: Paul South
Asst. Purch. Agent: P. J. Bjerke
Buyer: R. Woods
Eastern Sales Mgr.: I. G. Epstein
Western Sales Mgr.: W. Carlson

OTIS ELEVATOR CO., DEFENSE & INDUSTRIAL DIV.
35 Ryerson St., Brooklyn 5, N. Y. (Tel. ULster 5-6800)
Purch. Agent: A. Velto
Mgr., Mil. Customer Relations: R. M. Huff
MS, CT, RD

OVERHAUL & AEROSYSTEMS, DIV.-TEMCO AIRCRAFT
P. O. Box 1056, Greenville, Texas (GLadstone 5-3450)
Supvr.-Purch.: A. W. Melton
Supt.: Wayne Valentine
Mgr.-Sales: W. A. Dolan **S**

OVERHEAD DOOR CO. OF OREGON, INC.
3508 S. W. Moody St., Portland, Ore.

OVERLOAD CONTROL CO.
151 Pennsylvania Ave., Island Park, N. Y. (Tel. GEneral 2-1431)
Purch.: R. Ronnie
Sales: Earl Elwyn Smith **MS, CT**

OWATONNA TOOL CO., PRECISION HYDRAULICS DIV.
Owatonna, Minn. (Tel. 5591)
Purch. Agent: Clarence P. Kaplan
Dir.-Sales: J. A. Mullenmaster **M**

OWEN LABS., INC.
55 Beacon Pl., Pasadena, Calif. (Tel. MUrray 1-6901)
Purch. Agent: W. N. Fellows
Mgr.-Sales: R. P. Owen **CT**

OWENS-CORNING FIBERGLAS CORP.
National Bank Bldg., Toledo 1, Ohio (Tel. CHerry 8-6741)
Mgr.-Purch., Gen. Products: G. C. Stefango
Purch. Dept.: William H. Deardurff & John W. Moore
V. P.-Sales: T. V. Fowler **M**

OXYGEN EQUIPMENT & SERVICE CO.
8335 S. Halsted St., Chicago 20, Ill. (Tel. HUdson 3-3800)
Pres.: Albert E. McKee
Purch. Agent: Donald J. Freeburg **M**

OZONE METAL PRODUCTS CORP.
101-32 101st St., Ozone Park 16, N. Y. (Tel. VIrginia 6-3300)
Purch. Agent: E. S. Kulich
Gen. Sales Mgr.: F. A. Winzer **MS, CT**

P. B. R. MFG. CO.
H & Luzerne Sts., Philadelphia 24, Pa. (Tel. GArfield 6-0932)
Purch. Agent: J. Manfredonia
Dir.-Purch.: I. B. Rachman
Sales Mgr.: Sidney Bobb

PCA ELECTRONICS INC.
16799 Schoenborn St., Sepulveda, Calif. (Tel. EMpire 2-0761)
Purch. Agent: Allan Grotsky
Sales Mgr.: Charles Rubin

PIC DESIGN CORP., SUB.-BENRUS WATCH CO., INC.
477 Atlantic Ave., E. Rockaway, L. I., N. Y. (Tel. LYnbrook 3-6470)
Purch. Agent: Mrs. T. Balzer
Sales: P. Wellenberger

PSP ENGRG. CO., DIV.-IMC MAGNETICS CORP., N. Y.
6058 Walker Ave., Maywood, Calif. (Tel. LUdlow 3-4785)
Dir.-Purch.: Robert Morris
Exec. V. P.: David Menkin
Dir.-Engrg.: Robert Phinizy
Sales Mgr.: Ben Eder **MS, G, CT, TT, RD**

PACE ELECTRICAL INSTRUMENTS CO., INC.
70-31 84th St., Glendale 27, L. I., N. Y. (Tel. DAvenport 6-3982)
Dir.-Purch.: A. S. Weingast
Industrial Sales Mgr.: G. N. Goldberger **CT**

PACE ENGRG. CO.
13035 Saticoy St., N. Hollywood, Calif. (Tel. PO 5-0453)
Purch. Agent: William Johnston
Dir.-Sales: Bernard Helfand **CT, TT, RD**

PACIFIC AUTOMATION PRODUCTS, INC.
1000 Air Way, Glendale 1, Calif. (Tel. CHapman 5-8661)
Purch. Agent: Roland Satrom
Sales Mgr.: Robert L. Veloz **S, MS, M, CT, RD**

PACIFIC COAST ENGRG. CO.
Oak & Clement Sts., Alameda, Calif. (Tel. LA 2-6100)
Purch. Agent: L. L. Compiano
Gen. Sales Mgr.: Alex McClure **MS**

PACIFIC MAGNETIC CORP.
Electronic Center, Romoland, Calif. (Tel. Perris Exchange, OLympia 7-2637)
Pres.: H. L. Mills
Dir.-Purch. & Sales: E. A. Eckstein

PACIFIC MERCURY ELECTRONICS
8345 Hayvenhurst Ave., Sepulveda, Calif. (Tel. EMpire 2-3131); Junge Blvd. & Maiden Lane, Joplin, Mo.
Dir.-Purch.: Dan Stein (Tel. EMpire 2-3131)
V. P. & Chief Engr.: Hugh Pruss (Tel. EMpire 2-3131) **TT, RD**

PACIFIC OPTICAL CORP., DIV.-CHICAGO AERIAL INDUSTRIES
120 S. Glasgow Ave., Inglewood 1, Calif. (Tel. ORegon 8-1139)
Purch. Agent: Fred Schwind
Design Engr.: John Needham
Contract Admin.: James W. Shuck **G, TT, RD**

PACIFIC RELAYS, INC.
13915 Saticoy St., Van Nuys, Calif. (STate 2-2360)
Dir.-Purch.: Lou Junkin
Pres.: N. F. Leo **M**

PACIFIC SCIENTIFIC CO.
P. O. Box 22019, Los Angeles 22, Calif. (Tel. SPruce 3-2020)
V. P.-Aeronautical Div.: Andre W. Reichel
Purch. Mgr.: M. R. Hartigan
Buyers: L. B. Herr, Lee Marshek **G, TT, RD, HSE**

***PACIFIC SEMICONDUCTORS, INC.**
10451 W. Jefferson Blvd., Culver City, Calif. (Tel. TExas 0-4881)
Purch. Agent: Harry Rosen
Sales Mgr.: S. L. Spiegel
*(See advertisement this issue)

PACIFIC TUBE CO.
5710 Smithway St., Los Angeles 22, Calif. (Tel. RAymond 3-1331)
Purch. Agent: W. H. Kepp
Sales Mgr.: W. P. Armstrong **S, MS**

PACIFIC UNIVERSAL PRODUCTS CORP.
168 Vista Ave., Pasadena, Calif. (Tel. MUrray 1-7646)
Mgr.: Charles Chopnick **M**

PACKARD BELL COMPUTER CORP.
1905 Armacost Ave., Los Angeles 25, Calif. (Tel. GRanite 8-4247); 2341 Michigan Ave., Santa Monica, Calif.
Purch. Agent: Rod Lundstrom
Buyers: Frank Chesser & Gerald Luttrell
Sales Mgr.: T. J. Smith **CT, TT, RD**

PACKARD ELECTRIC DIV.-GENERAL MOTORS CORP.
Dana St., Warren, O. (Tel. 3250-1)
Procurement Mgr.: D. E. Tritten

Buyers: L. Raymond Clutter, K. F. Dymond, G. E. Gibbons, H. H. Grebe
Gen. Sales Mgr.: J. R. Lakin M

PACKARD-BELL ELECTRONICS CORP.
12333 W. Olympic Blvd., Los Angeles 64, Calif. (Tel. BRadshaw 2-6141)
Mgr.-Materiel: Wm. Winckler
Dir.-Sales & Admin.: Hugh L. Vick
Purch. Agent, Subcontracting: John Rickabaugh
Supvr., Materiel Control: Sam Julian MS, CT, RD

PACO ELECTRONICS CO., INC.
70-31 84th St., Glendale 27, L. I., N. Y. (Tel. DAvenport 6-3982)
Dir.-Purch.: A. S. Weingast
Purch. Dept.: H. Meir & Jean Best
Sales Mgr.: S. S. Sparer CT, RD

PAGE COMMUNICATIONS ENGINEERS, INC.
2001 Wisconsin Ave., N. W., Washington 5, D. C. (Tel. EXecutive 3-1523)
Asst. Dir.-Admin. for Proc.: G. H. Baldwin
Dir.-Customer Relations: W. R. Brehm

PAGE STEEL & WIRE DIV., AMERICAN CHAIN & CABLE CO., INC.
First & River Sts., Monessen, Pa.

PAK-RAPID, INC.
18 Elizabeth St., W. Conshohocken, Pa. (Tel. TAylor 8-3511)
Purch. Agent: Stanley Stevens
Pres.: Benjamin Karpowicz

M. V. PALMER, INC.
4108 N. W. Fruit Valley Rd., Vancouver, Wash. (Tel. OXford 3-0590)
Chief Engr.: Martin Palmer M

PALMER INSTRUMENTS
1017 Mission St., South Pasadena, Calif. (Tel. MUrray 2-1194)
Owner: M. C. Palmer
Mgr.-Electronics Div.: E. W. Johnson

PALMER THERMOMETERS, INC.
2501 Norwood Ave., Cincinnati, O. (Tel. ME 1-1500)
Purch. Agent: S. Rolfsen
Sales & Adv. Mgr.: Douglas H. Hitt

PALO ALTO ENGRG. CO.
620 Page Mill Rd., Palo Alto, Calif. (Tel. DA 6-5360)
Purch. Agent: Roger Earley
Sales Engr.: Lloyd Burkhart

PAN AMERICAN WORLD AIRWAYS, INC., GUIDED MISSILES RANGE DIV.
135 E. 42nd St., New York 17, N. Y. (Tel. OXford 7-6300)
Pres.: Juan T. Trippe
V. P.: Richard S. Mitchell

PANDUIT CORP.
14461 Waverly Ave., Midlothian, Ill. (Tel. HIlltop 5-3134) (Chicago)
Sales Mgr.: J. E. Caveney M

PANEL ENGRG. CORP.
222 W. Huron St., Chicago 10, Ill. (Tel. SUperior 7-8461)
Pres.: Robert K. Cameron MS, M, G, RD

PANISH CONTROLS
191-203 Bennett St., Bridgeport 5, Conn. (Tel. EDison 3-7371)
Pres. & Gen. Mgr.: Erwin J. Panish PS

PANOB CORP.
49 Beech St., Port Chester, N. Y. (Tel. WEstmore 9-3066)
Purch. Agent: Michael J. Vita
Buyers: Alfred A. Rich & Joseph Giandvrco
Sales: Charles H. Perchne, Jr. M

PANORAMIC RADIO PRODUCTS, INC.
520 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. OWens 9-4600)
V. P.-Purch.: Samuel Kleinman
Buyer: Sheldon Horton
Dir.-Sales: B. Schlessel CT, RD

PAPER MFRS. CO.
9800 Bustleton Ave., Philadelphia 15, Pa. (Tel. ORchard 3-4500)
Dir.-Purch.: J. Walker
Chicago Fld. Sales Reps.: Robert J. Moore & Samuel Du Bois, 510 N. Dearborn St., Chicago, Ill.
N. Y. State (Northern) Fld. Sales Rep.: Don Carroll, 308 Collins Ave., Fayetteville, N. Y.
N. Y. & N. J. Fld. Sales Rep.: Joseph I. Shields (Tel. N. Y. C.—DIgby 9-3720)
N. Y. C. & New England Fld. Sales Rep.: Charles R. Weber, Philadelphia office

PARAGON-REVOLUTE, DIV.-CHARLES BRUNING CO., INC.
77 South Ave., Rochester 6, N. Y. (Tel. BAker 5-2480)
Purch. Agent: W. T. Nurse
Sales Mgr.: B. W. Johnson S, MS, RD

PARABAM, INC.
13000 Yukon Ave., Hawthorne, Calif. (Tel. OSborne 9-3393)
V. P.-Purch.: J. T. Barnett
Asst. Purch. Agent: A. C. Ross
Pres.: T. A. Feeney MS, CT, TT, RD

PARAMOUNT DESIGNS CO.
408 Jay St., Brooklyn 1, N. Y. (Tel. UL 5-6161)
Supvr.-Field Services: S. Davidowitz
Sales Mgr.: William Varley (Tel. OVerbrook 1-1700) -RD

PARAMOUNT PAPER TUBE CORP.
614 S. Lafayette St., Ft. Wayne 2, Ind. (Tel. A-4197)
Gen. Mgr.: R. R. Weimer

PARAPLEGICS MFG. CO., INC.
10068 Franklin Ave., Franklin Park, Ill. (Tel. GLadstone 5-1697)
Purch. Agent: Alvin F. Engel
Dir.-Sales: Harry G. Bendtsen MS, G

PARISH PRESSED STEEL, DIV.-DANA CORP.
Box 1422, Robeson & Weiser Sts., Reading, Pa. (Tel. FRanklin 3-4211)
Dir.-Purch.: E. R. Kohl
Purch. Agent: W. H. Fahnestock
Buyers: C. R. Kline & K. Shugars
Sales Mgr.: S. L. Whitehall S, PS, MS

PARK NAMEPLATE CO., INC.
34-10 Linden Pl., Flushing 54, N. Y. (Tel. FLushing 9-7000)
Purch. Agent: Edith Weisbroth
V. P.-Sales: David Kend M

PARKER AIRCRAFT CO.
5827 W. Century Blvd., Los Angeles 45, Calif. (Tel. SP 6-1221)
Purch. Agent, Hydraulic Div.: R. W. Burnham
Purch. Agent, Air & Fuel Div.: R. R. Fix
Purch. Agent, Missile Fittings Div.: T. Janes
V. P.-Sales: A. V. Zukas

PARKER FITTINGS & HOSE DIV., PARKER-HANNIFIN CORP.
17325 Euclid Ave., Cleveland 12, Ohio (Tel. KE 1-3000)
Purch. Agent: F. A. Jenkins
Gen. Sales Mgr.: D. A. Cameron
Div. Sales Mgr.: W. D. Wynant MS

PARKER HYDRAULICS DIV., PARKER-HANNIFIN CORP.
17325 Euclid Ave., Cleveland 12, Ohio (KE 1-3000)
Purch. Agent: E. J. Anderson
Div. Mgr.: C. J. Giblin
Prod. Mgr.: J. Shaffer MS

PARKER RUST PROOF CO.
2177 E. Milwaukee, Detroit 11, Mich. (Tel. TRinity 5-3377)
Purch. Agent: John A. Gutha
Gen. Sales Mgr.: E. B. Thompson M

PARKER SEAL CO., DIV.-PARKER-HANNIFIN CORP.
10567 Jefferson Blvd., Culver City, Calif. (Tel. VErmont 9-1161)
Purch. Agent: Paul Glassford
V. P.-Sales: T. J. McCuistion

PARKER-HANNIFIN CORP.
17325 Euclid Ave., Cleveland 12, Ohio (Tel. KE 1-3000)
Purch. Agents: Walter Keller & F. A. Jenkins
Sales Mgr.: F. E. Nathanson PS, MS

PARKER-HARTFORD CORP., THE
650 Franklin Ave., Hartford 1, Conn. (Tel. CHapel 6-1651)
V. P.-Purch.: Tom Daly
Sales Mgr.: F. P. Clement PS, G

PARKWAY SPECIALTIES CO.
22519 Plymouth Rd., Detroit 39, Mich. (Tel. KE 5-0796)
Dir.-Purch.: A. J. Wallace
Sales Mgr.: P. V. Wallace

RALPH M. PARSONS CO., THE, ELECTRONICS DIV.
151 S. De Lacey Ave., Pasadena, Calif. (Tel. Los Angeles—MUrray 1-0461)
Mgr.-Proc.: Daniel M. Ogden
Mgr.-Bus. Dev.: Charles E. Burns CT, TT, RD

PARSONS CORP., SPECIAL PRODUCTS DIV.
P. O. Box 112, Traverse City, Mich. (Tel. WI 6-6710)
Purch. Agent: David Kipley
Sales Mgr.: Walter J. Hooper (Tel. WI 6-8422) S, RD

PARSONS DIAMOND PRODUCTS, INC.
22 Grassmore Ave., West Hartford 10, Conn. (Tel. ADams 6-2303) M

PARTS ENGRG. CO., INC.
760 N. Marshall Ave., El Cajon, Calif. (Tel. HIckory 4-9481)
Purch. Agent: Charles W. Sandlin
V. P.-Sales: Clyde W. Hull S, PS, CT

PASS & SEYMOUR, INC., DEFENSE DIV.
50 Boyd Ave., Syracuse 9, N. Y. (Tel. HOward 8-6211)
Dir.-Defense Div.: C. H. M. Roberts
Purch. Agent-Defense Div.: R. E. Martin MS, RD

PASTUSHIN INDUSTRIES, INC.
11221 Hindry Ave., Los Angeles 45, Calif. (Tel. ORegon 8-4226)
Supvr.-Buyers: June R. Young S, MS

PATTERSON MOOS RESEARCH, DIV.-LEESONA CORP.
90-28 Van Wyck Expwy., Jamaica 18, N. Y. (Tel. AXtel 7-4400)
Purch. Agent: Howard L. Abeel
V. P. & Gen. Mgr.: A. M. Moos MS, RD

PATWIN, DIV.-PATENT BUTTON CO.
41 Brown St., Waterbury 20, Conn. (Tel. PLaza 6-3636)
Purch. Agent: W. A. Carpenter
Sales Mgr.: F. O. Stratton S

F. H. PAUL & STEIN BROTHERS, INC.
235 5th Ave., New York 16, N. Y. (Tel. MU 4-6370) PS

PAUL & BEEKMAN, INC.
1801 Courtland St., Philadelphia 40, Pa. (Tel. DAvenport 9-9050)
Purch. Agent: Joseph H. Proctor
Works Mgr.: David R. Barnhart
V. P.-Sales: J. E. Schmidt S

HOWARD E. PAYNE
56 Beaverbrook Dr., Dayton 32, Ohio (Tel. CHapel 4-5600)
Consultant & Representative
S, PS, MS, M, G, CT, TT, RD, HSE

PEACOCK ENGRG. & MFG. CO.
10620 Firestone Blvd., Norwalk, Calif. (Tel. SPruce 3-3980)
Prod. Mgr.: Thomas E. Sadler
Purch. Agent: Stephen Gelet
Gen. Mgr. & Sales Mgr.: Earl L. Singleton S, PS, MS

PEARSON ELECTRONICS, INC.
707 Urban Lane, Palo Alto, Calif. (Tel. DAvenport 6-7285)
Pres.: Dr. Paul A. Pearson RD

PEASE & CURREN, INC.
780 Allens Ave., Providence 5, R. I.

PEE CEE TAPE & LABEL CO. INC.
521 N. La Brea Ave., Los Angeles 36, Calif. (Tel. WEbster 8-2134)
Dir.-Purch.: C. W. Richardson
Gen. Mgr.: Dow Gevirtz
Dir.-Sales: Robert Buckley

PEER, INC.
1220 Milton St., Benton Harbor, Mich. (Tel. WAlnut 5-8828)
Mgr.: Alton B. Parrott

PEERLESS ELECTRIC DIV.-H. K. PORTER CO., INC.
1401 W. Market St., Warren, Ohio (Tel. EXpress 3-1551)
Purch. Agent: R. C. Isler
Sales Mgr.: W. M. Gelvin S, MS, M

PEERLESS ELECTRONICS INC.
5338 Alhambra Ave., Los Angeles 32, Calif. (Tel. CApitol 1-5196)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Sales: Robert Monroe
Purch. Agent: E. N. Hough **S, PS, MS, CT**

PEERLESS PHOTO PRODUCTS INC.
Tesla Rd., Shoreham, N. Y. (Tel. 4-2817)
Purch. Agent: Pat Hajek
Sales: Arthur Taber

PEERLESS PUMP DIV., FOOD MACHINERY & CHEMICAL CORP.
301 West Ave. 26, Los Angeles 31, Calif. (Tel. CApitol 1-3151)
Purch. Agent: W. I. Nye
Sales Mgr.: E. W. Lundy **PS, MS, CT**

PEGASUS LABS., INC.
3690 W. Eleven Mile Rd., Berkley, Mich. (Tel. LIncoln 6-3636)
Dir.-Purch.: Charles E. Ikerman
Dir.-Sales: Theodore C. Smith **PS, MS, G, CT, RD**

PEMCO INC.
5663 Brecksville Rd., Cleveland 31, Ohio (Tel. LA 4-2991)
Purch. Agent: H. H. Heinbaugh
Supvr.-Inst. Dept.: C. G. Mittermiller
Supvr.-Fabrication: C. Bar **PS, CT**

PENETONE CO., THE
74 Hudson Ave., Tenafly, N. J. (Tel. LOwell 7-3000)
Purch. Agent: C. Goldberg
Dir.-Sales: H. E. Roberts
Gen. Sales Mgr.: Philip F. Rose **M**

PENFIELD MFG. CO., INC.
19 High School Ave., Meriden, Conn. (Tel. BE 5-1694)
Gen. Mgr.: Edward H. Clohessy **MS, M**

PENN FIBRE & SPECIALTY CO., INC.
2024 El Westmoreland St., Philadelphia 34, Pa. (Tel. REgent 9-5642)
V. P.-Sales: William K. Davis
Purch. Agent: William H. Frey
Asst. Purch. Agent: E. C. Timms **M**

PENN KEYSTONE CORP.
100 Hawkins St., Derby, Conn. (Tel. REgent 4-3301)
Purch. Agent: Robert A. Nagel
Dir.-Engrg.: Edward M. Parker **CT, RD**

PENN METAL CO., INC.
40 Central St., Boston 9, Mass. (Tel. CApitol 7-1932)
Dir.-Purch.: Gordon T. Wolfe, Box 1460, Parkersburg, W. Va. (Tel. AXminster 5-4521)
Dir.-Sales: M. K. Brown **M**

PENN-EAST ENGRG. CORP.
Industrial Ave., Kutztown, Pa. (Tel. OVerbrock 3-7308)
Material Control: H. W. Putnam
Pres.: G. L. Tawney

PENN-MICHIGAN MFG. CORP.
220 S. Kirk St., West Lafayette, Ohio (Tel. LIncoln 5-6311)
Purch. Agent: L. F. Howbert
Asst. Purch. Agent: William Lilja
Sales Mgr.: J. S. Hall

PENNSALT CHEMICALS CORP.
3 Penn Center, Philadelphia 2, Pa. (Tel. LOcust 4-4700)
Mgr., Research Products Dev. Dept.: Dr. John F. Gall, Box 4388, Philadelphia 18, Pa. (Tel. CH 7-6900) **PS, M, RD**

PENNSYLVANIA TOOL & MFG. CO., THE
130 S. Hartman St., York, Pa. (Tel. 8-1855)
Pres. & Gen. Mgr.-Purch. & Sales: J. M. Lehmayer, Jr.
V. P. & Prod. Mgr.: Philip E. Hirschfield
Supt.: Robert L. Witta, Jr. **G, CT, RD**

PEQUOT WIRE CLOTH CO.
35 Hoyt St., Norwalk, Conn. (Tel. TE 8-8438)
Plant Mgr.: R. K. Abercrombie
Asst. Div. Mgr.: C. P. Finney
Div. Sales Mgr.: W. H. Heidenrider **M**

RODNEY PERDEW, INC.
11616 Hart St., North Hollywood, Calif. (Tel. TR 7-5524)
Purch. Dept.: Edward A. Rassett & Helen M. Cotoni
Sales Mgr.: Donald L. Hengst **M**

PERFECTION DIV.-HUPP CORP.
1135 Ivanhoe Rd., Cleveland 10, O. (Tel. ULster 1-6200)
Purch. Agent: J. S. Zorn
V. P., Mobile Products: F. W. Hottenroth
Mgr., Specialty Sales, Mobile Products: W. E. Hamilton
Mgr., Heater Sales, Mobile Products: H. C. Gerboth
Buyers: D. Fetzer & H. H. Haldeman **MS**

PERFECTO CAST
5660 Kearney Villa Rd., San Diego 11, Calif. (Tel. BRowning 7-6711)
Plant Mgr.: Ralph F. Carlson
Pres.: George Wilson **M, RD**

PERFORMANCE MEASUREMENTS CO.
15120 Third Ave., Detroit 3, Mich.
Purch. Agent: Theo Schmalzriedt
Sales Mgr.: Louis H. Laramie **CT**

PERKIN ENGRG. CORP.
345 Kansas St., El Segundo, Calif. (Tel. OR 8-7215)
Purch. Agent: Pat Cerella
Buyer: Harry Sterling
Sales Mgr.: George W. Mousel **MS, CT**

PERKIN-ELMER CORP.
Main Ave., Norwalk, Conn. (Tel. VIctor 7-2422)
Dir.-Purch.: Patrick O'Gorman
Asst. Purch. Agent: George Hodge
Electronic Buyer: Arthur Cummings
Buyers: William Douda, David Fournier, Lew Jason
Mktg.-Electro-Optical Div.: C. B. Hazzard
Mktg.-Instrument Div.: John H. Rhodes
Sales-Vemistat Div.: Lionel Robbins **MS, CT, TT, RD**

PERKINS MACHINE & GEAR CO.
Circuit Ave., West Springfield, Mass. (Tel. REpublic 7-4751)
Purch. Agent: William Case **PS, MS, M, G**

PERMACEL
U. S. Hwy. #1, New Brunswick, N. J. (Tel. CHarter 7-7900)
Purch. Agent: J. S. Babiy
Buyers: J. E. Grover & G. Radcliffe
V. P.-Sales: G. A. Fitzgerald **M**

PERMANENT FILTER CORP.
1800 W. Washington Blvd., Los Angeles 7, Calif. (Tel. REpublic 1-7381)
Materials Control Mgr.: James P. Whitesel
Gen. Sales Mgr.: W. E. Johns **PS, MS, G, CT, RD**

PERMANENT MAGNET CO., INC., THE
4437 Bragdon St., Indianapolis 26, Ind. (Tel. LIberty 7-1336)
Purch. Agent: Ralph M. Burns
Buyer: James Phillips **G, TT, RD**

PERMATEX CO., INC.
300 Broadway, Huntington Sta., N. Y. (Tel. HAmilton 1-3800)
Purch. Agent: K. Carpenter, Jr.
Gen. Sales Mgr.: W. A. Sneed

PERMOFLUX PRODUCTS CO.
4101 San Fernando Rd., Glendale 4, Calif. (Tel. CHapman 5-5135)
Purch. Agent: S. H. Ise
Dir.-Sales: L. M. Heineman **PS, M**

PERRY PLASTICS, INC.
3409 W. 14th St., Erie, Pa. (Tel. TE 8-1971)
Purch. Agent: Frank Chrostowski
Admin. Asst. to Exec. V. P.: C. K. Reichert, Jr.
Defense Sales & Contract Officer: Lincoln S. Love **PS, MS, G, CT**

PESCHEL ELECTRONICS, INC.
R.F.D. 1, Patterson, N. Y. (Tel. TRinity 8-3251)
Pres.: Stephen S. Peschel **CT**

PESCO PRODUCTS DIV.-BORG-WARNER CORP.
24700 N. Miles Rd., Bedford, Ohio (Tel. MOntrose 2-2100)
Mgr.-Purch.: H. L. Sanders
Purch. Agent, Non-Prod.: G. T. Weidinger
Purch. Agent, Prod.: W. C. Erwin
V. P.-Sales: M. W. Nesbitt **PS, MS, RD**

PESCO PRODUCTS DIV., BORG-WARNER CORP., CALIF.
3310 Vanowen St., Burbank, Calif. (Tel. THornwall 5-7411)
Purch. Agent: J. J. Rocca
Sales Mgr.: W. L. Cook **MS, G, CT, TT**

PETER PARTITION CORP.
124 Boerum Pl., Brooklyn 1, N. Y. (Tel. TRiangle 5-4033)
Purch. Dept.: Andrew A. Viola
Pres.: Ludwig P. Raubenheimer

PETCH MFG. CO.
U. S. 23 South, Alpena, Mich. (Tel. EL 4-2131)
Purch. Agent: Clarence R. Meharg
V. P.: K. Doutt
Supt.: C. Helzer
Sales Mgr.: W. W. Hutcherson (Tel. TW 1-4240) **M**

PETTIBONE MULLIKEN CORP.
4700 W. Division St., Chicago, Ill. (Tel. SPaulding 2-9300)
Purch. Agent: T. M. Cavender
Asst. Purch. Agent: H. T. Samuels
Steel Buyer: C. R. Slocum
Fabricated Parts Buyers: L. Knapp, A. J. Salmon, W. C. Hinz
Sales: J. M. Hume **M**

PFAUDLER DIV., PFAUDLER PERMUTIT INC.
1000 West Ave., Rochester 3, N. Y. (Tel. BEverly 5-1000)
Dir.-Purch.: Joseph F. Kuder
Div. Sales Mgr.: Bruce T. Clarke **M**

PHALO PLASTICS CORP.
530 Boston Tpke., Shrewsbury, Mass. (Tel. VIking 4-4021)
Purch. Agent: H. A. Werme
V. P.-Sales: A. N. Averill

PHAOSTRON INSTRUMENT & ELECTRONIC CO.
151 Pasadena Ave., S. Pasadena, Calif. (Tel. CLinton 5-1471)
Purch. Agent: Al Lowenstein
Expediting-Purch.: Joseph Arbaugh
V. P.-Sales: H. J. Veitch **M**

PHELPS DODGE COPPER PRODUCTS CORP.
300 Park Ave., New York 22, N. Y. (Tel. PLaza 1-3200)
Purch. Agent: F. A. Scheffler
Electronic Prod. Dept., Sales: F. W. Lemly **G, TT**

PHILADELPHIA INSULATED WIRE CO.
333 New Albany Rd., Morrestown, N. J. (Tel. BElmont 5-6700)
Purch. Agent: E. B. Sheridan, Sr.
Sales Mgr.: R. W. Campbell **M**

PHILADELPHIA QUARTZ CO.
1146 N Public Ledger Bldg., Philadelphia 6, Pa. (Tel. MArket 7-7200)
Purch. Mgr.: Frank M. Franz
Sales Mgr.: John C. Russell **M**

PHILADELPHIA STEEL & WIRE CORP.
Penn St. & Belfield Ave., Philadelphia 44, Pa. (Tel. DAvenport 4-5600)
Purch. Agent: J. T. Messert
V. P.-Sales: E. C. Mincher

PHILAMON LABS. INC.
90 Hopper St., Westbury, N. Y. (Tel. EDgewood 3-1700)
Purch. Agent: George V. Wrynn
Sales Mgr.: Robert A. Hunt **CT, TT**

PHILCO CORP., GOVERNMENT & INDUSTRIAL GROUP
4700 Wissahickon Ave., Philadelphia 44, Pa. (Tel. VIctor 3-4000)
Purch. Mgr.: John R. McAllister
V. P.-Mktg.: Joseph M. Hertzberg **MS, G, CT, TT, RD, HSE**

PHILCO CORP., LANSDALE DIV.
Church Rd., Lansdale, Pa. (Tel. ULysses 5-4681)
Purch. Agent: A. G. McIlvaine
Buyers: W. R. Lewis, R. Haughs, E. C. Lutz, B. Carroll, Peter Rivera, Robert Bieling
Asst. Buyer: Mary Bartholemew
Gen. Sales Mgr.: Cyrus H. Warshaw **MS, G, CT, TT**

RICHARD PHILIP CO.
5007 Fyler Ave., St. Louis 39, Mo. (Tel. FLanders 2-2505)
Dir.-Proc.: Roy Moschner
Chief Purch. Agent: Robert N. Zimmer
Asst. Purch. Agent: Dorothy Guest
Sub-Contract Sales Mgr.: Richard P. Monahan **S, PS, MS, CT, RD**

PHILIPS & DAVIES INC.
1030 Steiner Ave., Kenton, O. (Tel. 2-1120)
Purch. Agent: G. R. Leoffert
V. P.-Sales: J. W. Stuckey **S, MS, M**

PHILIPS ELECTRONIC INSTRUMENTS
750 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. MO 4-4500)
Dir.-Purch.: Jack Hemphill
Dir.-Sales: C. J. Woods **S, MS, CT, RD**

PHILLIPS-CARTER-OSBORN, INC.
831 14th St., Denver 2, Colo. (Tel. AMherst 6-2481)
Pres.: Orley O. Phillips **S**

PHILLIPS CONTROL CORP.
59 W. Washington St., Joliet, Ill. (Tel. SAratoga 3-3431)
Purch. Agent: Charles E. Perkins
Purch. Dept.: Robert Moore
Sales Mgr.: W. R. Baughman **G, CT, TT**

PHILLIPS MFG. CO.
3475 W. Touhy Ave., Chicago 45, Ill. (Tel. AMbassador 2-6020)
Purch. Agent: Harry Pearl
V. P.-Sales: L. R. Anderson

PHILLIPS PROCESS CO. INC.
192 Mill St., Rochester 14, N. Y. (Tel. BA 5-8201)
Sales Mgr.: William D. Gerb

PHOENIX PRODUCTS CO.
4715 N. 27th St., Milwaukee, Wis. (Tel. UP 1-1680)
Purch. Agent: H. W. Heard
Asst. Mgr., Metal Spinning Div.: Edwin Weiss **RD**

PHOTOBELL CO., INC.
43 Vesey St., New York 7, N. Y. (Tel. WOrth 2-6739)
Purch. Agent: M. Gagliardo
Gen. Mgr.: A. Edelman **MS, CT**

PHOTOCIRCUITS CORP.
31 Sea Cliff Ave., Glen Cove, N. Y. (Tel. OR 6-8000)
Purch. Agent: William B. Sherriff
V. P.-Sales: Alan P. Kingsbury

PHOTOCON RESEARCH PRODUCTS
421 N. Altadena Dr., Pasadena, Calif. (Tel. SYcamore 2-4131)
Purch. Agent: Jean Hicks (Tel. MUrray 1-6752)
Dir.-Sales: P. C. Ganzell **CT, RD**

PHOTOGRAMMETRY, INC.
922 Burlington Dr., Silver Spring, Md. (Tel. JUniper 5-4600)
Purch. Agent: H. B. Miracle **RD**

PHOTOVOLT CORP.
95 Madison Ave., New York 16, N. Y. (Tel. MUrray Hill 6-3350)
Purch. Agent: H. W. Lindemann
V. P.-Sales: B. A. Silard

PHOTRON INSTRUMENT CO.
6516 Detroit Ave., Cleveland 2, O. (Tel. ATlantic 1-7020)
Sales: N. H. Fayerweather **CT, TT**

PIASECKI AIRCRAFT CORP.
Island Rd., International Airport, Philadelphia 42, Pa. (Tel. SAratoga 7-9750)
Acting Purch. Agent: William M. Collins
Treas.: J. J. Hensel
Pres.-Sales: F. N. Piasecki
V. P.: D. N. Meyers **S, MS, CT, RD**

PICKERING & CO., INC.
Sunnyside Blvd., Plainview, L. I., N. Y. (Tel. OVerbrook 1-0200)
Dir.-Purch.: Ruth Reisert

PIEZO CRYSTAL CO.
265 E. Pamfret St., Carlisle, Pa. (Tel. CH 9-2151)
Dir.-Purch.: Herman Shall
Sales Mgr.: Wallace Wilson **M**

PILOT CHEMICALS, INC.
36 Pleasant St., Watertown 72, Mass. (Tel. WAtertown 4-7775)
Business Mgr.: M. A. Sigal **M, RD**

PIMEX, INC.
18 E. 60th St., New York 28, N. Y. (Tel. PLaza 3-3041)
Sales Mgr.: G. Gudefin

PINES ENGRG. CO. INC.
601 Walnut St., Aurora, Ill. (Tel. TW 6-7701)
Purch. Agent: W. J. Carlson
Asst. Purch. Agent: J. J. McKeaige
Sales Mgr.: J. E. Hawking

PIONEER ALUMINUM INC.
5251 W. Imperial Hwy., Los Angeles 45, Calif. (Tel. OREgon 8-7621)
Purch. Agent: K. R. Cannon, 10035 Burtis St., South Gate, Calif. (Tel. LOrain 4-2646)
V. P.-Sales: William F. Morrow

PIONEER INDUSTRIES DIV., ALMAR-YORK CO. INC.
3455 W. Vickery, Fort Worth 7, Tex. (Tel. ED 2-7387)
Pres.: A. W. Stubbeman, Sr.
V. P.-Sales: Frank B. Self **S, M, CT, RD**

PIONEER PARACHUTE CO., INC.
168 Forrest St., Manchester, Conn. (Tel. MItchell 9-5211)
Purch. Agent: Cliff Schumacher
Pres.: Michael Kagan
Exec. V. P.: William Bell

PIQUA ENGRG. INC.
Piqua, Ohio (Tel. PR 3-2464)
Purch. Agent: C. Rice
Pres.: J. Scarbrough **MS, CT**

PITMAN MFG. CO.
Grandview, Mo. (Tel. SOuth 1-1851)
Mgr.-Purch.: R. K. Doty
Buyer: G. Oliver
Chief Engr.: D. E. Broderson
Sales Mgr.: B. M. McMillin **MS**

PITOMETER LOG CORP.
237 Lafayette St., New York 12, N. Y. (Tel. CAnal 6-7250)
Purch. Agent: John J. Newman
Asst. Purch. Agent: Charles K. Koesting
Dir.-Engrg. Sales: Bernard Kahn **MS, G, CT, TT, RD**

PITTSBURGH CORNING CORP.
1 Gateway Center, Pittsburgh 22, Pa. (Tel. COurt 1-2900)
V. P.-Sales: R. E. Buckley
Purch. Agent: B. B. Coffo, P. O. Box 39, Port Allegany, Pa. (Tel. Port Allegany 2-2552)
Purch. Agent: G. E. Gibbs, P. O. Box 72, Sedalia, Mo. (Tel. TAylor 6-4660) **S, M, RD**

PITTSBURGH-DES MOINES STEEL CO.
3476 Neville Island, Pittsburgh 25, Pa. (Tel. FE 1-3000)
Purch. Agent: G. L. Bader
V. P. & Sales Mgr.: T. W. Fauntleroy

PITTSBURGH LECTODRYER DIV.-Mc GRAW-EDISON CO.
P. O. Box 1766, Pittsburgh 30, Pa. (Tel. GRant 1-8782)
Purch. Agent: S. B. Wilson
Chief Engr.: H. E. Zankey
Gen. Sales Mgr.: J. D. Boydston, Jr.

PLANNING RESEARCH CORP.
1333 Westwood Blvd., Los Angeles 24, Calif. (Tel. GRanite 9-7725)
Pres.: Robert W. Krueger
V. P.: Stuart A. Krieger

PLAS-KEM CORP., DIV.-DYNA-THERM CHEMICAL CORP.
100 W. Alameda Ave., Burbank, Calif. (Tel. VIctoria 9-1121)
Pres.: H. H. Clarke, Jr. (Tel. UPton 0-4751)
Gen. Sales Mgr.: R. F. Dawson
Sales Mgr.-Adhesives: Ernie Stern
Buyer: Mrs. Cleo Mullins **S, MS, M, RD**

PLASMADYNE CORP.
3839 S. Main St., Santa Ana, Calif. (Tel. KImberly 5-7171)
Dir.-Purch.: Pete DePaolo
Purch. Dept.: Marge Gavlin
Adm. Engr.: M. H. Sturmer **PS, MS, G, RD**

PLASTIC AGE SALES, INC.
14300 Davenport Rd., Saugus (Mint Canyon), Calif. (Tel. MAdison 6-8895)
Purch. Agent: Adolph S. Kramer **S, MS, RD**

PLASTIC CAPACITORS, INC.
2620 N. Clybourn Ave., Chicago 14, Ill. (Tel. DIversey 8-3735)
Purch. Agent: Robert Tamkin
Sales Mgr.: Stephen Meskan

PLASTIC FILM CO., INC.
Plainfield, Conn. (Tel. Moosup, Conn., LOgan 4-2741)
V. P.-Mgr., Indsl. Sales: T. A. Lancaster

PLASTICS DISTRIBUTOR OF NEW ENGLAND
P. O. Box 574, Manchester, N. H.
Dir.-Sales: John F. McGranahan
V. P.-Purch.: John C. Stanhope, 71 Canton St., Manchester, N. H. (Tel. NA 5-8397) **S, M, RD**

PLASTOID CORP.
42-61 24th St., Long Island City 1, N. Y. (Tel. STillwell 6-6200)
Purch. Agent: Ernest Brown
Sales-Serv. Mgr.: Don J. Nichols, Hamburg, N. J. (Tel. Van Dyck 7-7141)

PNEU-HYDRO VALVE CORP.
52 Horse Hill Rd., Cedar Knolls 2, N. J. (Tel. JEfferson 8-7200)
Purch. Agent: Robert Demmert
Buyer: John Neal
Sales Mgr.: George T. Stern **PS, MS, G, CT, RD**

PNEUMAFIL CORP.
2516 Wilkinson Blvd., Charlotte, N. C. (Tel. EXpress 9-7441)
Dir.-Purch.: Jack B. Greegan
Sales Mgr., Mechtronics: Jay B. Deyton

POLARAD ELECTRONICS CORP.
43-20 34th St., Long Island City 1, N. Y. (Tel. EXeter 2-4500)
Dir.-Purch.: Ben Katz
Buyers: J. Pearl, B. Flax, I. Wasserman & D. Rosenbloom
Sales Mgr.: A. A. Goldberg **CT**

POLAROID CORP.
119 Windsor St., Cambridge 39, Mass. (Tel. UNiversity 4-6000)
Dir.-Purch.: P. E. Sullivan
Asst. Dir.-Purch.: H. R. Pickering
Purch. Engr.: G. W. Bramhall
Sales Mgr., Polarizer Div.: J. H. Mulhall

JOSEPH POLLAK CORP.
85 Freeport St., Boston 25, Mass. (Tel. AVenue 2-9550)
V. P.-Purch.: Henry Brandt
Purch. Agent: James Burns
Sales Mgr.: H. A. MacDonald

POLYMER CORP., THE
2120 Fairmont Ave., Reading, Pa. (Tel. FRanklin 6-7241)
Purch. Agent: Alvin S. Mallatratt
Sales Mgr.: Robert E. Barthold **M**

POLYMICA & INSULATION CO. INC.
683 Main St., Willimantic, Conn. (Tel. HA 3-0584)
Mgr.: M. Kronenberg
Asst. Mgr.: J. Kronenberg

POLYPHASE INSTRUMENT CO.
E. 4th St., Bridgeport, Montgomery Co., Pa. (Tel. BRoadway 9-4660)
Purch. Agent: D. C. Morris
Sales Mgr.: D. J. Seifert

POLY-SCIENTIFIC CORP.
Rte. 460 N., Blacksburg, Va. (Tel. PRescott 2-8212)
Purch. Agent: Herbert Albert
V. P.-Sales: A. S. Hackley

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC.
202 Tillary St., Brooklyn 1, N. Y. (Tel. ULster 2-6800)
Dir.-Purch.: Walter A. Cuskie
Electronic Buyers: Frank H. Roberts & James J. Alfieri
Subcontract Buyers: Alphonse Pristupa & A. C. Heldman
Misc. Buyer: John La Scala
Expediters: Walter Ezoch & Frank Sidoti
Sales Mgr.: Harry C. Nelson **CT, RD**

POMONA ELECTRONICS CO., INC.
1126 W. 5th Ave., Pomona, Calif. (Tel. NAtional 9-9549)
Purch. & Sales Mgr.: Carl Wm. Musarra **CT**

PORTLAND COPPER & TANK WORKS INC.
80 2nd St., S. Portland, Me. (Tel. SPruce 9-3341)
Purch. Agent: Willard Jones
Buyer, Special Prod. Dept.: Leo Lyons
Buyer, New Prod. Dept.: Joe Feeney
V. P.-Sales: Frank Hugo **S, PS, MS, RD**

L. POTTER, INC.
4040 Hempstead Tpke., Bethpage, N. Y. (Tel. PE 5-7000)
Asst. Treas.: O. P. Dieffenbach
Secy.: John Potter

POTTER AERONAUTICAL CORP.
U. S. Rt. 22, Union, N. J. (Tel. MUrdock 6-3010)
Purch. Agent: Harry Carlson
Gen. Sales Mgr.: Irving Hirsch **MS, CT, RD**

POTTER & BRUMFIELD, DIV.-AMERICAN MACHINE & FOUNDRY CO.
Princeton, Ind. (Tel. FUlton 5-5251)
Purch. Agent: Charles Schrader
Asst. Purch. Agent: Everett Cox
Gen. Mgr.: Nelson Havill

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

POTTER INSTRUMENT CO., INC.
Sunnyside Blvd., Plainview, L. I., N. Y. (Tel. OVerbrook 1-3200)
Purch. Agent: Walter Gerber
Asst. Sales Mgr.: R. A. Schramm **CT, TT**

HAROLD H. POWELL CO.
2102 Market St., Philadelphia 3, Pa. (Tel. LOcust 4-1440)
Purch. Agent: Joseph Harris
Dir.-Sales: Charles Daugherty

WM. POWELL CO., THE
2525 Spring Grove Ave., Cincinnati 8, Ohio (Tel. DUnbar 1-4600)
Purch. Agent: John Ellis
Pres.: David M. Forker
V. P. & Chief Engr.: William E. Heilig **PS, MS**

POWER SUPPLIES INC.
Rt. 143, P. O. Box 269, Highland, Ill. (Tel. 2139)
Purch. Agent: Dale Rutz
Sales Mgr.: R. F. Cota **MS, G, CT**

J. J. POWERS CO.
818 N. 22nd St., P. O. Box 254, Melrose Park, Ill. (Tel. FIlmore 5-3500)
Pres.: J. J. Powers **TT**

POWERS REGULATOR CO., THE
3400 Oakton St., Skokie 66, Ill. (Tel. COrnelia 7-6300)
Purch. Agent: R. Bennett
Buyer: P. Kempe
Sr. Buyer: V. Wiland

PRATT & WHITNEY AIRCRAFT DIV., UNITED AIRCRAFT CORP.
400 Main St., East Hartford 8, Conn. (Tel. JAckson 8-4811)
Purch. Mgr.: E. E. Champion
Sales Mgr.: Charles T. McKinnie **PS, RD**

PRECISE DEVELOPMENT CORP.
2 Neil Ct., Oceanside, N. Y. (Tel. Rockville 6-0171)
Dir.-Sales: Melville Byron
V. P.-Purch.: Sol Schwartz **MS, CT, RD**

PRECISION APPARATUS CO., INC.
7031 84th St., Glendale 27, L. I., N. Y. (Tel. DAvenport 6-3982)
Dir.-Purch.: A. S. Weingast
Sales Mgr.: S. S. Sparer **CT, RD**

PRECISION CASTINGS, INC.
1550 Superior Ave., Costa Mesa, Calif. (Tel. LIberty 8-2278)
V. P.-Prod.: Charles R. Salmon
Dir.-Sales: John J. Hall **S, M, RD**

PRECISION CASTPARTS CORP.
4600 S. E. Harney Dr., Portland 6, Ore. (Tel. PRospect 5-4391)
Purch. Agent: John M. Vranizan
V. P. & Sales Mgr.: K. H. Pierce **RD**

PRECISION CIRCUITS, INC.
705 S. Fulton Ave., Mt. Vernon, N. Y. (Tel. MOunt Vernon 4-3737)
V. P.-Prod.: Herbert L. Schwartz
Dir.-Sales: Charles Sabel **G, CT, TT, RD**

PRECISION ELECTROPLATING CO.
519 S. Oakley Blvd., Chicago 12, Ill. (Tel. SEeley 3-5855)
Dir.-Purch.: James Zacharias
Dir.-Sales: Richard Zacharias

PRECISION EQUIPMENT CO., INC.
1740 Crenshaw Blvd., Torrance, Calif. (Tel. SPruce 5-2501)
Pres.: Richard Gilman
Purch. Agent: Jack Berry **PS, MS, CT**

PRECISION GEARS & PRODUCTS, INC.
132 Iowa Ave., Paterson, N. J. (Tel. MUlberry 4-1460)
Exec. V. P.: Robert C. Williams
V. P.-Engrg.: Martin Stevens
Works Mgr.: David Wills **MS, RD**

PRECISION, INC.
4748 France Ave. N., Minneapolis 22, Minn. (Tel. JUniper 8-9441)
Pres.: A. H. Benner
V. P.-Sales: D. G. Benner **G**

PRECISION LAPPING CO. INC.
34 Clinton Ave., Valley Stream, N. Y. (LOcust 1-2770)
Purch. Agent: R. Dietz
Chief Engr.: M. Lipkins
Dir.-Sales: J. Deane **G, RD**

PRECISION LINE INC.
63 Main St., Maynard, Mass. (Tel. TWin Oaks 7-2451)
Gen. Mgr.: L. M. Burgess
Sales Mgr.: Paul Hokanson **G, TT, RD**

PRECISION METAL PRODUCTS CO. INC.
41 Elm St., Stoneham 80, Mass. (Tel. SToneham 6-3650)
Pres.: John H. Jarvis
Sales Engr.: Robert A. Degnan **M**

PRECISION METALSMITHS, INC.
1081 E. 200 St., Cleveland 17, Ohio (Tel. IVanhoe 1-8900)
Purch. Agent: E. K. Hutchinson
Sales Mgr.: W. W. Lamb **S, PS, MS, G, TT, RD**

PRECISION RADIATION INSTRUMENTS, INC.
5810 S. Normandie St., Los Angeles 44, Calif. (Tel. PL 3-3501)
Pres.: Carl Doshay
Natl. Sales Mgr.: Robert Blythe
Customer Relations: Patricia Clark **M**

PRECISION RUBBER PRODUCTS CORP.
3110 Oakridge Dr., Dayton 17, Ohio (Tel. AMherst 3-2631)
Purch. Agent: Margaret Yoder
Sales Mgr.: E. N. Cunningham **M**

PRECISION SCIENTIFIC CO.
3737 W. Cortland St., Chicago 47, Ill. (Tel. CApitol 7-2660)
Mgr.-Purch.: Edmund A. Bloss, Jr.
Asst. Mgr.-Purch.: Nester A. Gunderlach
Sr. Buyer: Joseph C. Cacioppo
V. P. & Sales Mgr.: John J. Kinsella **MS, RD**

PRECISION SHAPES, INC.
15 Washington Ave., Suffern, N. Y. (Tel. SUffern 5-0226)
Procurement Mgr.: Ronald Lockyer
Sales Mgr.: Norman M. Dickson

PRECISION SPECIALTIES, INC.
1342 E. 58th St., Kansas City 10, Mo. (Tel. EMerson 1-1619)
Pres.: John S. Baer (Tel. LUther 9-0815)
V. P.-Sales: Roy S. Baer **RD**

PRECISION THERMOMETER & INSTRUMENT CO.
1434 Brandywine St., Philadelphia 30, Pa. (Tel. LOcust 3-6671)
Purch. Agent: I. H. Shubin
Sales Mgr.: Carl H. Waser

PRECISION TUBE CO., INC.
Church Rd. & Wissahickon Ave., North Wales, Pa. (Tel. OXbow 9-4806)
Purch. Agent: Otto Chvoka
V. P.-Sales: Matthew F. Balch, Jr. **M**

PRE-FLITE INDUSTRIES CORP., SUB.-AVCO MFG. CORP.
18118 S. Broadway, Gardena, Calif. (Tel. FAculty 1-5252)
Purch. Agent: Robert Smith
Pres.: P. B. Proctor
V. P.-Mktg.: A. J. Dillon, Jr. **MS, CT**

H. P. PREIS ENGRAVING MACHINE CO.
651 U. S. Highway 22, Hillside 5, N. J. (Tel. MU 6-7736)
Purch.: M. H. Preis
Prod. Mgr.: J. A. Hoffmann **M**

PREMAX PRODUCTS DIV., CHISHOLM-RYDER CO., INC.
College & Highland Avenues, Niagara Falls, N. Y. (Tel. BUtler 5-9186)
Dir.-Purch.: Lawrence Fischer
Sales Mgr.: B. B. Mitchell **CT, TT**

PREMIER METAL PRODUCTS CO.
337 Manida St., New York 59, N. Y. (Tel. WYandotte 1-6600)
V. P.-Purch.: Mayer Faynberg
Sales Mgr.: E. Kossoy
Asst. Sales Mgr.: H. L. Miller **M**

PREMIER RESEARCH LABORATORIES, INC.
78-85 7th Ave., New York 11, N. Y. (Tel. ALgonquin 5-0700)
Purch. Agent: W. J. Gutman
Sales Mgr.: M. H. Proelsdorfer

PRESIN CO.
2014 Broadway, Santa Monica, Calif. (Tel. EXbrook 3-9738)
Pres.: M. D. Teichner
Dir.-Sales: W. P. Simpson **CT**

PRESSED STEEL TANK CO.
1445 S. 66th St., Milwaukee 14, Wisc. (Tel. GReenfield 6-0500)
Purch. Agent: R. E. Holmes
Mgr.-Industrial Prods. Div.: T. V. Montgomery
V. P.-Sales: N. A. Evans **S, PS, MS, RD**

PRESSMAN ASSOCIATES INC.
7803 Farnsworth St., Philadelphia 15, Pa. (Tel. DE 3-8064)
Pres.: A. I. Pressman **CT, RD**

PRESSTITE DIV., AMERICAN-MARIETTA
3738 Chouteau Ave., St. Louis 10, Mo. (Tel. MOhawk 4-6000)
Purch. Agent: G. C. Weston
V. P.-Sales: J. R. Moore **M**

PRESTOLE CORP.
1345 Miami St., Toledo 5, Ohio (Tel. OXford 1-2465)
Purch. Agent: Harry Tice
V. P.-Sales: E. G. Bradner **M**

PREWITT AIRCRAFT CO.
Holly & Madison Aves., Clifton Heights, Pa. (Tel. MAdison 6-6500)
Prod. Mgr.: Robert J. Neal
Chief Engr.: Harold E. Bishop **S, MS, RD**

D. W. PRICE CORP.
11161 W. Pico Blvd., Los Angeles 64, Calif. (Tel. GRanite 7-6791)
Dir.-Sales: Russ C. Bremmer **S, MS, G**

PRICE ELECTRIC CORP.
E. Church & 2nd Sts., Frederick, Md. (Tel. MOnument 3-5141)
Purch. Agent: Robert H. Haines
V. P. & Sales Mgr.: R. J. Harrant **MS, G**

PRINTLOID INC.
10-10 44th Ave., Long Island City 1, N. Y. (Tel. EMpire 1-1770)
Pres.: G. Martin
Sales Dept.: J. M. Wodiska **M**

J. F. PRITCHARD & CO. OF CALIFORNIA
4625 Roanoke Pkwy., Kansas City 12, Mo.
Gen. Sales Mgr.: W. R. Roeyer **MS, M**

PROBESCOPE CO. INC.
8 Sagamore Hill Dr., Port Washington, N. Y. (Tel. PO 7-8150)
Purch. Agent: J. Langmer
Sales Mgr.: Lawrence Zarrow **TT, RD**

PROCESS & INSTRUMENTS
15 Stone Ave., Brooklyn 33, N. Y. (Tel. GLenmore 2-8380)
Dir.-Purch.: L. Peimer **RD**

PRODELIN INC.
307 Bergen Ave., Kearny, N. J. (Tel. WYman 1-8600)
Purch. Agent: G. D. Higgins
Dir.-Sales: A. Haselman **MS, G, TT**

PRODUCT & INDUSTRIAL ENGRG. CORP.
3806 S. Four Mile Run Dr., Arlington 6, Va. (Tel. JAckson 4-6565)
V. P., Secy. & Treas.: C. J. Ritchie, Jr. **MS, G**

PRODUCTION RESEARCH CORP., SUB.-RADIO CONDENSER CO.
Claremont Ave., Thornwood, N. Y. (Tel. ROgers 9-2766)
V. P.: George Q. Herrick
Mgr.-Services: J. Medalie **CT, TT, RD**

PRODUCTION SERVICES CORP., THE
81 Market Sq., Newington 11, Conn. (Tel. MOhawk 6-3363)
Pres.: R. H. Whitney

PRODUCTS RESEARCH CO.
3126 Los Feliz Blvd., Los Angeles 39, Calif. (Tel. NOrmandy 5-5951)
Materiel Mgr.: R. Brooks Parker
Sales Mgr.: W. L. Smith **M, RD**

PROJECTS UNLIMITED INC.
1926 E. Siebenthaler Ave., Dayton 14, Ohio (Tel. CR 8-4244)
Purch. Agent: R. W. McClure
Project Estimator: G. Jerry Cameron
Admin. Asst.: George Gianopulos **MS, CT**

PROPELLEX CHEMICAL DIV., CHROMALLOY CORP.
Box 187, Edwardsville, Ill. (Tel. 3400)
Purch. Agent: J. H. Rulon
Buyer: S. L. Meister
Dir.-Sales: R. H. Bleikamp **PS, RD**

PROPULSION TEST FACILITIES, DIV.-MB ELECTRONICS
20 Fitch St., New Haven 8, Conn. (Tel. FUlton 9-1551)

Purch. Agent: Carl Uerderame
Asst. Purch. Agents: Richard O'Gorman & Matthew Servaty
Dir.-Sales: Arthur Deichmiller **PS, MS, RD**

PROTECTIVE COATINGS, INC.
Box 3985, Detroit 27, Mich. (Tel. VE 6-4664)
H. Tom Collord **M**

PROTECTOSEAL CO., THE
1920 S. Western Ave., Chicago 8, Ill. (Tel. CH 3-1400)
Purch. Agent: T. Parker
Sales Dir.: John Mock **M**

PROTEX-A-COTE, INC.
251 Grove Ave., Verona, N. J. (Tel. CEnter 9-2000)
Pres.: Ira Zeitlin
V. P.-Sales: David R. Minkoff **M**

PROTO TOOL CO.
2209 Santa Fe Ave., Los Angeles 58, Calif. (Tel. LUdlow 9-3311)
Purch. Agent: J. R. Dysert
Buyer: Jack Koehler
V. P.-Sales: R. E. Reich **M**

PRY WELDING & MFG., INC.
Modena, Pa. (Tel. DUdley 4-8321)
Secy.-Treas.: Gilbert Pry
Pres.: E. C. MacBean **S, MS**

PRYOR MFG. CO.
210 W. Longview St., Mansfield, Ohio (Tel. LA 4-1511)
V. P. & Gen. Mgr.: K. W. Kraft
Buyer: C. Koehler
Chief Engr.: G. K. Eggleston **MS, RD**

PRYOR MARKING PRODUCTS
434 S. Wabash Ave., Chicago 5, Ill. (Tel. HA 7-0495)
V. P.: D. J. Wilken

PSYCHOLOGICAL RESEARCH ASSOCIATES, INC.
(West Coast) 14827 Ventura Blvd., Sherman Oaks, Calif. (Tel. STate 8-2700); (East Coast) 507 Eighteenth St., S., Arlington 2, Va. (Tel. OTis 4-6600)
West Coast Rep.: Harold E. Price
East Coast Rep.: Theodore J. Post **RD, HSE**

PUBLIC INFORMATION PROGRAMS, INC.
10000 Riverside Dr., Bldg., Suite 6, Toluca Lake, North Hollywood, Calif. (Tel. TR 7-3238)
Associate: James H. Flint
Gen. Mgr.: David R. Showalter **CT, RD**

PULSE ENGRG., INC.
560 Robert Ave., Santa Clara, Calif. (Tel. CH 8-6040)
Purch. Agent: Ronald R. Knight
Sales Mgr.: Newt Wayne **M**

PURE CARBON CO. INC.
441 Hall Ave., St. Marys, Pa. (Tel. TE 4-1578)
Purch. Agent: H. W. McGeehin
V. P.-Sales & Engrg.: M. C. Burr

PURITAN AEROSPACE DIV., PURITAN COMPRESSED GAS CORP.
2012 Grand Ave., Kansas City 8, Mo. (Tel. HArrison 1-2122)
Purch. Agent: A. A. Oakley
Products Mgr.: Dudley H. Grimm

PURITAN COMPRESSED GAS CORP.
2012 Grand Ave., Kansas City 8, Mo. (Tel. HArrison 1-2122)
Aviation Sales Mgr.: F. C. Stebbins

PUROLATOR PRODUCTS INC.
970 New Brunswick Ave., Rahway, N. J. (Tel. FUlton 8-4000)
Purch. Agent: John T. Gaffney
Gen. Sales Mgr.: R. T. Karr **PS**

PYLE-NATIONAL CO., THE
1334 N. Kostner Ave., Chicago 51, Ill. (Tel. DIckens 2-6300)
Purch. Agent: Carl Mackprang
Asst. Purch. Agents: Charles Skobel & William Sheridan
V. P.-Mktg.: E. M. Nesvig
Mgr.-Connector Div. (Missile Prod. Sales): J. Shearer **MS**

PYLES INDUSTRIES, INC.
20855 Telegraph Rd., Detroit 41, Mich. (Tel. KE 4-3820)
Purch. Agent: H. L. Kehoe
V. P.: C. M. Singleton
Gen. Sales Mgr.: Clifford G. Davis **S, MS, M**

PYRAMID ELECTRIC CO.
Orange St., Darlington, S. C. (Tel. EXpress 3-3821)
Purch. Agent: D. Stanzione
Gen. Sales Mgr.: M. A. De Matteo **G**

PYROFERRIC CO. INC.
Bronx Blvd. at 216th St., Bronx 67, N. Y. (Tel. OL 4-3930)
Purch. Agent: Elliott Reiss
Sales Mgr.: E. B. Winett **M**

PYROFILM RESISTOR CO., INC.
U. S. Highway 46, Parsippany, N. J. (Tel. DEerfield 4-8282)
Pres.: John M. Hinkle **MS**

PYROMETER INSTRUMENT CO., INC.
92 Portland Ave., Bergenfield, N. J. (Tel. DUmont 4-5140)
Purch. Agent: J. Crystall
Sales: A. Bollerman **CT**

PYROTECTOR INC.
349 Lincoln St., Hingham, Mass. (Tel. RIverview 9-3466)
Purch. Agent: Lee F. Mattioli
V. P.-Sales: John J. Caldwell **MS, M**

Q. O. S. CORP.
Bronx Blvd. at 216th St., New York 67, N. Y. (Tel. OLinville 4-3930)
Purch. Agent: Elliott Reiss **M, RD**

Q. V. S. INC.
20 N. 15th St., E. Orange, N. J. (Tel. ORange 3-3996)
Purch. Agent: Mrs. D. Fogle
Sales Mgr.: Milton C. Ward
Pres.: Dr. M. E. Fogle

Q-CIRCUITS, DIV.-ETCHING CO. OF CALIF.
1208 Howard St., San Francisco 3, Calif. (Tel. MArket 1-7670)
Gen. Mgr.: Sterling Call
Dir.-Sales: Harry Scott **M**

QUAKER CITY FELT CO.
1734-36 Ludlow St., Philadelphia 3, Pa. (Tel. LO 3-6995)
Owner: Richard W. Freeth
Mgr.: Richard W. Freeth, III **M**

QUALITY COMPONENTS, INC.
St. Marys, Pa. (Tel. TErminal 42-817)
Dir.-Purch.: A. E. Kronenwetter **M**

QUAN-TECH LABS., INC.
60 Parsippany Blvd., Box 187, Boonton, N. J. (Tel. DEerfield 4-8500)
Pres.: John M. van Beuren
Sales Mgr.: Ronald C. Pittenger **RD**

QUARTZITE PROCESSING INC.
197 Chelsea St., Everett 49, Mass. (Tel. DUnkirk 9-8793)
Pres.: Julius H. Westerman
Treas.: Philip S. Yanofsky
V. P.: Leonard Yanofsky **M**

QUIETROLE CO.
395 St. John St., Spartanburg, S. C. (Tel. 8996)
Gen. Mgr.: Robert O. Monk
Dir.-Sales: Ralph M. Rouse **M**

QUINCY COMPRESSOR CO.
217 Maine St., Quincy, Ill. (Tel. BA 2-7700)
Purch. Agent: Richard Busch
Sales Mgr.: Loren Gillhouse

QUTRONIC TRANSFORMER CORP.
525 Broadway, New York, N. Y. (Tel. WOrth 2-3639)
Dir.-Purch.: E. H. Loganoff
Purch. Agent: Angelo Lomascolo
Gen. Mgr.: Louis L. Weintraub **MS, G, CT, TT, RD**

RBM CONTROLS DIV.-ESSEX WIRE CORP.
131 Godfrey St., Logansport, Ind. (Tel. 5121)
Purch. Agent: C. R. Carr
Sales Mgr.: W. T. Hopkins **MS, G**

REF MFG. CORP.
393 Jericho Tpke., Mineola, N. Y. (Tel. PI 2-8400)
Purch. Agent: Narge Stratigos
Supvr.-Sales: Harold Maron **S, MS, RD**

R-P&C VALVE DIV., AMERICAN CHAIN & CABLE CO. INC.
Tulpehocken St., Reading, Pa.

RS ELECTRONICS CORP.
435 Portage Ave., P. O. Box 368, Station A, Palo Alto, Calif. (Tel. DAvenport 1-1130)
V. P.-Purch.: Robert Parks
Dir.-Sales: Albert B. Worch **G, CT, TT, RD**

RACON ELECTRIC CO. INC.
1261 Broadway, New York, N. Y. (Tel. MU 4-6258)
Dir.-Purch. & Sales: A. I. Abrahams
Purch. Dept.: Leon A. Abrahams & Ceil Lester

RADALAB INC.
87-17 124th St., Richmond Hill 18, N. Y. (Tel. VIrginia 9-8181)
Pres.: Martin W. Tomberg
Sales Dept.: Herbert Brown **M, CT, TT, RD**

RADAR DESIGN CORP.
P. O. Box 38, Pickard Dr., Syracuse 11, N. Y. (Tel. GLenview 4-4418)
Pres.: Glyn Bostick **G, CT, RD**

RADAR RELAY, INC.
2322 Michigan Ave., Santa Monica, Calif. (Tel. EXbrook 4-2230)
Purch. Agent: Dennis Sullivan
Sales Mgr.: Dick Sil

RADEX CORP.
2076 Elston Ave., Chicago 14, Ill. (Tel. ARmitage 6-6900)
Purch. Agent: R. R. Cook

RADIAL BEARING CORP.
Taylor St., Danbury, Conn. (Tel. Pioneer 8-2577)
Pres.: Leo Papish
Mgr.: M. Kravats **PS, MS, G**

RADIANT LAMP CORP.
300 Jelliff Ave., Newark 8, N. J. (Tel. BIgelow 3-6850)
Purch.: L. Macerino
Sales Mgr.: D. Forman **M**

RADIAPHONE CO. INC.
609 E. Evergreen St., Monrovia, Calif. (Tel. Elliott 8-2585)
Purch. Agent: H. E. Adams, Jr.
Mgr.-Contracts Dept.: Frederick Feinstein **MS, CT, TT, RD**

RADIATION DYNAMICS, INC.
1800 Shames Drive, Westbury, L. I., N. Y. (Tel. EDgewood 4-3990)
V. P.: Marshall R. Cleland
Prod. Mgr.: Don C. Reynolds
Sales Mgr.: Seymour Katz **RD**

RADIATION, INC.
Melbourne, Fla. (Tel. PArkway 3-1511)
Purch. Agent: W. R. Pierpont
Chief Buyer, Contracts: W. M. Erbe
Chief Buyer, Purch.: J. I. Markham
V. P.-Mktg.: W. W. Dodgson, Jr. **MS, G, CT, TT, RD, HSE**

RADIATION INSTRUMENT DEVELOPMENT LAB., INC.
5737 S. Halsted, Chicago 21, Ill. (Tel. TRiangle 3-2345)
Purch. Agent: J. F. Miller
Sales Mgr.: W. J. Buffo **M, CT, RD**

RADIATION RESEARCH CORP.
1114 First Ave., New York, N. Y. (Tel. TEmpleton 8-2513)
Purch. Agent: Stanley Grand
Sales Mgr.: Maury Ray **RD**

RADIATRONICS, INC.
5956 Kester Ave., Van Nuys, Calif. (Tel. State 2-1461; Stanley 3-2736)
Pres.: G. E. Hewitt
V. P.-Sales: E. H. Lockhart

RADIO CITY PRODUCTS CO. INC.
Centre & Glendale Sts., Easton, Pa. (Tel. BLackburn 8-9122)
Purch. Agent: R. Schwartz
Pres.: George W. Fellendorf **G, CT, TT**

RADIO CONDENSER CO.
Davis & Copewood Sts., Camden 3, N. J. (Tel. EMerson 5-5500)
Purch. Agent: William Thackeray
Buyer: J. W. Rattray
Sales Mgr.: Raymond A. Butor **G, TT, RD**

RADIO CORES, INC.
9540 Tulley Ave., Oak Lawn, Ill. (Tel. GArden 2-3353)
V. P.-Sales: Arthur J. Mark

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

***RADIO CORP. OF AMERICA**
Front & Cooper Sts., Camden 2, N. J. (Tel. WOodlawn 3-8000)
V. P.-Materials: V. deP. Goubeau
*(See advertisement this issue)

***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Front & Cooper Sts., Camden 2, N. J. (Tel. WOodlawn 3-8000)
Purch. Agent: W. Covert
Mgr., Mktg.: W. Bain **MS, G, CT, TT, RD**
*(See advertisement this issue)

***RADIO CORP. OF AMERICA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY**
838 N. Henry St., Alexandria, Va. (Tel. OVerlook 3-1900)
Mgr. Purch.: R. G. Middleton **CT, RD**
*(See advertisement this issue)

RADIO DEVELOPMENT & RESEARCH CORP.
100 Pennsylvania Ave., Paterson 3, N. J. (Tel. LAmbert 5-2200)
Prod. Mgr.: Milton Slavin
Pres.: K. R. Gerlach **MS**

RADIO FREQUENCY CO., INC.
44-46 Park St., Medfield, Mass. (Tel. Boston: NOrwood 7-4900)
Pres.: J. G. D. Manwaring
Purch. Agent: E. Rowean
Sales Mgr.: Harry E. Gower **RD**

RADIO INDUSTRIES, INC.
666 Garland Pl., Des Plaines, Ill. (Tel. VAnderbilt 7-4402)
Purch. Agent: Roy Sielisch
V. P.-Sales: John T. Driscoll

RADIO RECEPTOR CO., INC., SUB.-GENERAL INSTRUMENT CORP.
81 N. Fourth St., Brooklyn 11, N. Y. (Tel. EVergreen 8-6000)
Dir.-Purch.: Robert Dalzell
Purch. Agents: Maurice Markowitz & Thomas Lordahl
V. P.-Sales: S. D. Gurian **G, CT, TT, RD**

RADIO SPECIALTY MFG. CO.
2023 S. E. 6th Ave., Portland 14, Ore. (Tel. BE 2-8123)
Purch. Agent: Ellis R. Schlosser
Dir.-Sales: Kenneth C. Johnson

RADIOPLANE, DIV.-NORTHROP CORP.
8000 Woodley Ave., Van Nuys, Calif. (Tel. TRiangle 3-1150)
Dir.-Material: Joe Barlow (Tel. STate 6-7020) **MS**

RAE MOTOR CORP.
2009 Kewaunee St., Racine, Wis. (Tel. MElrose 3-7741)
Purch. Agent: J. Costabile
V. P.: E. K. Hansen **M**

RAFFI & SWANSON, INC.
100 Eames St., Wilmington, Mass. (Tel. Woburn, WEIls 3-4200)
Dir.-Purch.: Richard W. Swanson
Dir.-Sales: Charles L. Raffi, Jr.
Sales Mgr.: Harold E. Duston **M**

RAHM INSTRUMENTS, DIV.-AMERICAN MACHINE & METALS, INC.
65 Rushmore St., Westbury, N. Y. (Tel. EDgewood 3-4840)
Purch. Agent: J. Walsh
Sales Mgr.: J. J. Frey **TT, RD**

RAILWAY COMMUNICATIONS INC.
9351 E. 59th St., Raytown 33, Mo. (Tel. FLeming 3-2100)
Sales: E. E. Tuel **CT**

RAM METER INC.
1100 Hilton Rd., Ferndale 20, Mich. (Tel. LIncoln 7-1000)
Gen. Mgr.-Purch.: Robert M. Whalen
Pres. & Chief Engr.: R. A. Monnier
V. P. & Sales Mgr.: George C. Hale **MS, CT**

RAMO WOOLDRIDGE, DIV.-THOMPSON RAMO WOOLDRIDGE INC.
4800 Ramo-Wooldridge Rd., P. O. Box 5073, Terminal Annex, Denver 17, Colo. (Tel. PY 4-4311)
Purch. Mgr.: L. Ortman
Buyers: M. J. Spencer & R. E. Hite
Mgr., Contract Relations: M. C. Baldridge, Jr.
MS, G, CT, TT, RD

RAMPE MFG. CO.
14915 Woodworth Ave., Cleveland 10, Ohio (Tel. MU 1-2800)

RANDALL ENGRG. CORP.
5933 Bowcroft St., Los Angeles 16, Calif. (Tel. UPton 0-8533)
Dir.-Purch.: Mike Thames
V. P.-Sales: Rex Oberbeck

RANDALL GRAPHITE BEARINGS, INC.
Box 839, Greenlawn & Lake Sts., Lima, Ohio (Tel. CApitol 3-1075)
Purch. Agent: Frank O. Burnette
Sales Mgr.: Ray Chaney

RANGERTONE INC.
73 Winthrop St., Newark 4, N. J. (Tel. HU 5-2550)
Prod. Mgr.: Robert Somerville
Engrg.: George Zendell **TT, RD**

RANSBURG ELECTRO-COATING CORP.
P. O. Box 23122, Indianapolis 23, Ind. (Tel. TRinity 8-2311)

RANSOHOFF CO.
N. 5th St. & Ford Blvd., Hamilton, Ohio (Tel. TW 3-5813)
Purch. Agent: C. V. Noonan
V. P.: R. C. Wigger

RANTEC CORP.
Calabasas, Calif. (Tel. Diamond 7-5446)
Purch. Agent: Marvin Shipman
Prod. Mgr.: A. T. Cunningham
Dir.-Mktg. & Contracts: G. H. Singer **MS, TT, RD**

RAPIDS-STANDARD CO., INC., THE
Rapistan Bldg., Grand Rapids 2, Mich. (Tel. GL 9-0281)
Dir.-Purch.: Robert Gunnell
Dir.-Sales: H. M. Rasmussen **M**

RATTAN MFG. CO., THE
P. O. Box 1745, 10 Wall St., New Haven 7, Conn. (Tel. UNiversity 5-2141)
Pres.: G. H. Keith Miller
Dir.-Sales: Gerard F. Murphy

RAULAND CORP., THE
4245 North Knox Ave., Chicago 41, Ill. (Tel. MUlberry 5-5000)
Dir.-Purch.: J. Loibl
Asst. Purch. Agent: J. Nee
Sales Mgr.: H. Wunderlich
Military Sales: T. M. Snow **RD**

RAVEN INDUSTRIES INC.
Box 227, Sioux Falls, S. Dak. (Tel. ED 4-7586)
Purch. Agent: R. D. Dullerud
Contract & Sales Mgr.: J. R. Smith **CT, RD**

RAVENNA METAL PRODUCTS, DIV.-STANDARD SCREW CO.
6518 Ravenna Ave., Seattle 15, Wash. (Tel. LAkeview 5-5555)
Purch. Agent: L. O. Johnson
Gen. Mgr.: I. K. Schlamp
Sales Mgr.: Dick Francisco **S, MS, M, G, CT, RD**

RAWAY BEARING CO., INC.
141 M Chrystie St., New York 2, N. Y. (Tel. WAlker 5-8150)
Purch.: Rubin Yarmush
Sales: Aharon Baskin **M**

RAWSON ELECTRICAL INSTRUMENT CO.
128 Potter St., Cambridge 42, Mass. (Tel. Kirkland 7-4041)
Chief Engr.: M. J. Lush
Office Mgr.: G. C. Henderson

RAY PROOF CORP.
843 Canal St., Stamford, Conn. (Tel. DAvis 5-2201)
Pres.: Arnold Zais
Gen. Mgr.: G. R. Brownridge
Chief Engr.: R. Aronson **M, RD**

RAYBESTOS-MANHATTAN, INC.
Passaic, N. J. (Tel. GRegory 3-2000)

RAYBESTOS-MANHATTAN, INC., REINFORCED PLASTICS DEPT.
Manheim, Pa. (Tel. MOhawk 5-2211)
Product Mgr.: M. M. Gibson
Purch. Agent: F. R. Bitzer

RAYMOND ENGRG. LAB., INC.
Smith St., Middletown, Conn. (Tel. Diamond 7-5611)
Purch. Agent: Herbert E. Cruickshanks
Subcontr. Rep.: Valmore J. Labbe
Liaison Coord.: Joseph G. Lombardo **G, RD**

RAY-O-VAC CO., DIV.-ELECTRIC STORAGE BATTERY CO.
212 E. Washington Ave., Madison 10, Wisc. (Tel. ALpine 5-7201)
Purch.: G. P. Wiedenbeck
V. P.-Mktg.: O. R. Slauson

***RAYTHEON CO.**
Waltham, Mass. (Tel. TWinbrook 9-8400)
Dir.-Proc.: Paul Wilson
Dir.-Comm. Mktg. Services: S. D. Cowan
*(See advertisement this issue)

***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
55 Chapel St., Newton 58, Mass. (Tel. BIgelow 4-7500)
Purch. Agent: V. Gramont
Buyer: T. W. Stewart
Chief Engr.: F. Blattel
Sales Mgr.: J. Dorfman **M**
*(See advertisement this issue)

***RAYTHEON CO., MISSILE SYSTEMS DIV.**
520 Winter St., Waltham 54, Mass. (Tel. TWinbrook 9-8000)
Gen. Purch. Agent: Bruce A. Brace
Contracts Mgr.: Stephen W. Rowen
Purch. Agent, Andover, Mass.: Frank Samuel
Purch. Agent, Lowell, Mass.: Vincent Sorrentino
Purch. Agent, Bedford, Mass.: Robert H. Pohl
Purch. Agent, Bristol, Tenn.: Richard Holland
Purch. Agent, Oxnard, Calif.: Charles A. Wisenbaker
Purch. Agent, White Sands, N. M.: Harry Leiper
S, MS, M, G, CT, TT, RD, HSE
*(See advertisement this issue)

J. B. REA CO.
2202 Broadway, Santa Monica, Calif. (Tel. EXbrook 3-3768)
Purch. Agent: Kay McCauley
Gen. Mgr.-Electronic Div.: Lyle E. Sharpe

REA MAGNET WIRE CO., INC., DIV.-ALUMINUM CO. OF AMERICA
3610 E. Pontiac St., Fort Wayne 4, Ind. (Tel. ANthony 5201)
Purch. Agent: W. W. Bonham
Exec. V. P.: R. L. Wheatley
V. P.-Operations: A. C. Sheldon
Gen. Sales Mgr.: J. L. McKinley **M**

REACTION MOTORS DIV., THIOKOL CHEMICAL CORP.
Denville, N. J. (Tel. OAkwood 7-7000)
Purch. Agent: Ernest DeRome
Purch. Supvrs.: Laurance Levy & J. Young
Supvr.-Expediting: C. Birckholtz
Purch. Coordinator: J. Daley
Dir.-Sales: R. Frazee **PS, RD**

READ STANDARD, DIV.-CAPITOL PRODUCTS CORP.
S. Richland Ave. Ext'd., York, Pa. (Tel. 82891)
Dir.-Purch.: W. W. Lauer
Purch. Agent: C. W. Ness
Dir.-Sales: A. K. Brennan **M**

READY-POWER CO., THE
11231 Freud Ave., Detroit 14, Mich. (Tel. VAlley 2-1717)
Purch. Agent: Henry J. Craska
V. P. & Sales Mgr.: W. S. Jewell **MS**

RECONY DIV., VINCO CORP.
Box 442, Richmond 3, Va. (Tel. MIlton 3-7365)
Purch. Agent: J. H. Smith
Sales Engr.: J. G. MacCabe **MS, CT, RD**

***RECEIVING TUBE DIV., RAYTHEON CO.**
465 Centre St., Quincy 69, Mass. (Tel. GRanite 9-5300)
Purch. Mgr.: J. J. Grabiec
Purch. Agent: C. P. Rolfe **M**
*(See advertisement this issue)

RECTICO, INC.
963 Frelinghuysen Ave., Newark, N. J. (Tel. BIgelow 3-8739)
Purch. Agent: F. Fertell **M**

RED DEVIL MFG. CO.
1401 N. Ogden Ave., Chicago 10, Ill. (Tel. Michigan 2-5161) **M**

RED POINT CORP.
105 W. Spazier Ave., Burbank, Calif. (Tel. TH 2-4895)
Gen. Mgr.: Ralph P. Craig
Gen. Sales Mgr.: Roy A. Woltman

REDA PUMP CO.
Bartlesville, Okla. (Tel. FEderal 6-7900)

Dir.-Purch.: Jack Loveland
Asst. Purch. Agents: William C. Bearden & Clarence Wilson
V. P.-Sales: Sergei Arutunoff MS

REDCO CORP.
Red Lion, Pa. (Tel. 33211)
Purch. Agent: D. W. Royston
Dir.-Sales: F. A. Bowles S, PS, MS, RD

REDEL INC.
2300 E. Katella Ave., Anaheim, Calif. (Tel. PRospect 4-3624)
Purch. Agent: C. D. Young
Sales Mgr.: Jay W. DeDapper PS, RD

REDMAN ELECTRONICS CORP.
92 Prospect St., Thompsonville, Conn. (Tel. RIverview 5-8024)
Purch. Agent: David Engleman
Pres.: Edward Tavidian M

REDMOND CO., INC., SUB.-CONTROLS CO. OF AMERICA
201 Monroe St., Owosso, Mich. (Tel. SAratoga 5-5151)
Dir.-Purch.: G. L. R. Baumhardt
Gen. Sales Mgr.: M. J. Koenig MS

REED INSTRUMENT CO.
1048 Potomac St., N. W., Washington 7, D. C. (Tel. FE 3-7000)
Dir.-Purch.: Frederick S. Mozingo
Sales Adm.: Russell E. Travis MS, RD

REED MFG. CO.
1045 Main St., Waltham 54, Mass. (Tel. TW 4-1464)
Pres.: H. F. Stewart
Gen. Mgr.: Earl Spears M

REED-PRENTICE, DIV.-PACKAGE MACHINERY CO.
330 W. Chestnut St., East Longmeadow, Mass. (Tel. LAurel 5-3381)
Purch. Agent: D. B. Dalbeck
Sales Mgr.: J. D. Sherman

REED RESEARCH INC.
1048 Potomac St., N. W., Washington 7, D. C. (Tel. FEderal 3-7000)
Dir.-Purch.: Fred Mozingo
Sales Admin.: Russell E. Travis, Jr. MS, RD

REEVE ELECTRONICS, INC.
609 W. Lake St., Chicago 6, Ill. (Tel. RAndolph 6-9755)
Purch. Agent: E. F. Steichmann
Sales Engr.: I. R. Wayne

REEVES BROTHERS, INC.
1071 Avenue of the Americas, New York 18, N. Y. (Tel. PE 6-8600)
Gen. Sales Mgr.: James Cooper M, RD

REEVES BROS. INC., VULCAN RUBBER DIV.
1071 Avenue of the Americas, New York 18, N. Y. (Tel. PEnnsylvania 6-8600)
V. P.-Sales: E. C. Hemes
Gen. Sales Mgr.: J. R. Cooper
Dept. Sales Mgr.: L. W. Isom M

REEVES INSTRUMENT CORP.
Roosevelt Field, Garden City, N. Y. (Tel. Pioneer 6-8100)
Purch. Mgr.: A. J. Rutherford
Mgr., Systems Mktg.: P. Andrepont
Mgr., Components Mktg.: P. F. G. Holst MS, G, CT, TT, RD

REEVES SOUNDCRAFT CORP.
Great Pastures Rd., Danbury, Conn. (Tel. Pioneer 3-7601)
Purch. Agent: Guy Bonham
Sales Mgr., Instrumentation Products: William A. Morrison

REEVES-HOFFMAN DIV.
145 Cherry St., Carlisle, Pa. (Tel. CHapel 3-5929)
Purch. Agent: Helen Sheaffer
Sales Mgr.: C. M. Rahn M

REFLECTONE ELECTRONICS, INC.
Post Rd. & Myano Lane, Stamford, Conn. (Tel. DAvis 5-2251)
Purch. Agent: Frank G. Hill
Buyers: Howard Auleta & Mrs. Joan Bolanis
Sales Mgr.: John B. Thaler RD

REFRACTORIES DIV., THE CARBORUNDUM CO.
Latrobe, Pa. (Tel. KEystone 7-3331)
Purch. Agent: James W. Bell, Jr.
Mgr.-Sales Engrg.: Thomas J. Kuehn M

REFRACTORIES DIV., THE, FERRO CORP., LOUTHAN PLANT
2000 Harvey Ave., East Liverpool, Ohio (Tel. FUlton 5-1538)
Works Mgr.: Fred A. Layne
Supt.: Leonard Kupchinsky
Chief Ceramic Engrg.: Howard C. Pearch M

REGAL AIR CORP.
500 Fifth Ave., New York 36, N. Y. (Tel. LOnacre 5-4122)
V. P.: Sanford Schimmel M

REGENT JACK MFG. CO., INC.
11905 Regentview Ave., Downey, Calif. (Tel. SPruce 3-0103)
Purch. Agent: Don Norton
V. P.-Sales: W. S. Noblett PS, MS

REICHHOLD CHEMICALS, INC.
RCI Bldg., White Plains, N. Y. (Tel. WHite Plains 8-6200)
V. P.-Purch.: G. C. Sweet
V. P.-Sales: R. T. Urich M

RELAY SALES INC.
Box 186 MM, W. Chicago, Ill. (Tel. West Chicago 1100)
V. P.-Sales: A. Scandora
Pres.: E. E. Rullman, Jr.

RELAYS, INC.
162 W. 83rd St., New York 24, N. Y. (Tel. TRafalgar 3-4500)
Chief Engr.: S. H. Hartley MS

RELIABLE SPRING & WIRE FORMS CO.
3167 Fulton Rd., Cleveland 9, O. (Tel. MElrose 1-2800)
Purch. Agent: Gilbert Gnewotta
V. P.-Sales: Ronald F. Pond M

RELIANCE ELECTRIC & ENGRG. CO.
24701 Euclid Ave., Cleveland 17, Ohio (RE 2-7000) MS, CT, TT

RELIANCE INDUSTRIAL PROD., INC.
168 Forest St., Manchester, Conn. (Tel. Mitchell 9-5211)
Purch. Agent: Cliff Schumacher
Exec. V. P.-Sales: William Bell
Pres.: Michael Kagan

REMBAR CO., INC., THE
67 Main St., Dobbs Ferry, N. Y. (Tel. OWens 3-2620) M

REMINGTON RAND UNIVAC DIV.-SPERRY RAND CORP.
315 Park Ave., S. New York, N. Y. (Tel. SPring 7-8000)
Dir.-Procurement: W. R. Gerhardt
V. P.-Univac Sales: J. W. Schnackel G, RD

REMLER CO.
2101 Bryant St., San Francisco 10, Calif. (Tel. VA 4-3435)
Purch. Agent: S. Mahr
Sales Mgr.: A. B. Hart MS, CT

REN PLASTICS, INC.
5422 S. Cedar St., Lansing 9, Mich. (Tel. TUrner 2-2411)
V. P.-Purch.: H. James Rengvo
Dir.-Sales: D. J. Doll M

RENBRANDT, INC.
6 Parmelee St., Boston 18, Mass. (Tel. HIghlands 5-8910)
Sales: M. Rogers

EDW. RENNEBURG & SONS CO.
2639 Boston St., Baltimore 24, Md. (Tel. PE 2-1665)
V. P.: Paul E. Kiefer
Dir.-Sales: E. J. Leister S, PS, MS

REON RESISTOR CORP.
155 Saw Mill River Rd., Yonkers, N. Y. (Tel. YOnkers 5-9850)
Sales Mgr.: J. J. McCann
Purch. Agent: J. Schuldenfrei

REPUBLIC AVIATION CORP.
Conklin St., Farmingdale, L. I., N. Y. (Tel. CH 9-1100)
Dir.-Material: E. I. Little
V. P.-Sales: J. L. Murray S, PS, M, G, TT, RD, HSE

REPUBLIC AVIATION CORP., MISSILE SYSTEMS DIV.
223 Jericho Tpke., Mineola, L. I., N. Y. (Tel. Pioneer 2-4013)
Dir.-Purch.: Al Owens
Dir.-Sales: R. G. Melrose (Tel. CHapel 9-1100) S, PS, MS, G, CT, TT, RD

REPUBLIC FOIL INC.
55 Triangle St., Danbury, Conn. (Tel. Pioneer 3-2731)
Purch. Agent: D. E. Hancock, Jr.
V. P.-Engrg.: J. D. Post
Engrg. Dept.: S. G. Timmerman, Jr.
V. P.-Sales: W. H. Maxwell M

REPUBLIC LENS CO., INC.
31 E. 169th St., New York 52, N. Y. (Tel. CYpress 3-2790)
Purch. Agent: M. Matthewson
Sales Mgr.: Jack Lurie

REPUBLIC MFG. CO.
15655 Brookpark Rd., Cleveland 35, O. (Tel. CLearwater 2-1800)
Purch. Agent: R. Riley
V. P.-Sales: L. J. Henderson PS, MS, M, CT

REPUBLIC STEEL CORP.
Republic Bldg., Cleveland 11, O. (Tel. PRospect 1-1400)
Mgr.-Purch. & Raw Materials: W. T. Adams
Asst. Mgr.-Purch.: L. H. Ransom
V. P.-Chg. Sales: Norman W. Foy M

RESEARCH CHEMICALS
170 W. Providencia, Burbank, Calif. (Tel. VI 9-6276)
Purch. Agent: Fred Nathanson
Gen. Mgr.: Dr. E. V. Kleber M, RD

RESEARCH INDUSTRIAL LAB. OF ELECTRONICS
Roslyn, Pa. (Tel. TUrner 4-8098)
Purch. Agent: E. Schempp
Dir.-Sales: R. Patterson CT

RESDEL ENGRG. CORP.
330 S. Fair Oaks Ave., Pasadena, Calif. (Tel. MUrray 1-7689)
Asst. to V. P.-Engrg.: M. F. Brown, Jr.
Dir.-Purch.: Joseph P. Moran (Tel. MUrray 1-9529) MS, CT, TT, RD

RESE ENGRG., INC.
731 Arch St., Philadelphia 6, Pa. (Tel. WAlnut 2-5841)
Chief Purch. Agent: Philip Marder
V. P.-Digital Systems: Lowell Bensky
Pres.: Richard O. Endres

RESEARCH CONTROLS
7902 E. 11th St., Tulsa, Okla. (Tel. TEmple 5-7163)
Sales: Roy Horton S, PS, MS, CT

RESEARCH DEVELOPMENT MFG. INC.
429 E. Collom St., Philadelphia, Pa. (Tel. GLadstone 5-9700)
Purch. Agent: A. G. Kamm
Asst. Purch. Agent: Frank Wm. Doll
Treas.: L. Kassvan S, G

RESEARCH, INC.
P. O. Box 6164, Edina Branch, Minneapolis 24, Minn. (Tel. WEst 5-2156)
Purch. Agent: G. N. Butzow
Buyers: D. H. Whitcomb & R. W. Jungk
V. P. & Sales Mgr.: A. E. Abramson MS, M, CT, RD

RESEARCH PRODUCTS CORP.
1015 E. Washington Ave., Madison 1, Wisc. (Tel. ALpine 6-0621)
V. P.-Sales: A. W. Brown
V. P.-Purch.: E. B. Schlatter, Jr.
Purch. Agent: Howard E. Hoveland RD

RESINITE CORP. DIV.-PRECISION PAPER TUBE CO.
6980 N. Central Park, Chicago 45, Ill. (Tel. OR 5-6200)
Dir.-Purch.: R. Hatton
Dir.-Sales: H. T. Blair M

RESISTANCE PRODUCTS CO.
914 S. 13th St., Harrisburg, Pa. (Tel. CEdar 6-5081)
Pres.: R. M. Peffer
V. P.-Sales: S. S. Saul
V. P.-Engrg.: Karl A. Stock
Engr.-Metal Film Dept.: H. M. Wutz
Engr.-High Voltage Sales: R. M. McKay M

RESISTOFLEX CORP.
Woodland Rd., Roseland, N. J. (Tel. CApitol 6-7700)

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

Purch. Agent: R. Atkins
Asst. Purch. Agent: S. Stein
Buyer: W. Tomlin
Sr. V. P.: H. E. Krebs **PS, MS, M, CT, RD**

RESISTORS, INC.
5226 W. 26th St., Chicago 50, Ill. (Tel. OL 2-7555)
Purch. Agent: Marian Kliemek
Sales Mgr.: Myrtle J. Bryans **PS, MS, G, CT, TT, RD**

RESITRON LABS., INC.
2908 Nebraska Ave., Santa Monica, Calif. (Tel. EXbrook 3-5217)
Purch. Agent: Clifford LeBeau
Sales Mgr.: A. W. Westbrook **RD**

REVERE COPPER & BRASS INC.
230 Park Ave., New York 17, N. Y. (Tel. MU 9-6800)
V. P.-Gen. Sales Mgr.: R. P. Winberg
Mgr., Metal Purch.: E. J. Flanagan **M**

REVERE CORP. OF AMERICA, SUB.-NEPTUNE METER CO.
N. Colony Rd., Wallingford, Conn. (Tel. COlony 9-7701) **MS, CT**

REVOLVATOR CO.
2000 86th St., North Bergen, N. J. (Tel. UNion 9-1220)
Chief Engr.: P. D. Germond
Sales: H. S. Germond III

J. W. REX CO.
8th St. & Franconia Ave., Lansdale, Pa. (Tel. ULysses 5-1131)
Pres.: J. W. Rex
Gen. Mgr.: O. Meyers
Sales Mgr.: John E. King

REX RHEOSTAT CO.
149 Babylon Tpke., Roosevelt, L. I., N. Y. (Tel. FReeport 9-1030)
Owner: Edmund Abrahamson **M**

REYNOLDS METALS CO.
P. O. Box 2346, Richmond 18, Va. (Tel. ATlantic 2-2311)
Dir.-Purch.: E. C. Silver
Exec. V. P.-Sales: David P. Reynolds **S, M, RD**

REYNOLDS METALS CO., PLASTICS DIV.
Reynolds Metals Bldg., Richmond 26, Va. (Tel. ATlantic 2-2311)
Dir.-Purch.: Earl Silver
Purch. Agents: Kyle Cook & J. H. Norris
Gen. Mgr.-Plastic Markets Sales: W. J. Vogel **M**

REYNOLDS METALS CO., SHEFFIELD MISSILE PLANT
Sheffield, Ala. (Tel. EV 3-6341)
Purch. Agent: Robert Schmidt
Plant Mgr.: M. C. Duke **S, M, RD**

REZOLIN, INC.
1651 18th St., Santa Monica, Calif. (Tel. UPton 0-7328)
Purch. Agent: Fred Polich
Prod. Mgr.: William Windsor
Mktg. Dir.: Lloyd J. Oye **M, RD**

RHEEM MFG. CO., ELECTRONICS DIV.
7777 Industry Ave., Rivera, Calif. (Tel. TOpaz 1-9271)
Dir.-Purch.: Roy Smith
Div. Sales Mgr.: Hugh C. Bream

M. H. RHODES, INC.
30 Bartholomew Ave., Hartford 6, Conn. (Tel. JAckson 2-4265)
Dir.-Purch.: Miss E. M. Sanderson
Sales Mgr.: E. J. Doyle **G, RD**

RICHARDS-WILCOX MFG. CO.
333 Third St., Aurora, Ill. (Tel. TWinoaks 7-6951)
Dir.-Purch.: Robert W. Gehring
Purch. Dept.: T. Phares
Sales Mgr.: Elmer R. Ransom **M**

RICHMONT, INC.
922 S. Myrtle Ave., Monrovia, Calif. (Tel. ELliott 9-2555)
Pres.: M. S. Zimmerman
V. P.: J. R. Ewell
Purch. Agent: J. F. Hubbard
Dir.-Mktg.: H. B. Banta, Jr. **CT, RD**

RIEHLE TESTING MACHINES DIV., AMERICAN MACHINE & METALS, INC.
East Moline, Ill. (Tel. 5-4561)
Dir.-Purch.: N. Clark
Gen. Sales Mgr.: Ib Jensen

RIGGS NUCLEONICS CORP.
145 W. Magnolia Blvd., Burbank, Calif. (Tel. VIctoria 9-2481)
Purch. Agent: Philip Solomon
Sales Mgr.: John R. Foster
Pres.: Harvey Riggs

RIMAK, INC.
10929 Vanowen St., North Hollywood, Calif. (Tel. TRiangle 7-5526)
Dir.-Purch.: Richard H. Flint
Pres. & Gen. Mgr.: Rinard W. Flint **S, MS, RD**

RINCO, INC.
7962 S. E. Powell Blvd., Portland 6, Ore. (Tel. PRospect 4-3259)
Purch. Agent: Jesse L. Brown
Sales Mgr.: Franklin M. Brown **M, CT**

RIPLEY CO., INC.
Factory St., P. O. Box 31, Middletown, Conn. (Tel. Diamond 6-6679)
Purch. Agent: H. I. Thayer, Jr.
Sales Mgr.: P. J. Rinaldi **MS, CT**

RIVERBANK LABS., DEPT.-ENGRG.
P. O. Box 65, Geneva, Ill. (Tel. CEnter 2-2207)
Buyer: R. J. Eisenhaur
Chief Engr.: B. E. Eisenhour, Jr. **M, CT, RD**

RIVERDALE PLANT, ACF ELECTRONICS DIV., ACF INDUSTRIES, INC.
Riverdale, Md. (Tel. WA 7-4444)
Purch. Agent: W. S. Hall
Materiel Mgr.: C. E. Totoritis
Mktg. Mgr.: J. A. Curtis
Sr. Buyers: E. T. Wagner, H. L. Blaylock, R. F. Borke & J. J. Keegan

RIVETT LATHE & GRINDER INC.
P. O. Box 7, Brighton 35, Mass. (Tel. STadium 2-4530)
Purch. Agent: W. R. Wright
Sales Mgr.-Hydraulic Div.: J. A. Marsh

J. R. ROBBINS CO.
9046 Sunset Blvd., Los Angeles 46, Calif. **MS, G, CT, TT, RD**

ROBBINS AVIATION, INC.
2350 E. 38th St., Los Angeles 58, Calif. (Tel. LUdlow 9-5221)
Dir.-Materiel: R. E. Bixler
V. P.-Sales: H. N. Mabery **MS**

ROBBINS & MYERS, INC., HOIST & CRANE DIV.
Springfield 99, Ohio (Tel. FA 3-6461)
Purch. Agent: Robert A. Harley
Gen. Sales Mgr.: M. L. Aitken
Sales Mgr.: Rodger A. Metz **MS**

FRED T. ROBERTS & CO.
Danbury Rd., Wilton, Conn. (Tel. POrter 2-7002)
V. P.: R. E. Roberts
Pres.: Fred T. Roberts **M, RD**

ROBERTS INDUSTRIES, INC.
Box 71, Branford, Conn. (Tel. HU 8-1671)
Pres.: H. W. Wallace

ROBERTS TOLEDO RUBBER CO., THE
4143 Monroe St., Toledo 13, O. (Tel. GReenwood 9-4466)
Pres.: Robert Roberts **M**

ROBERTSHAW-FULTON CONTROLS CO., A&I DIV.
Santa Ana Freeway at Euclid Ave., Anaheim, Calif. (Tel. KEystone 5-8151)
Dir.-Purch.: L. L. Moloney
Asst. Purch. Agent: W. Houseworth
Buyer: W. Hamilton
Dir.-Field Engrg. & Sales: R. H. Heller **PS, MS**

ROBERTSHAW-FULTON CONTROLS CO., FULTON SYLPHON DIV.
P. O. Box 400, Knoxville 1, Tenn. (Tel. 4-1641)
Purch. Agent: Fred Coker
Asst. Purch. Agent: Jack Cremeans
Buyer: Robert Combs
Gen. Sales Mgr.: G. L. Ogdin, Jr.

ROBINS INDUSTRIES CORP.
36-27 Prince St., Flushing 54, N. Y. (Tel. HIckory 5-7200)
Dir.-Purch.: Rodney Lumel
Sales Mgr.: Larry Post

R. C. ROBINSON CO., INC.
P. O. Box 3494, North Sacramento 15, Calif. (Tel. WAbash 5-3827)
Gen. Mgr.: Alice Schoener **PS**

ROBINSON TECHNICAL PRODUCTS, INC.
Teterboro Air Terminal, Teterboro, N. J. (Tel. ATlas 8-2500)
Sr. Buyer: Harold Adler
Buyers: James Eames, Raymond Vetrini
V. P.-Proj. Dev.: H. Erich Nietsch **S, MS, RD**

ROBOT INDUSTRIES INC.
7041 Orchard St., Dearborn, Mich. (Tel. TIffany 6-2623)
Purch. Agent: K. Krake
Sales Mgr.: F. J. O'Such **S, MS**

ROCHESTER MFG. CO. INC.
113 Rockwood St., Rochester 10, N. Y. (Tel. BRowning 1-2020)
Purch. Agent: L. A. Mumford
Sales Mgr.: David McEwen **MS, M, G, RD**

ROCHESTER MFG. CO. INC. OF CALIF.
1401 S. Shamrock St., Monrovia, Calif. (Tel. ELliott 9-9317)
Pres.: C. L. Hastings
Purch. Agent: L. A. Mumford, 100 Rockwood St., Rochester 10, N. Y. (Tel. BRowning 1-2020) **PS, MS, CT, RD**

ROCK ISLAND ARSENAL
Rock Island, Ill. (Tel. 88411)
Chief-Proc. Branch: Clarence E. Wagner (Tel. 21214)
Asst. Chief-Proc. Branch: Paul H. Johnson (Tel. 22241)
Purch. Agent: Richard L. Maynard (Tel. 23113)

ROCKBESTOS WIRE & CABLE CO., DIV.-CERRO de PASCO CORP.
Nicoll & Canner Sts., New Haven 4, Conn. (Tel. STate 7-1141)
Purch. Agent: R. B. Miniter
Mgr., Sales Service: R. F. Coyle

ROCKETDYNE DIV., NORTH AMERICAN AVIATION, INC.
6633 Canoga Ave., Canoga Park, Calif. (Tel. Diamond 7-5651)
Gen. Purch. Agent: M. J. Dubuc
Dir.-Material: W. D. Bailey
Mgr., Sales Engrg.: A. Andrews
Dir.-Plans & Programs: E. F. Brown **PS, RD**

ROCKWELL-STANDARD CORP.
843 Fourth Ave., Coraopolis, Pa. (Tel. SPalding 1-1800)
V. P. & Dir.-Purch.: V. E. Gumbleton
Exec. V. P.-Sales, Mktg.: C. B. Black **GS, GH**

ROCKWELL-STANDARD CORP., BRAKE DIV.
Ashtabula, Ohio
Gen. Sales Mgr.: C. M. Heath **MS**

ROCKWELL-STANDARD CORP., TRANSMISSION & AXLE DIV.
100-400 Clark Ave., Detroit 32, Mich. (Tel. TAshmoo 6-6000)
V. P.-Purch.: V. E. Gumbleton
Dir.-Engrg.: K. M. Koch
Gen. Sales Mgr.: J. R. White

ROCKWOOD SPRINKLER CO., DIV.-THE GAMEWELL CO.
38 Harlow St., Worcester 5, Mass. (Tel. PLeasant 6-2426)
Purch. Agent: L. H. Bostwick
Sales Mgr.: A. H. O'Connell

RODNEY METALS INC.
1357 Rodney French Blvd., New Bedford, Mass. (Tel. WY 6-5691)
V. P.: C. W. Smith
Purch. Agent: L. A. Dobson **M**

JOHN A. ROEBLING'S SONS DIV., THE COLORADO FUEL & IRON CORP.
640 S. Broad St., Trenton, N. J. (Tel. EXport 6-6511)
Dir.-Purch.: R. K. Spofford
Asst. Dir.-Purch.: K. S. Dickel
Buyers: J. G. Hottinger, C. G. Bennighoff, J. R. Nemeth, W. P. Strohauer & P. S. Toth
V. P.-Sales: E. George Hartmann **M**

ROGERS CORP.
Rogers, Conn. (Tel. PRescott 4-9605)
Purch. Agent: Austin R. Schillinger
Dir.-Mktg.: N. L. Greenman **M**

ROHM & HAAS CO., REDSTONE ARSENAL RESEARCH DIV.
Huntsville, Ala. (Tel. JEfferson 6-4411)
Supvr.-Purch.: A. H. Belcher
Asst. Supvr.-Purch.: C. R. Lumpkin
Gen. Mgr.: A. R. Deschere **RD**

ROHN MFG. CO.
116 Limestone St., Peoria, Ill. (Tel. 7-8416)
Pres.: Dwight Rohn

Mgr.: William Hall
Sales Mgr.: R. A. Kleine S

ROHR AIRCRAFT CORP.
Foot of H St., Chula Vista, Calif. (Tel. GArfield 2-7111)
Materiel Mgr.: C. R. Campbell
Mgr.-Purch.: R. J. Rucci
Purch. Agents: J. W. O'Reilly, G. F. Guerin
Contracts Mgr.: A. R. Campbell

ROLL FORMED PRODUCTS CO.
3760 Oakwood Ave., Youngstown, O. (Tel. SWeetbriar 9-3223)
Purch. Agent: S. Kakish
Sales Mgr.: L. C. Colleran

ROLLAN ELECTRIC CO.
8233 S. Princeton Ave., Chicago 20, Ill. (Tel. RAdcliffe 3-4000)
Purch. Agent: William Pierucci
Sales Mgr.: C. E. Schneider

ROLLE MFG. CO.
3rd & Cannon Ave., Lansdale, Pa. (Tel. UL 5-1171)
Purch. Agent: H. Wardle
Sales Mgr.: W. F. Trakat

ROLLER BEARING CO. OF AMERICA
Sullivan Way, W. Trenton, N. J. (Tel. EX 3-7191)
Purch. Agent: R. J. McCoy
Sales Mgr.: Robert R. Voorhees PS, MS, CT

ROLLWAY BEARING CO., INC.
541 Seymour St., Syracuse 4, N. Y. (Tel. GR 5-2121)
Purch. Agent: William R. Bowes
Gen. Sales Mgr.: Alfons Alven M

ROLOCK INC.
1350 Kings Hwy., Fairfield, Conn. (Tel. FO 7-8611)
Purch. Agent: Robert L. Larkin
V. P.-Sales: Robert Platt M

ROME CABLE DIV., ALCOA
421 Ridge St., Rome, N. Y. (Tel. Rome 3000)
Purch. Agent: S. O. Williams
Asst. Purch. Agent: J. H. McCann
V. P. & Dir.-Mktg.: G. E. Rolston MS

ROME-TURNEY RADIATOR CO.
109 Canal St., Rome, N. Y. (Tel. 2200)
Dir.-Purch.: R. Yutzler
Dir.-Sales: W. L. Lynch, Jr. MS, M

RONAN & KUNZL, INC.
502 S. Kalamazoo Ave., Marshall, Mich. (Tel. STory 1-2861)
Cryogenic Sales Engr.: Herbert A. Eichstaedt
Purch. Agent: Mark Cato
V. P.: C. B. Vandenberg MS

RONAN & KUNZL, INC., CRYOGENIC DIV.
Marshall, Mich. (Tel. STory 1-2861)
Purch. Agent: Mark Cato
Sales: H. E. Eischstaedt

RONSON HYDRAULIC UNITS CORP.
1313 Lincoln Ave., Pasadena, Calif. (Tel. MUrray 1-0221)
Purch. Agent: M. E. Boltz
Dir.-Sales: R. K. Boltz MS, G, RD

ROOVERS LOTSCH CORP.
P. O. Box 97, Old Forge, Pa. (Tel. GLenwood 7-6737)
V. P. & Gen. Mgr.: C. F. Lotsch
Treas.: P. D. Payne M

ROSAN, INC.
2901 W. Coast Hwy., Newport Beach, Calif. (Tel. LIberty 8-5533)
Purch. Agent: Robert A. Carr
Gen. Sales Mgr.: E. G. Miller M

ROSE MFG. CO.
2700 W. Barberry Place, Denver 4, Colo. (Tel. AC 2-7847)
V. P.: J. E. Sharp RD

ROSEMOUNT ENGRG. CO.
4900 W. 78th St., Minneapolis 24, Minn. (Tel. WAlnut 7-7711)
Secy.-Treas.: Vernon H. Heath
Buyer: Harry Boquist
Sales Mgr.: B. L. Sadler CT, TT, RD

CHARLES ROSS & SON CO., INC.
148-156 Classon Ave., Brooklyn 5, N. Y. (Tel. MAin 2-8400)
Pres.: C. K. Ross
V. P. & Treas.: R. M. Ross
Purch. Dept.: J. Teleky PS, RD

MILTON ROSS METALS CO., THE
237 Jacksonville Rd., Hatboro, Pa. (Tel. OSborne 2-0550)
Purch. Agent: P. Hazelwood

ROTARY LIFT CO., DIV.-DOVER CORP.
1054 Kansas St., Memphis 2, Tenn. (Tel. WHitehall 8-8561)
V. P.-Purch.: W. E. Rier
Sales Mgr.-Elevator Div.: H. G. Sanders
Sales Mgr.-Indsl. Div.: H. T. Hamm

ROTEX PUNCH CO., INC.
2350 Alvarado St., San Leandro, Calif. (Tel. ELgin 7-3600)
Prod. Mgr.: Mark Hamlin
Sales Mgr.: John B. Sweeney

ROTO-FINISH CO.
3700 Milham Rd., P. O. Box 2065, Kalamazoo, Mich. (Tel. FIreside 3-5578)
V. P. & Dir.-Purch.: J. W. Servaas
Sales Mgr.: W. J. Walther

ROTOTEST LABS., INC.
2803 Los Flores Blvd., Lynwood, Calif. (Tel. NEvada 6-9238)
Purch. Agent: Mrs. Tim Taylor
V. P.-Sales: J. R. Duncan CT

ROTRON MFG. CO.
7-9 Schoonmaker Lane, Woodstock, N. Y. (Tel. ORiole 9-2401)
Purch. Agent: A. J. Gibson, Jr.
Dir.-Sales: Paul M. Beard
Asst. Sales Mgr.: W. W. Blelock, Jr. M

MILTON ROY CO.
1300 E. Mermaid Lane, Philadelphia 18, Pa. (Tel. CHestnut Hill 7-8000)
Purch. Agent: E. W. Brook
Sales Mgr.: John Procopi

ROYAL ELECTRIC CORP.
95 Grand Ave., Pawtucket, R. I. (Tel. PAwtucket 2-8600)
Purch. Agent: H. Spanglet
V. P.-Sales Operations: S. B. Alperin M

ROYAL JET, DIV.-ROYAL INDUSTRIES, INC.
1035 Westminster Ave., Alhambra, Calif. (Tel. CU 3-8151)
Mgr.-Materials: D. S. MacKenzie, Sr.
Buyers: Ruth Young & R. Proctor
Asst. to Pres.: J. D. Strickland S, CT

ROYLYN INC.
620 Paula Ave., Glendale 1, Calif. (Tel. CHapman 5-8521)
Purch. Agent: Leo Harris
Asst. Purch. Agent: Harold Conley
Outside Purch.: James McEwen PS, MS, M, G, RD

RUBATEX DIV., GREAT AMERICAN INDUSTRIES INC.
Bedford, Va. (Tel. JUstice 6-2611)
Purch. Agent: Mary B. Dean
Asst. Sales Mgr.: C. R. Thaxton

RUBBER & ASBESTOS CORP.
225 Belleville Ave., Bloomfield, N. J. (Tel. PIlgrim 8-1300)
Purch. Agent: Mrs. A. Golden
Gen. Sales Mgr.: Harold Greene M

RUBBERCRAFT CORP. OF CALIFORNIA
1800 W. 220th St., Torrance, Calif. (Tel. FAirfax 8-5402)
V. P.-Sales: Robert N. Merralls M

RUBY CHEMICAL CO.
68-70 McDowell St., P. O. Box 1108, Columbus, Ohio (Tel. CApital 1-3055)
Gen. Mgr.: Dale F. Baker M

RUCKER CO., THE
4700 San Pablo Ave., Oakland 8, Calif. (Tel. OLympic 3-5221)
V. P.-Gen. Mgr.: Clarence J. Woodard MS, CT, RD

RULAND MFG. CO., INC.
380 Pleasant St., Watertown 72, Mass. (WA 4-8000)
Pres.: Fred F. Ruland G, TT

RUSSELL MFG. CO.
Middletown, Conn. (Tel. Diamond 6-7721)
Purch. Agent: Henry Fischer, Jr.
Dir.-Automotive Research & Mfg.: H. C. Morton
Dir.-Research, Textile Div.: T. I. Read
V. P.-Sales: L. S. Sullivan M, RD

RUST-OLEUM
2425 Oakton St., Evanston, Ill. (Tel. BRoadway 3-3200)
Pres. & Dir.-Sales: Robert A. Fergusson
V. P. & Dir.-Purch.: D. W. Fergusson M

RUTHERFORD ELECTRONICS CO.
8944 Lindblade St., Culver City, Calif. (Tel. UPton 0-7393)
Purch. Agent: George S. Ollen
Sales: N. T. Holzer MS, CT, RD

RUTHMAN MACHINERY CO., THE
1813 Reading Rd., Cincinnati 2, O. (Tel. MA 1-5462)
V. P.-Purch.: A. H. Ruthman

RYAN AERONAUTICAL CO.
2701 Harbor Dr., San Diego 12, Calif. (Tel. CYpress 6-6681)
Dir.-Materiel: M. K. Smith
Gen. Supvr.-Purch.: J. H. Stromberg
Gen. Supvr.-Outside Prod.: R. W. Carr S, PS, MS, RD

RYAN INDUSTRIES, INC., DEPT. M
888 E. 70th St., Cleveland 3, Ohio (Tel. UTah 1-6883)
Purch. Agent: William Stratton
Buyer: Ed Oberle
V. P.-Sales & Engrg.: R. M. Haas MS

RYE SOUND CORP.
145 Elm St., Mamaroneck, N. Y. (Tel. OWens 8-0082)
Gen. Mgr. & Dir.-Purch.: R. M. Livingston
Dir.-Sales: S. M. Scher

JOSEPH T. RYERSON & SON, INC.
16th & Rockwell Sts., Chicago 8, Ill. (Tel. ROckwell 2-2121)
V. P.-Proc.: J. M. Mead
V. P.-Sales: W. E. Falberg M

RYTRON CO., INC.
7303 Lankershim Blvd., N. Hollywood, Calif. (Tel. POplar 5-0756)
Purch. Agent: Jack Kennedy
Dir.-Engrg.: Robert E. Schlegel
Chief Engr., Filters: Carl Nelson
Chief Engr., Mag. Amplifier: Ralph Holanov
Sales Mgr.: D. S. Shaw M, TT

S & G MFG. CORP.
1017 Magazine St., New Orleans 10, La. (Tel. JA 5-3142)
Gen. Mgr.: Roy J. Surgi

SKF INDUSTRIES, INC.
Front St. & Erie Ave., Philadelphia 32, Pa. (Tel. GArfield 6-6400)
Dir.-Purch.: F. E. Whyte
Purch. Agent: J. R. Bremer
Supvrs.: W. R. Sine
Buyers: B. F. Maurer, J. A. McCarron, W. R. Conlogue, & J. A. Choman
Expediter: D. P. Haggerty

S-P MFG. CORP., THE
30201 Aurora Rd., Cleveland 39, Ohio (Tel. CHurchill 8-6141)
Purch. Agent: A. W. Fisher
Sales Mgr.: R. E. Sutherland M

SAFETEE GLASS CO.
4717 Stenton Ave., Philadelphia 44, Pa. (Tel. DA 9-1200)
V. P.: James W. Gibbs
Dir.-Sales: C. A. McCusker M

SAFETY ELECTRICAL EQUIPMENT CORP.
1187 Dixwell Ave., New Haven 14, Conn. (Tel. UN 5-3171)
Purch. Agent: Joseph Prestianni
Indsl. Sales Mgr.: Charles Pierce
V. P.-Sales: J. J. Kennedy

SAFEWAY HEAT ELEMENTS, INC.
Middlefield St., Middletown, Conn. (Tel. Diamond 6-6601)
Secy.-Asst. Treas.: Joseph F. O'Rourke
Dir.-Sales: T. A. Dissel PS, MS, M, G, RD

SAFFRAN ENG. CO.
20225 E. 9 Mile Rd., St. Clair Shores, Mich. (Tel. PR 7-5300)
Purch. Agent: Samuel A. Tomaino
V. P. & Sales: B. C. Kosack

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

SAFWAY STEEL PRODUCTS, INC.
6228 W. State St., Milwaukee 13, Wisc. (Tel. BLuemound 8-2700)
Purch. Agent: W. F. Cook
R & D Engr.: R. B. Weidner
V. P.-Sales: J. C. Jay

SAGE ELECTRONICS CORP.
Country Club Road, East Rochester, N. Y. (Tel. LU 6-8010)
Treas.: A. P. Mills
Pres.: F. D. Sage

SAGE EQUIPMENT CO., INC.
30 Essex St., Buffalo, N. Y. (Tel. ELmwood 5242)
Purch.: Charles Taravela
Plant Mgr.: John Haynes S

SAGE LABS., INC.
3 Huron Dr., Natick, Mass. (Tel. OLympic 3-0844)
Purch. Agent: William S. Patsos
Sales Mgr.: William J. Kennedy MS, RD

SAGE-CRAFT, INC.
Norwich, N. Y. (Tel. 4-6118)
Pres.: Earle R. Sage

SAGINAW BEARING CO.
967 S. Water St., Saginaw, Mich. (Tel. PLeasant 2-3169)
Purch. Agent: Robert L. Hamlin
Sales Mgr.: Robert L. Pieschke

ST. JOHN X-RAY LABORATORY
Califon, N. J. (Tel. Califon 49)
Pres.: Herbert R. Isenburger RD

ST. MARYS CARBON CO.
W. State St., St. Marys, Pa. (Tel. TErminal 4-2844)
Dir.-Purch.: C. J. Ehrensberger
V. P.-Sales: L. W. Eberl

ST. REGIS PAPER CO., PANELYTE DIV.
Enterprise Ave., Trenton, N. J. (Tel. EXport 2-2181)
Purch. Agent: Frank P. Yaccarino, Sr.
Indsl. Sales Mgr.: John M. Zeier MS

SAN FERNANDO ELECTRIC MFG. CO.
1509 1st St., San Fernando, Calif. (Tel. EMpire 1-8681)
Purch. Agent: Ben J. Schenkelberg
Gen. Sales Mgr.: Lyle R. Smith RD

SANBORN CO.
175 Wyman St., Waltham 54, Mass. (Tel. TW 4-6300)
Purch. Dir.: E. A. Craddock
V. P.-Sales: A. E. Lonnberg

SANCOR CORP.
1661 Franklin Ave., El Segundo, Calif. (Tel. ORegon 8-5069)
Purch. Agent: A. H. Knight
V. P.-Sales: L. H. Sanderfer S, MS, CT

SANDERS ASSOCIATES, INC.
95 Canal St., Nashua, N. H. (Tel. TUxedo 3-3321)
Purch. Agent: Chandler Goldthwaite
Dir.-Sales: James I. Chesterley MS, G, CT, TT, RD

SANDVIK STEEL, INC.
1702 Nevins Rd., Fairlawn, N. J. (Tel. SWarthmore 7-6200)
Purch. Agent: Robert G. Reveri
Pres.: Carl Hildebrand M

SANFORD PLASTICS CORP.
P. O. Box 126, Matawan, N. J. (Tel. LOwell 6-3900) M

SANGAMO ELECTRIC CO.
11th & Converse, Springfield, Ill. (Tel. KI 4-6411)
Purch. Agent-Springfield, Ill.: H. C. Chambers
Purch. Agent-Pickens Div., Pickens, S. C.: R. W. Kreppert (Tel. 6311)
Purch. Agent-Ordill Div., Marion, Ill.: Rex McCluskey (Tel. 231)
V. P.-Sales: R. C. Lanphier, Jr. RD

SANTA ANITA ENGRG. CO.
2451 E. Colorado Blvd., Pasadena 8, Calif. (Tel. MUrray 1-7441)
Mgr., Prod. & Purch.: Robert Blyth
V. P.-Engrg. & Sales: L. D. Bonham
Gen. Mgr.: R. M. Modisette, Jr. S

SARAN PROTECTIVE COATINGS CO.
2415 Burdette Ave., Ferndale 20, Mich. (Tel. LIncoln 4-8303)
Pres.: C. J. Weine
Dir.-Sales: Robert R. Spencer M

SANTA BARBARA RESEARCH CENTER
Bldg. 316, Municipal Airport, Goleta, Calif. (Tel. WOodland 7-2331)
Mgr., Comm. Operations: D. T. Shiffman G, TT, RD

SARGENT ELECTRIC CORP.
630 Merrick Rd., Lynbrook, N. Y. (Tel. LYnbrook 3-5600)
Purch. Agent: Mike Krutman
Dir.-Sales: Joe Perz M

SARGENT ENGRG. CORP.
2533 E. 56th St., Huntington Park, Calif. (Tel. LUdlow 3-4161)
Purch. Agent: C. A. Brock
Asst. Purch. Agent: Tom Chapman
Dir.-Contracts: R. A. Thomas
Dir.-Sales: J. H. Howard S, MS, M, RD

SARKES TARZIAN, INC., SEMICONDUCTOR DIV.
415 N. College Ave., Bloomington, Ind. (Tel. EDison 2-1435)
Purch. Agent: Max Robertson

SAUEREISEN CEMENTS CO.
1045 N. Canal St., Pittsburgh 15, Pa. (Tel. STerling 1-2323)
Purch. Agent: G. W. Read
V. P.-Sales: P. F. Sauereisen M

SAVAGE-ROWE PLATING CO., INC.
2152 Portage St, Kalamazoo, Mich. (Tel. FIreside 5-0532)
Pres.: Frank K. Savage
V. P.-Sales: A. K. Graham

SAWYER COATED FABRICS, DIV.-FARRINGTON TEXOL CORP.
76 Stanley Ave., Watertown 72, Mass. (Tel. WAlnut 6-1200) M

SAXONBURG CERAMICS, INC.
Box 157, Saxonburg, Pa. (Tel. FL 2-1566)
Pres.: George Aderhold
Plant Mgr.: J. G. Pabst
Ceramic Engr.: W. C. Stetson M

SAYLOR ELECTRIC PRODUCTS CORP.
277 Pierce, Birmingham, Mich. (Tel. JOrdan 6-7122)
Purch.: W. R. Saylor
Sales: B. F. Stiles

SCALA RADIO CO.
2814 19th St., San Francisco 10, Calif. (Tel. VA 6-2898)
Purch. Agent: E. M. O'Neill
Dir.-Sales: Bruno Zucconi

SCAM INSTRUMENT CORP., THE
1811 Irving Park Rd., Chicago 13, Ill. (Tel. GRaceland 7-7850)
Purch. Agent: E. W. Waller
Sales Mgr.: Roscoe Garrett

SCANIVALVE CO.
631 30th St., San Diego 2, Calif. (Tel. BE 4-2090)
Purch. Agent: V. L. Jones
Sales Mgr.: J. C. Pemberton CT, RD

SCHAEVITZ ENGRG.
U. S. Rt. 130 & Schaevitz Blvd., Pennsauken, N. J. (Tel. NOrmandy 2-8000)
Purch. Mgr.: Marvin E. Brenner
Dir.-Sales & Mktg.: George E. Merer MS, G, CT, RD

SCHAFFER AIR INDUSTRIES, INC.
290 N. Henry St., Brooklyn 22, N. Y. (Tel. EVergreen 3-5300)
Purch.: Bernard Schaffer MS, CT

RAY A. SCHARER & CO.
17411 E. Warren, Detroit 24, Mich. (Tel. TUxedo 2-7172)
Purch. Agent: R. C. Colegrove
Sales Mgr.: Ray A. Scharer M

SCHAUER MFG. CORP.
4500 Alpine Ave., Cincinnati 42, O. (Tel. SYcamore 1-3030)
Purch. Agent: David T. Face
V. P.-Sales: S. E. Wright

SCHELLENS-TRUE CORP.
Pondmeadow Rd., Ivoryton, Conn. (Tel. Essex-South 7-8248)
V. P.: E. Peter Schellens
Pres.: E. L. Schellens PS

SCHENECTADY VARNISH CO., INC.
Congress St. & 10th Ave., Schenectady 3, N. Y. (Tel. DIckens 6-2354)
Order Service Mgr.: Morley Wales
V. P.-Mktg.: John B. Emans M

SCHLEGEL MFG. CO.
1555 Jefferson Rd., P. O. Box 197, Rochester 1, N. Y. (Tel. HIllside 5-5110)
Dir.-Purch.: James Doris
Asst. Purch. Agent: Donald Nesbitt
Sales Mgr.: William K. Sittig

D. A. SCHULTZ CO.
801 S. E. 8th St., Minneapolis 14, Minn. (Tel. FEderal 9-7701)
Purch. Agent: Marge Knight
Sales Engr.: Burton Dahlsten

SCHUTTE & KOERTING CO.
Cornwells Hts., Bucks Co., Pa. (Tel. MErcury 9-0900)
Purch. Agent: C. Alsentzer
V. P.-Sales: F. L. Seibold

SCHWEBER ELECTRONICS
60 Herricks Rd., Mineola, L. I., N. Y. (Tel. PIoneer 6-6520)
Buyer: George P. Heller
Sales: Jack Laskin

SCIAKY BROS., INC.
4915 W. 67th St., Chicago 38, Ill. (Tel. POrtsmouth 7-5600)
Purch. Agent: John Bilik
Chief Appl. Engr.: William Farrell RD

SCIENTIFIC ELECTRIC INC.
105-119 Monroe St., Garfield, N. J. (Tel. PRescott 7-0507)
Pres.: John Sedlacsik
Gen. Mgr.: C. P. Breen
V. P.-Sales: John Sedlacsik, Jr. M, RD

SCIENTIFIC ENGRG. CO.
653 11th Ave., New York 36, N. Y. (Tel. COlumbus 5-7286)
Purch. Agent: Gilbert Goodgion
Sales Mgr.: R. J. Black RD

SCIENTIFIC ENGRG. LABS., INC.
1510 Sixth St., Berkeley 10, Calif. (Tel. LA 6-2772)
Purch. Agent: Mrs. Alberta Proteau
Sales Mgr.: A. D. Wickstrom
Pres.: G. C. McFarland CT, RD

SCIENTIFIC & PROCESS INSTRUMENTS DIV.-BECKMAN INSTRUMENTS, INC.
2500 Fullerton Rd., Fullerton, Calif. (Tel. TRojan 1-4848)
Supvr.-Purch.: Kenneth Bruner
Sales Mgr., Scientific: John Manypenny
Mktg. Mgr.: Roy Brown CT

SCIENTIFIC RADIO PRODUCTS, INC.
2303 W. 8th St., Loveland, Colo. (Tel. NOrmandy 7-2261)
Treas. & Purch. Agent: G. E. Ulfers
V. P. & Sales Mgr.: G. C. Follmer M, G, TT

SCIENTIFIC RADIO SERVICE
4301 Sheridan St., University Park, Hyattsville, Md. (Tel. WArfield 7-0535)
Owner: Harry D. Eisenhauer M

SCIENTIFIC-ATLANTA, INC.
2162 Piedmont Rd., N. E., Atlanta 9, Ga. (Tel. TRinity 5-7291)
Buyer: George Ray
Chief Mechan. Engr.: S. F. Hutchins
Chief Elect. Engr.: C. H. Currie
Sales Mgr.: William H. Bradley CT, TT, RD

SCINTILLA DIV., BENDIX AVIATION CORP.
Delaware Ave., Sidney, N. Y. (Tel. LOwell 3-9511)
Purch. Agent: W. B. Wilson
Dir.-Sales & Adv.: D. B. Morse MS, CT

SCIOTO SIGN CO.
370 Vine St., Kenton, O. (Te. 2-1146)
Pres.: Collins M. Shaw
Purch. Agent: K. Buck
Sales Mgr.: B. Deardorff

SCOPES CO., INC., THE
P. O. Box 56, Monsey, N. Y. (Tel. ELmwood 6-6339)
Dir.-Purch.: M. Silver (DIamond 3-3070)
Pres.: M. Rickard CT

H. H. SCOTT, INC.
111 Powder Mill Rd., Maynard, Mass. (Tel. TWin Oaks 7-8801)
Sales Mgr.-Instr. Div.: E. G. Dyett, Jr.
Proc. Mgr.: I. C. Whittemore, Jr. CT, RD

H. M. SCOTT CO., THE
396 S. Pacific St., Stamford, Conn. (Tel. FIreside 8-4259)
Purch. Dept.: H. M. Scott, Jr.
Prod. Supt.: P. Blasko M

SCOTT AVIATION CORP.
Erie St.,Lancaster, N. Y. (Tel. REgent 5100)
Purch. Agent: K. J. Albrecht
V. P.-Sales & Finance: R. D. Pollock **MS, RD, HSE**

SCOVILL MFG. CO.
99 Mill St., Waterbury, Conn. (Tel. PLaza 4-1171)
V. P. & Gen. Mgr.: P. E. Fenton
Sales: R. Woodacre **M**

SCREW CORP.
157 N. Rivergrade Rd., City of Industry, Calif. (Tel. EDgewood 8-5501)
Pres.: F. Huhn
V. P.: K. R. Brooks
Secy.-Treas.: H. Wechsler **S, PS, MS, G**

SCREW PRODUCTS CORP. OF AMERICA
5211 Southern Ave., South Gate, Calif. (Tel. LOrain 6-5141)
Purch. Agent: Albert Jenkins
Sales Mgr.: Walter Cleary

SEALECTRIC SWITCH & RELAY CORP.
6025 N. Keystone Ave., Chicago 46, Ill. (Tel. KEystone 9-7502)
Purch. Agent: J. C. Miller
Sales Mgr.: E. M. Paradise

SEALECTRO CORP.
139 Hoyt St., Mamaroneck, N. Y. (Tel. OW 8-5600)
Purch. Agent: Ralph Low
V. P. & Dir.-Sales: George E. Mohr **M**

***SEALMASTER BEARING DIV., STEPHENS-ADAMSON MFG. CO.**
Ridgeway Ave., Aurora, Ill. (Tel. AUrora 2-4311)
Purch. Agent: K. L. Johnson
Sales Mgrs.:
Sealmaster Bearings: C. B. Hurd, V. P.
Engrg. Div.: E. J. Renner, V. P.
Standard Products Div.: R. H. Humm
Speedwalk Div.: R. O. Schaeffer
Export Dept.: Roger Barton **M**
*(See advertisement this issue)

SEALOL CORP.
460 Post Rd., Providence 5, R. I. (Tel. STuart 1-4700)
Purch. Agent: Nathaniel Burnham
Pres.: Clement W. Williamson **M, RD**

SEAL-PEEL, INC.
775 Stephenson Hwy., Royal Oak 3, Mich. (Tel. JUniper 8-1055)
V. P. & Purch. Agent: Frank Evans
Pres.: Arthur Aaron

SEALTRON CORP.
Reading Rd. at Amity, Cincinnati 15, Ohio (Tel. VAlley 1-7444)
Purch. Agent: Eugene O'Connell
Gen. Mgr.: J. B. Homoelle **M**

SEAMAN PRODUCTS, DIV.-SEAMAN PAPER CO.
13001 Bradley, Sylmar, Los Angeles, Calif. (Tel. EMpire 7-1881) **S, MS, M**

SEAMLESS PRODUCTS CO., INC.
126 11th Ave., New York 11, N. Y. (Tel. ALgonquin 5-2152)

SECO MFG. CO.
5015 Penn Ave., S., Minneapolis 19, Minn. (Tel. WAlnut 6-4545)
Pres. & Chief Engr.: E. A. Bramsen
Sales Mgr.: L. P. Henaman

SECODE CORP.
555 Minnesota St., San Francisco 7, Calif. (Tel. MA 1-2643)
Purch. Mgr.: H. Gross
Buyer: R. Abeyta
Plant Mgr.: L. J. Naper
Gen. Mgr.: I. Herman **MS, CT, TT, RD**

SECON METALS CORP.
7 Intervale St., White Plains, N. Y. (Tel. WHiteplains 9-4757)
Pres.: Eugene Cohn **M**

SEDCO
814 W. Hyde Park Blvd., Inglewood 3, Calif. (Tel. OR 8-2264)
Purch. Agent: E. E. Parker
V. P. & Dir.-Sales: W. L. Heckerman **PS, MS**

SEEBURG CORP., THE
1500-38 N. Dayton St., Chicago 22, Ill. (Tel. MIchigan 2-0800)
Purch. Agents: Walter Metcalf & Ritchie Tredwell
Buyers: Walter Korzun, Daniel Dolce & George Keller
Contract Adm.: W. Cummins **MS, G, TT**

SEEGER-WILLIAMS, INC.
4 Norman St., Bridgeport 5, Conn. (Tel. EDison 5-5123)
V. P. & Dir.-Purch.: Erwin F. Welch
Pres. & Dir.-Sales: T. W. Becker

SEISCOR, DIV.-SEISMOGRAPH SERVICE CORP.
6200 E. 41st St., Box 1590, Tulsa 1, Okla. (Tel. Riverside 3-1381)
Purch. Agent: M. G. Steil
Asst. Purch. Agent: T. G. Burton
Gen. Mgr.: J. E. Hawkins **MS, CT, RD**

SELAS CORP. OF AMERICA
Dresher, Pa. (Tel. Mitchell 6-6600)
Pres.: F. O. Hess
Purch. Agent: J. E. Kerns **RD**

SELLSTROM MFG. CO.
Hwy. 53 at U. S. 14, Palatine, Ill. (Tel. FLanders 8-2000)
Dir.-Purch.: H. A. Kline
Sales Mgr.: Lester Gooch

SEL-REX CORP.
75 River Rd., Nutley 10, N. J. (Tel. NOrth 7-5200)
Branch Offices: 1629 S. 55th Ave., Chicago, Ill. (Tel. OL 6-4400); 2180 Colorado Ave., Santa Monica, Calif. (Tel. EX 4-6771)
Purch. Agent: J. R. Ezzo
V. P.-Sales: S. S. Wilson **M, RD**

***SEMICONDUCTOR DIV., RAYTHEON CO.**
215 First Ave., Needham Hgts., Mass. (Tel. HIllcrest 4-6700)
Sales Mgr.: H. F. Schunk
Purch. Agent: P. L. Gregory
Purch. Agent: P. Erickson, 150 California St., Newton, Mass. (Tel. DEcatur 2-7177) **M, RD**
*(See advertisement this issue)

SEMI-ELEMENTS, INC.
Saxonburg Blvd., Saxonburg, Pa. (Tel. FLanders 2-2548)
Pres.: Joseph V. Fisher
Asst. Secy.: Charles Laine **M, RD**

SEMIMETALS, INC.
133-27 91st Ave., Richmond Hill 18, N. Y. (Tel. AXtel 7-0200)
Purch. Agent: A. Jacobson
Gen. Sales Mgr.: R. A. Jewett **M**

SEMINOLE ASPHALT REFINING, LTD.
St. Marks, Fla. (Tel. 441)
Supt.: H. H. Clardy
Mgr.: M. J. Lewis **M**

SENSITIVE RESEARCH INSTRUMENT CORP.
310 Main St., New Rochelle, N. Y. (Tel. BE 5-2300)
Purch. Agent: Miss Helen Tripler
Chief Engr.: H. Russell Brownell
Mechanical Engr.: William A. McNulty
V. P. & Sales Mgr.: Marvin I. Steinberg **PS, MS, CT, TT, RD**

SEQUOIA WIRE & CABLE CO., SUB.-ANACONDA WIRE & CABLE CO.
2201 Bay Rd., Redwood City, Calif. (Tel. EMerson 9-0331)
V. P.-Sales: Bruce Van Wagner
Purch.: P. Panzarella

SERDEX, INC.
12 Bowdoin Sq., Boston 14, Mass. (Tel. CA 7-7160)
Purch. Agent: Miss M. A. Turell
Dir.-Sales: G. Santo

SERVICAIR CO.
1841 Flower St., Glendale, Calif. (Tel. CH 5-5161)
Purch. & Material: Fabian Forero
Gen. Sales Mgr.: Robert R. Robertson **PS, MS, M**

SERVICE STEEL DIV.
P. O. Box 532, Detroit 32, Mich. (Tel. TWinbrook 3-0350) **M**

SERVO CONSULTANTS LTD.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Sales Mgr.: Sy Bosworth

SERVO CORP. OF AMERICA
111 New South Rd., Hicksville, N. Y. (Tel. WElls 8-9700)
Purch. Agent: S. Wojcie
Mktg. Mgr.: A. Freed **MS, CT, TT, RD**

SERVOMECHANISMS, INC.
12500 Aviation Blvd., Hawthorne, Calif. (Tel. ORegon 6-7841)
Materiel Mgr.: W. Foulds
Purch. Supvr.: H. Muller
Purch. Agent: R. McGraw
Customer Liaison Mgr.: C. H. Hartley **MS, G, CT, TT, RD**

SERVONIC INSTRUMENTS, INC.
640 Terminal Way, Costa Mesa, Calif. (Tel. MIdway 6-2427)
Buyer: Earl Boroughf
Sales Mgr.: Roy A. Steckmesser

SERVO-TEK PRODUCTS CO.
1086 Goffle Rd., Hawthorne, N. J. (Tel. HAwthorne 7-3100)
Purch. Agent: C. DePuy
Dir.-Sales: J. L. Duffy **MS, G, CT, TT, RD**

SERVWELL PRODUCTS CO.
6541 Euclid Ave., Cleveland 3, Ohio (Tel. EXpress 1-0497)
Dir.-Purch.: I. W. McCulley
Sales Mgr.: R. McCulley

J. H. SESSIONS & SON
Riverside Ave., Bristol, Conn. (Tel. LUdlow 2-3127)
Pres.: Paul B. Sessions
Dir.-Sales: James McC. Sessions **M**

SEYMOUR MFG. CO., THE
15 Franklin St., Seymour, Conn. (Tel. TUxedo 8-2541)
Dir.-Purch.: O. Schemwick
V. P.-Sales: G. T. Underhill **M**

SEYMOUR PRODUCTS CORP., THE
Seymour, Conn. (Tel. TUxedo 8-2511)
V. P. & Gen. Mgr.: John B. Lightfoot

SHAFER BEARINGS, CHAIN BELT CO.
Belmont at Curtiss St., Downers Grove, Ill. (Tel. WOodland 9-1770)
Purch. Agent: Robert L. Kaiser
Sales Mgr.: Robert W. Lange

SHALLCROSS MFG. CO.
Preston St., Selma, N. C. (Tel. WOodlawn 5-2341)
Purch.: Hal Oldham
Sales Mgr.: D. M. O'Halloran **MS, G, TT**

SHALLITE, INC.
128 W. First Ave., Roselle, N. J. (Tel. CHestnut 5-9800)
Purch. Agent: George Kalousis
Pres. & Sales Mgr.: C. K. Krause

W. S. SHAMBAN & CO.
11617 W. Jefferson Blvd., Culver City, Calif. (Tel. UPton 0-6877)
Purch. Agent: Howard Drake
Sales Mgr.: Carl Wolff

SHANNON LUMINOUS MATERIALS CO., AFFILIATE-CURTISS-WRIGHT CORP., PRINCETON DIV.
7356 Santa Monica Blvd., Hollywood 46, Calif. (Tel. HOllywood 7-5509)
Purch. Agent: Iris M. Guider
Admin. Asst.: T. Hook
Owner: James R. Alburger **M, RD**

SHARON STEEL CORP.
Sharon, Pa. (Tel. DI 6-4141)
V. P.-Purch.: J. D. Neuman
Purch. Agent: G. R. McQuiston
V. P.-Comm.: W. J. McCune **M**

SHARPLES CORP., THE
2300 Westmoreland St., Philadelphia 40, Pa. (Tel. BAldwin 8-9100)
Purch. Agent: W. M. Neall
Sales Mgr.: Allen R. Greenlaw

SHAW BURNER CO.
140 E. Pine St., Columbus, Kans. (Tel. 194)
Pres.: Walter Shaw **S, PS, MS**

SHAW PROCESS DEVELOPMENT CORP., DIV.-BRITISH INDUSTRIES CORP.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Pres.: Leonard Carduner
Mktg. Dir.: Arthur Gasman
Gen. Mgr.: Irwin Lubalin **M, RD**

CODING	
Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

SHEFFIELD CORP., THE, SUB.-BENDIX AVIATION CORP.
Box 893, 721 Springfield St., Dayton 1, O. (Tel. CLearwater 4-5377)
Purch. Agent: Joseph Geyer

SHELL CHEMICAL CO., INDUSTRIAL CHEMICAL DIV.
110 W. 51st., New York 20, N. Y. (Tel. JUdson 6-5060)
Dir.-Purch.: W. H. Bratches
Dir.-Sales: W. Q. Mooney

SHELL CHEMICAL CO., PLASTICS & RESINS DIV.
110 W. 51st St., New York 20, N. Y. (Tel. JUdson 6-5060)
Gen. Mgr.: W. H. Bratches (Tel. JUdson 6-5000)
Mgr.: D. P. Jones M

SHELTERED WORKSHOPS
2521 5th St., Santa Monica, Calif. (Tel. EXbrook 9-7741)
Factories: Plant #1, 2521 5th St., Santa Monica, Calif.; Plant #2, 10835 Hawthorne Blvd., Inglewood 2, Calif.
Gen. Mgr.: J. E. Anthony
S, PS, MS, M, G, CT, TT, RD, HSE

SHENANGO FURNACE CO., THE, CENTRIFUGALLY CAST PRODUCTS DIV.
W. Third St., Dover, O. (Tel. 4-2114)
Purch. Agent: Leonard Snyder
Sales Mgr.: K. L. Jansen M

SHERIDAN-GRAY, INC.
24701 Crenshaw Blvd., Torrance, Calif. (Tel. DAvenport 6-6702)
Purch. Agent: Robert L. Sinner
V. P.-Sales: Charles W. Frazee S, M, RD

SHERMAN INDUSTRIAL ELECTRONICS CO., DIV.-ELECTRONIC DEVELOPMENT INC.
Box 813, Marylyn Ave., State College, Pa. (Tel. ADams 8-0061)
Dir.-Purch.: H. H. Stitzle
Chief Engr.: G. W. McCook
Sales Mgr.: G. H. Seemar M, RD

SHIELDING, INC.
514 N. Read Ave., Box 110, Riverton, N. J. (Tel. TAlmadge 9-1433)
Gen. Mgr.: W. J. Ryan
V. P.-Sales: T. P. Reath
Purch. Agent: J. H. Chant, Rte. 130, Riverton, N. J. (Tel. TAlmadge 9-4877) S, M

SHOCKLEY TRANSISTOR CORP.
1117 California Ave., Palo Alto, Calif. (Tel. DAvenport 1-2121)
Mktg. Mgr.: Frank Newman
Purch. Agent: Jack Carlson M, RD

SHUR-LOK CORP.
879 S. East St., Anaheim, Calif. (Tel. PRospect 4-2773) M

SIBLEY CO., THE
Bridge St., Haddam, Conn. (Tel. Diamond 5-4523)
Purch. Agent: William James
Asst. Purch. Agent: Charles Gates
Prod. Mgr.: Phillip Geffken
Sales Mgr.: Daniel Dewey M

SIBLEY MACHINE & FOUNDRY CORP.
206 E. Tutt St., South Bend 23, Ind. (Tel. AT 8-4611)
Purch. Agent: E. A. Evans
Sales Mgr.: William H. Voll S

SIER-BATH GEAR & PUMP CO., INC.
9252 Hudson Blvd., N. Bergen, N. J. (Tel. UNion 9-3000)
Purch. Agent: Martin Naclerio
Sales Mgr.: J. A. Glaser G, RD

SIERRA ELECTRONIC CORP., DIV.-PHILCO CORP.
3885 Bohannon Dr., Menlo Park, Calif. (Tel. DAvenport 6-2060)
Purch. Agent: William R. Smith
Sales Mgr.: C. M. Volkland CT, TT

SIERRA ENGRG. CO.
123 E. Montecito Ave., Sierra Madre, Calif. (Tel. ELgin 5-3318)
Purch. Agent: L. Shepherd RD, HSE

SIERRACIN CORP., THE
903 N. Victory Blvd., Burbank, Calif. (Tel. Victoria 9-2421)
Purch. Agent: Miss Helen Tyle
Sales Mgr.: F. J. Carrig, Jr. M

SIERRA-SCHROEDER CONTROLS, DIV.-IDAHO MARYLAND MINES CORP.
4310 San Fernando Rd., Glendale 4, Calif. (Tel. CHapman 5-5563)
Dir.-Materiel: Ray Williams
Purch. Agent: Walter Henderson
Dir.-Customer Relations: Robert O. Borst

SIGHTMASTER CORP.
50 Aleppo St., Providence, R. I. (Tel. TEmple 1-6200)
Purch. Agent: Frank Spinard
Sales Mgr.: Gilbert Glass M

SIGMA INSTRUMENTS, INC.
170 Pearl St., S. Braintree, Mass. (Tel. Victor 3-5000)
Purch. Mgr.: Alfred E. Foley
Purch.: Kjell Pehrson
Sales Mgr.: R. B. Wolf MS

SIGMAMOTOR, INC.
3 N. Main St., Middleport, N. Y. (Tel. RE 5-3611)
Pres.: Van G. Hungerford
Gen. Mgr.: Phillip J. Slattery RD

SIGNAL EQUIPMENT CO., INC.
2706 3rd Ave., Seattle 1, Wash. (Tel. MAin 4-4712)
V. P. & Dir.-Purch.: H. B. Lander
Pres. & Dir.-Sales: J. F. Johnson MS, CT, RD

SILENT HOIST & CRANE CO.
841 63rd St., Brooklyn 20, N. Y. (Tel. BEachview 8-2525)
Purch. Agent: Anthony Yuzzolino
Sales: M. M. Botnick

SILICON TRANSISTOR CORP.
150 Glen Cove Rd., Carle Pl., Long Island, N. Y. (Tel. Ploneer 2-4100)
Purch. Agent: Joseph Zack
Sales Mgr.: Laurence Le Bow G

SILICONE PRODUCTS DEPT., GENERAL ELECTRIC CO., DEPT. C
Waterford, N. Y. (Tel. ADams 8-3330)
Mgr.-Materials: Robert Treat
Purch. Agent: Joseph Cox
Mgr.-Sales: Thomas J. March M

SILICONE SEALS, INC.
3694 Milwaukee Ave., Chicago 41, Ill. (Tel. AVenue 2-3787)
Secy.: Robert Shattow
Sales: Leonard E. Brown

SILICONES DIV.-UNION CARBIDE CORP.
30 E. 42nd St., New York 17, N. Y. (Tel. MUrray Hill 6-1700)
Purch. Agent: R. G. Koehler, Long Reach Plant, P. O. Box 180, Sistersville, W. Va. (Tel. OLdfield 2-3211)
Sales Mgr.: C. T. Schieman, Jr. M

SILLCOCKS-MILLER CO.
460 W. Parker Ave., Maplewood, N. J. (Tel. SOuth Orange 2-6171)
Purch. Dir.: R. W. Davis
V. P.: J. F. Herslow
Dir.-Mktg.: A. E. Wunderlich M, RD

SIMMONDS AEROCESSORIES, INC.
105 White Plains Rd., Tarrytown, N. Y. (Tel. MEdford 1-7500)
Purch. Agent: Grant W. Meister
Gen. Contracts Mgr.: H. C. Pringle
PS, MS, G, CT, TT, RD

SIMMONS FASTENER CORP.
P. O. Box 1985, Albany 1, N. Y. (Tel. HO 2-5431)
V. P. & Gen. Mgr.: Harry H. Rose
Asst. Mgr.: Charles H. Palmer
Prod. Mgr.: Kenneth MacDonald M

SIMONDS SAW & STEEL CO.
470 Main St., Fitchburg, Mass. (Tel. Diamond 3-3731)
Purch. Agent: Louis A. Little, Intervale Rd., Fitchburg, Mass.
Gen. Sales Mgr.: Clyde N. Mansur

SIMS CASTINGS CORP.
2174 E. Erie Blvd., Syracuse 3, N. Y. (Tel. GRanite 2-2489)
Pres. & Dir.-Purch.: Robert L. Sims
Secy.: Richard D. Sims
Dir.-Sales: C. L. Sims M

SIMPSON ELECTRIC CO.
5200 W. Kinzie St., Chicago 44, Ill. (Tel. EStebrook 9-1121)
Purch. Agent: James Werner
Dir.-Sales: M. O. Buehring

SINCLAIR MFG. CO.
S. Worcester St., P. O. Box 398, Chartley, Mass. (Tel. ATtleboro 1-2627)
Pres. & Treas.: John C. Sinclair
Sales Mgr.: Howard C. Brownell

SINCLAIR REFINING CO.
600 Fifth Ave., New York 20, N. Y. (Tel. CIrcle 6-3600)

SINCLAIR-COLLINS VALVE CO., DIV.-IBEC
454 Morgan Ave., Akron, Ohio (Tel. PR 3-6623)
Dir.-Purch.: R. R. Stull
Sales Mgr.: J. J. Mudd S, CT

SINGER MILITARY PRODUCTS DIV., THE SINGER MFG. CO.
149 Broadway, New York 6, N. Y. (Tel. DIgby 9-1200)
Div. Mgr.: F. W. Howells RD

SINTERCAST DIV., CHROMALLOY CORP.
134 Woodworth Ave., Yonkers, N. Y. (Tel. YOnkers 9-6767)
Dir.-Purch.: Fred Fuld
Prod. Mgr.: Stuart Tarkan RD

SIRVALCO SYSTEMS CORP.
43 Kendrick St., Wrentham, Mass. (Tel. EVergreen 4-3121)
Engrg.-Div.: 139 Highland Pkwy., Roselle, N. J.
Dir.-Purch.: T. J. Bagarozy
V. P.: V. F. Siravo
Dir.-Sales: E. R. Bagarozy PS, MS, RD

SITTLER CORP.
18 N. Ada St., Chicago 7, Ill. (Tel. SEeley 3-4616)
V. P.-Purch.: S. J. Lanasa CT

SIZE CONTROL CO., DIV.-AMERICAN GAGE & MACHINE CO.
2500 W. Washington Blvd., Chicago 12, Ill. (Tel. MO 6-6710)
Sales Mgr.: E. E. Olds
Purch. Mgr.: P. J. Sommer, Jr. M, CT, RD

C. SJOBERG & SON
415 Station St., Cranston 10, R. I. (Tel. HO 1-8220)
Owner: C. Sjoberg, Sr. M

SKAGGS FREIGHT LINES, INC.
851 Brookhurst Dr., Dallas 18, Texas (Tel. DAvis 8-1386)
Pres.: A. G. Jacobson

SKIATRON ELECTRONICS & TELEVISION CORP.
180 Varick St., New York, N. Y. (Tel. WAtkins 4-7060)
Purch. Agent: N. J. Ackerman
Sales Mgr.: Carl MacHover MS, G, CT, TT, RD

SKIDMORE-WILHELM MFG. CO.
442 Green Rd., Cleveland 21, Ohio (Tel. IVanhoe 1-4774)
Pres.: J. W. Wilhelm
Dir.-Purch.: Carl Sutherland S, MS, CT

SKINNER ELECTRIC VALVE DIV., THE SKINNER CHUCK CO.
95 Edgewood Ave., New Britain, Conn. (Tel. BAldwin 5-6421)
Purch. Agent: Clifford Nelson
V. P.-Sales: D. M. Stevenson PS, MS, G, TT

SKINNER ENGINE CO.
337 W. 12th St., Erie 6, Pa. (Tel. GLendale 2-3661)
Purch. Agent: M. E. Davis
V. P.-Sales: K. W. Van Eman M

SKOTTIE ELECTRONICS, INC., SUB.-ASTRON CORP.
204 Bridge St., Peckville, Pa. (Tel. HUnter 9-4726)

SKYDYNE, INC.
River Rd., Port Jervis, N. Y. (Tel. 3-2241)
Sales Mgr.: W. F. Maccallum
Purch. Agent: B. E. Marchant
V. P.: Robert L. Weill

SKYLINE ELECTRIC & MFG. CO.
203 W. Thomas St., Seattle 99, Wash. (Tel. ATwater 4-8420)
Project Engr.: Benno Persitz (Tel. ATwater 3-6941)

SKYLINE PRODUCTS, INC.
819 Grand Blvd., Deer Park, N. Y. (Tel. DEer Park 2-8644)
V. P.-Sales: Thomas A. Perry
Buyer: John Canning
Pres.: Morris Herberg S

SKYPRODUCTS
Ottsville, Pa.
Owner: Robert G. Sheppard

SKYTRONICS, INC.
10515 Burbank Blvd., North Hollywood, Calif. (Tel. PO 1-5197)
Purch. Agent: V. G. Whitson
V. P.-Sales: Rex O. Pirkle **PS, MS**

SKYVALVE, INC.
831 W. Fayette St., Syracuse 4, N. Y. (Tel. GR 8-3195) also West Coast Div.: 1022 Raymond Way, Anaheim, Calif. (Tel. LA 6-3341)
Purch. Agent: A. Vespa (Tel. GR 8-3195)
V. P.-Sales: Robert Schaller (Tel. GR 8-3195) **MS, CT**

SLAUGHTER CO., INC.
Piqua 18, O. (Tel. PRospect 3-5936)

SLIP RING CO. OF AMERICA
3612 W. Jefferson Blvd., Los Angeles 16, Calif. (Tel. Republic 5-0253)
Purch. Agent: Ray Anderson
Sales Mgr.: Chuck Gehrke **G**

SMALL MOTORS INC.
2076 Elston Ave., Chicago 14, Ill. (Tel. ARmitage 6-6900)
Pres.: R. R. Cook

C. M. SMILLIE & CO.
1162 Woodward Hgts. Blvd., Ferndale 20, Mich. (Tel. JOrdan 4-6060)
Purch. Agent: Lee Goddard
Sales Dir.: Charles M. Smillie

A. O. SMITH CORP.
P. O. Box 584, 3533 N. 27th St., Milwaukee, Wisc. (Tel. UPtown 3-3000)
Dir.-Purch.: A. J. Riedel
Purch. Dept.: J. E. Borchert, T. J. Pas & L. H. Lennart
Dir.-Defense Products: H. D. Barnes

A. O. SMITH CORP., SMITH-ERIE DIV.
1602 Wagner St., Erie, Pa. (Tel. TWinbrook 9-3134)
Purch. Agent: A. B. Modjeski
Buyer: J. E. Robinson
Dir.-Mktg.: H. D. Leisenring **MS**

E. C. SMITH MFG. CO., INC.
Forrest & Hector Sts., Conshohocken, Pa. (Tel. TAylor 8-4790)
Dir.-Purch.: Arthur R. Morrow **CT**

L. B. SMITH AIRCRAFT CORP.
P. O. Box 456, International Airport Br., Miami 48, Fla. (Tel. TUxedo 8-8481)
Mgr.-Materials: Lloyd G. Culbertson
Purch. Agent: George Ceglar
V. P.-Aerosmith Prod.: W. Peckham
V. P.-Aircraft Sales & Serv.: George R. Dutton

SMITH-GATES CORP., THE
P. O. Box 7, Farmington, Conn. (Tel. ORchard 7-2657)
Purch. Agent: Richard L. Cozens
V. P.-Sales: Howard C. Smith **M**

SMOOTH-ON MFG. CO.
572 Communipaw Ave., Jersey City 4, N. J. (Tel. HEnderson 3-0076)
Gen. Mgr.: H. M. Silver
Tech. Dir.: J. H. Tompkins
Dir.-Sales: G. T. Morse **M**

SNAP-ON-TOOLS CORP.
8154 28th Ave., Kenosha, Wisc. (Tel. OL 4-8681)
Dir.-Purch.: Frank A. Tetzlaff
Dir.-Sales: Rogers Palmer

***SNAP-TITE, INC.**
201 Titusville Rd., Union City, Pa. (Tel. 497)
Purch. Agent: Alfred Werle
V. P.-Sales: Leonard M. Clark **PS, MS, CT, TT**
*(See advertisement this issue)

SNOW-NABSTEDT GEAR CORP.
251 Welton St., Hamden, Conn. (Tel. STate 7-3505)
Purch. Agent: W. C. Huth
Works Mgr.: H. A. Reil
Appli. Eng.: P. E. Hills
Sales Mgr., Indsl.: W. L. Peterson **CT**

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2200 Pacific Hwy., San Diego 17, Calif. (Tel. BElmont 3-8241)
Purch. Agent: H. A. Lubke
V. P.-Sales: Lynn D. Richardson **S, PS, MS, CT, TT, RD**

SOLAR MFG. CORP.
4553 Seville Ave., Los Angeles 58, Calif. (Tel. LUdlow 3-1411)
Purch. Agent: A. E. Neuhauser
V. P.-Sales: E. Huling **M**

SOLID PROPULSION OPERATIONS, ROCKETDYNE DIV., NORTH AMERICAN AVIATION, INC.
Box 548, McGregor, Texas (Tel. GR 5-2811)
Mgr., Material: R. S. Mulligan
Purch. Agent: R. C. Terry
Supvr., Proc.: W. M. St. John **PS, RD**

SOLON FOUNDRY, INC.
7370 SOM Ctr. Rd., Solon, O. (Tel. CHurchill 8-5304)
Purch. Agent: H. A. Lucas
Dir.-Sales: George N. Wright

SOMERS BRASS CO. INC.
94 Baldwin Ave., Waterbury, Conn. (Tel. PLaza 6-8321)
Purch. Agent: William Jay
Sales Mgr.: Claude S. Speicher **M**

SONEX, INC.
185 W. Schoolhouse Lane, Philadelphia 44, Pa. (Tel. VIctor 3-3606)
Purch. Agent: David J. Barnes
Pres. & Dir.-Sales: Harold Weinberg **MS, CT**

SONOTONE CORP.
Elmsford, N. Y. (Tel. LYric 2-9600)
Dir.-Purch.: John J. Downs
Battery Sales: E. F. Murphy
Electronic Applications Sales: R. J. Mahler **PS, MS, G, CT, RD**

SORENSEN & CO., INC.
Richards Ave., S. Norwalk, Conn. (Tel. TE 8-6571)
Dir.-Purch.: Clifton Boylan
Dir.-Sales: P. J. Deery **MS, CT**

SOROBAN ENGRG., INC.
Box 1717, Melbourne, Fla. (Tel. PA 3-7221)
Purch. Agent: Arthur G. Smith
Pres.: C. F. West

SOUTH RIVER METAL PRODUCTS CO., INC.
377 Turnpike, S. River, N. J. (Tel. CLifford 4-5253)
Gen. Mgr.: J. Cohn
Sales Mgr.: Martin L. Roth **S, M, RD**

SOUTH WIND DIV., STEWART WARNER CORP.
1514 Drover St., Indianapolis, Ind. (Tel. MElrose 2-8411)
Dir.-Purch.: Paul Ostler
Purch. Agent: George Leiendecker
Buyer: Sam Salatich
Prod. Mgr.: L. E. Bass
Mgr.-Field Repres.: L. E. Bass **PS, MS, G, RD**

SOUTHCO DIV., SOUTH CHESTER CORP.
Lester, Pa. (Tel. LEhigh 4-1800)
Purch. Agent: C. R. Hirzel
Gen. Mgr.-Sales: T. R. Dunlevy **M**

SOUTHERN ELECTRONICS CORP.
150 W. Cypress Ave., Burbank, Calif. (Tel. VIctoria 9-3193)
Purch. Agent: R. A. Hirst
Sales Mgr.: George E. Gansell **PS, MS, G, RD, HSE**

SOUTHERN PLASTICS CO.
408 Pendleton St., Columbia, S. C. (Tel. ALpine 6-0651)
Pres.: J. W. Lindau III
V. P.: Leonard Bogen **M**

SOUTHWEST PRODUCTS CO.
1705 S. Mountain Ave., Monrovia, Calif. (Tel. ELliott 8-0181)
Pres. & Gen. Mgr.: K. V. Hackman **S, M**

SOUTHWEST RESEARCH INSTITUTE
8500 Culebra Rd., San Antonio, Texas (Tel. GEneral 2-5221)
Asst. to Pres., Indsl. Liaison: S. H. Simpson, Jr.
Treas., Contracts: A. C. Hulen **RD**

SOUTHWESTERN INDUSTRIAL ELECTRONICS CO.
10201 Westheimer St., P. O. Box 22187, Houston 27, Texas (Tel. HOmestead 5-3471)
Purch. Agent: T. C. Woodell
Buyer, Mil. Electronics: Jack Faloure
Buyer, Mech. & Misc.: C. Brock
Gen. Mgr., Mktg.: Robert O. Vaughan **MS, CT, TT, RD**

SOUTHWESTERN INDUSTRIES, INC.
5880 Centinela Ave., Los Angeles 45, Calif. (Tel. OREgon 8-8915)
Purch. Agent: Dean F. Dirkson
Pres.: F. P. Jenks **S, PS, MS, G**

SOUTHWESTERN VALVE CORP.
2215 Standard Ave., Santa Ana, Calif. (Tel. KI 5-5535)
Purch. Agent: Eugene M. Gerrard
Gen. Mgr.: Elmer L. Hart **PS, MS, CT**

SOUTHWIRE CO.
14 Fertilla St., Carrollton, Ga. (Tel. TErrace 2-6311)
Purch. Mgr.: James A. Hatley
Sales Mgr.: J. H. Griffin **M**

SPACE COMPONENTS, INC.
1048 Potomac St., N. W., Washington 7, D. C. (Tel. FE 3-7000)
Dir.-Purch.: Chauncey Brooks, Jr.
Pres.: Stanley F. Reed
Sales Admin.: Russell E. Travis, Jr. **MS, RD**

SPACE CORP.
P. O. Box 5175, Dallas 22, Texas (Tel. BR 6-5121)
Mgr.-Materiel: H. G. Rowe
Buyers: Ken Gracy, Al Cozby, Joe A. Carroll
V. P.-Contracts: Ellie Jones **S, MS, CT, RD**

SPACE TECHNOLOGY LABS., INC.
5500 W. El Segundo Blvd., P. O. Box 95001, Los Angeles 45, Calif. (Tel. OSborne 5-4677)
Mgr., Proc.: John E. Paterson
Mgr., Materiel: Fran M. Brown
Mgr., Subcontracts: Robert J. Kaufman
Purch. Agent: C. L. Scott **RD**

SPACEATOMICS DIV., THE BUDD CO.
2450 Hunting Park Ave., Philadelphia 32, Pa. (Tel. BAldwin 5-9100)
Dir.-Purch., The Budd Co.: W. A. Ehresman
Purch. Agent, Hunting Park Plant: W. G. Sutter
Sales Mgr., SpaceAtomics Div.: W. H. Knowles, Jr. **S, MS, RD**

SPACEFLIGHT FILMS
9 W. 19th St., New York 11, N. Y. (Tel. AL 5-1827)
Dir.-Purch.: Alex Haberstroh

SPARTA MFG. CO., DIV.-U. S. CERAMIC TILE CO.
P. O. Box 107, Dover, O. (Tel. DOver 4-2380)
Plant Mgr.: C. M. Starkey
Sales Engr.: Harry F. Burkholder
Asst. Sales Mgr.: Ray Stahl **M**

SPAULDING FIBRE CO., INC.
310 Wheeler St., Tonawanda, N. Y. (Tel. JAckson 2000)
Purch. Agent: W. E. Hutchins
V. P.-Mktg.: W. R. Gilsdorf **M**

SPECIAL PRODUCTS DEPT., MELPAR, INC.
3000 Arlington Blvd., Falls Church, Va. (Tel. JEfferson 4-6000)
Dir.-Purch.: C. K. Craggs
Purch. Agents: W. Bradbury & J. Rooney **MS, M, RD**

SPECIAL PROGRAMS SECTIONS, GENERAL ELECTRIC CO.
Radnor-Chester Rd., Radnor, Pa. (Tel. MU 8-8000)
Mgr.-Subcontracting: H. Dihackus
Mgr.-Sales: E. Bold **G, RD**

SPECIALTIES, INC.
Skunks Misery Rd., Syosset, N. Y. (Tel. WAlnut 1-2345)
Purch. Agent: George Chadwick
V. P.-Sales: John C. Slocum **RD**

SPECIALTIES MFG. CO., INC.
125 Bruce Ave., Stratford, Conn. (Tel. EDison 7-4429)
Purch. Agent: J. J. Zimmer
Sales Mgr.: A. I. Zimmer

SPECIALTY AUTOMATIC MACHINE CORP.
80 Cambridge St., Burlington, Mass. (Tel. BR 2-0800)
V. P.: N. K. Donaghy

SPECIALTY ELECTRONICS DEVELOPMENT CORP.
115 Eileen Way, Syosset, N. Y. (Tel. WAlnut 1-5200)
V. P.-Purch.: Joseph Ross
Purch. Agent, Machined Parts: Robert Reinstein
Purch. Agent, Electronics: David Alster
Sales Mgr.: William Prichet **MS, G, TT, RD**

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SPECIALTY PRODUCTS CORP.
29980 Lakeland Blvd., Wickliffe, O. (Tel. WHitney 3-3040)
Purch. Agent: Howard Seabeck
Dir.-Sales: J. J. Skelly

SPECIFIC PRODUCTS
P. O. Box 425, Woodland Hills, Calif. (Tel. Diamond 0-3131)
Purch. Agent: M. Bean
Pres. & Dir.-Sales: J. C. Van Groos — TT, RD

SPECTRA ELECTRONICS CORP.
250 E. Third St., Mount Vernon, N. Y. (Tel. MO 8-1378)
Purch. Agent: L. Geien
Mgr.-Applications Engrg.: Edward J. Warner — MS, CT, TT, RD

SPECTRACOAT, INC.
248 Harbor Blvd., Belmont, Calif. (Tel. LYtell 1-0358)
Business Mgr.: Jared Elliot
Prod. Mgr.: Albert A. Kusch, Jr.
Pres.: John R. Jennings

SPECTRALAB INSTRUMENTS
608 Fig Ave., Monrovia, Calif. (Tel. EL 9-3208)
Purch. Mgr.: K. McElroy
Partner: F. R. Goodman
Asst. Chief Engr.: T. D. Eccles — TT, RD

SPECTRA-STRIP WIRE & CABLE CORP.
P. O. Box 415, 10052 Larson Ave., Garden Grove, Calif. (Tel. JEfferson 7-4530)
Purch. Agent: Donald D. Lang
Sales Mgr.: John Ford — M

SPECTROL ELECTRONICS CORP.
1704 S. Del Mar Ave., San Gabriel, Calif. (Tel. ATlantic 7-9761)
Purch. Agent: H. J. Fedora
Sales Mgr.: Robert K. Burtner — G, RD

SPECTRONIC PLATING CO., INC., DIV-SPECTRANOME PLATING CO., INC.
330 W. 13th St., New York 14, N. Y. (Tel. ALgonquin 5-8677)
Purch. Agent: K. Philips
Sales Mgr.: E. J. Brennan

SPECTRUM INSTRUMENTS, INC.
Box 61 Steinway Sta., Long Island City 3, N. Y. (Tel. AStoria 8-8033)
Purch. Agent: J. F. McClean — M, RD

SPEER CARBON CO.
St. Marys, Pa. (Tel. TErminal 4-2801)
Dir.-Purch.: Jack Garlitz
Sales Mgr.: I. L. Harvey — M

SPELLMAN HIGH VOLTAGE CO.
3029 Webster Ave., New York 67, N. Y. (Tel. KIngsbridge 7-0306)
Owner: William Spellman — RD

SPENCER TURBINE CO.
New Park Ave., West Hartford 7, Conn. (Tel. ADams 3-6293)

SPENCER-KENNEDY LABS., INC.
1320 Soldiers Field Rd., Boston 35, Mass. (Tel. ALgonquin 4-5400)
Purch. Agent: Thomas Quinn
V. P.-Prod.: Albert Clark
Prod. Supt.: Frederick Marz
V. P.-Sales: W. K. Headley — CT, TT

SPERRY ELECTRONIC TUBE DIV.-SPERRY RAND CORP.
Gainesville, Fla. (Tel. FRanklin 2-0411)
Purch. Agent: T. T. Reilly
Buyers: Ray Lohr & Dennis Minor
Sales Mgr.: William J. McClenahan — G, CT, TT, RD

SPERRY GYROSCOPE CO., DIV.-SPERRY RAND CORP.
Great Neck, L. I., N. Y. (Tel. Fieldstone 7-3600)
Purch. Mgr.: W. F. Batten
Dir.-Engrg. & Sales: R. F. Garbarini — G, CT, TT, RD

SPERRY FARRAGUT CO., DIV.-SPERRY RAND CORP.
Bristol, Tenn. (Tel. WOodland 8-1151)
Purch. Agent: E. J. Flanagan
Buyer, Subcontracts: J. V. Wilson
Buyers: C. R. Keith, H. W. Peters, T. R. Rutledge & W. J. McCracken
Sales Mgr.: J. R. Bailey — G, RD

SPERRY GYROSCOPE CO., MARINE DIV., SPERRY RAND CORP.
7 Aerial Way, Syosset, L. I., N. Y. (Tel. WE 8-9300)
Sales Mgr.: C. W. Whall
Purch. Agent: L. F. Wichser, 3 Aerial Way, Syosset, L. I., N. Y. (Tel. WEIls 8-9300)

SPERRY MICROWAVE ELECTRONICS CO., DIV.-SPERRY RAND CORP.
P. O. Box 1828, Clearwater, Fla. (Tel. REdwood 6-4161)
Sales Mgr.: E. C. Best
Chief Buyer: C. E. Butler — CT

SPERRY PIEDMONT CO., DIV.-SPERRY RAND CORP.
Rt. 29, Charlottesville, Va. (Tel. 3-6111)
Chief Buyer: E. Hopkins
Chief Buyer-Comm. Prods.: T. McCartin
Sales Mgr.: L. W. Gibson — G, RD

SPERRY PRODUCTS CO., DIV.-HOWE SOUND CO.
2700 Shelter Rock Rd., Danbury, Conn. (Tel. Pioneer 8-3581)
Purch. Agent: C. W. Penque
Sales Mgr.: H. T. Lowell

SPERRY SEMICONDUCTOR DIV., SPERRY RAND CORP.
Wilson Ave., South Norwalk, Conn. (Tel. VOlunteer 6-1641)
Material Control Supvr.: D. S. Sinclair
Purch. Supvr.: Ronald Stevenson
Mktg. Mgr.: Arthur M. Vamum

SPHERE CO. INC., THE
25 Amity St., Little Falls, N. J. (Tel. CLifford 6-2550)
Pres.: C. E. Beronio
Sales Mgr.: A. D. Travis — M

SPINCRAFT, INC.
4158-C W. State St., Milwaukee 8, Wisc. (Tel. DIvision 2-0730)
Purch. Agent: Anthony Brinovec
V. P.-Sales: George F. Farley — S

SPIROID DIV.-ILLINOIS TOOL WORKS
2501 N. Keeler Ave., Chicago, Ill. (Tel. CA 7-2200)
Purch. Agent: Arthur Froehlich
Div. Mgr.: F. Bohle

SPLIT BALLBEARING, DIV.-MPB
Lebanon, N. H. (Tel. 800)
Purch. Agent: R. E. Tinkham
Sales Mgr.: A. J. Renz — M

SPRAGUE ELECTRIC CO.
North Adams, Mass. (Tel. MOhawk 3-5311)
Dir.-Purch.: Francis Jenkins
V. P.-Sales: Neal W. Welch — M, RD

SPRAYING SYSTEMS CO.
3201 W. Randolph St., Bellwood, Ill. (Tel. LInden 4-0380)
Purch. Agent: W. C. Bloomer
Sales Mgr.: Joseph Pelej — M

SPRAYLAT CORP.
1 Park Ave., New York 16, N. Y. (Tel. MU 3-1289)
V. P.: R. D. Oppenheim — M

SPRINGFIELD BRASS CO., INC.
821-827 W. Main St., P. O. Box 952, Springfield, Ohio (Tel. FA 2-2291)
Pres.: R. R. Kelley
V. P.: G. W. Kelley
Dir.-Purch. & Sales: G. R. Jones — M

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SPRUCE PINE MICA CO.
P. O. Box 456, Spruce Pine, N. C. (Tel. POplar 5-4241)
Pres.: E. H. Farnam
Bd. Chm.: S. A. Montague — M

SQUIERS GAGE CO.
3784 W. 11 Mile Road, Berkley, Mich. (Tel. JO 4-5980)
Purch. Agent: C. F. McDonald
Pres.: R. D. Squiers — CT

STACKBIN CORP.
1079 Main St., Pawtucket, R. I. (Tel. PA 2-1600)
Purch. Agent: W. E. Hughes
Pres.: Thomas E. Shaw

STACKPOLE CARBON CO.
1942 Stackpole St., St. Marys, Pa. (Tel. TE 4-1521)
Purch. Agent: O. R. Hagan
Sales Mgr., Electronics Div.: A. K. Neff
Sales Mgr., Carbon Div.: W. E. Clancy — M

J. S. STAEDTLER, INC.
25 DiCarolis Ct., Hackensack, N. J. (Tel. HUbbard 9-9200)
V. P. & Dir.-Purch.: R. J. Urmston, Jr.
Sales Mgr.: D. C. Urmston — M

STAHLIN BROS. INC.
500 Maple St., Belding, Mich. (Tel. 1500)
Exec. V. P.: Lyle Jackson
V. P. & Sales Mgr.: Paul H. Dillow — M

STAINLESS INC.
North Wales, Pa. (Tel. OXbow 9-4871)
Purch. Agent: R. F. Farrington
Engrg. Sales Mgr.: John F. Guzewicz — S, MS, TT

STALKER CORP., THE
903 Woodside Ave., Essexville, Mich. (Tel. TWinbrook 3-7562)
Controller: F. K. Olson
Sales Mgr.: W. W. Dempsey — S, PS, RD

STAMPING DIV.-ROCKWELL STANDARD CORP.
Oswego St., Utica 1, N. Y. (Tel. SWift 7-1600)
Purch. Agent: M. Loramie
Div. Gen. Mgr.: F. J. Griffiths
Chief Engr.: G. Fauth
Sales Mgr.: J. A. Leake — S, MS, M

STANDARD ARMAMENT INC.
631 Allen Ave., Glendale, Calif. (Tel. VIctoria 9-1314)
Purch. Agent: Ronald F. Parish
Pres.: Curtis V. Correll — RD

STANDARD CABINET CO., INC.
61 Washington Ave., Carlstadt, N. J. (Tel. GEneva 8-1500)
Asst. Purch. Agent: L. H. Gasperoni
Pres.: E. S. Brown
Sales Mgr.: R. O. Norton — PS, CT

STANDARD CONDENSER CORP.
3749 N. Clark St., Chicago 13, Ill. (Tel. EAstgate 7-5440)
Pres. & Dir.-Purch.: M. P. McLean
Quality Control Supt.: Richard Peters
Prod. Supt.: Joseph Genovese
Sales Mgr.: Richard T. McLean — M

STANDARD CONTROLS, INC.
1130 Poplar Pl., Seattle 44, Wash. (Tel. EAst 4-8888)
Pres.: W. A. Paine, II
Buyer: R. Helmick
Sales Mgr.: W. E. Forland — MS, CT

STANDARD ELECTRIC CO., INC.
P. O. Box 6356, 3016 Austin Hwy., San Antonio 9, Tex. (Tel. TA 2-3341)
Pres.: Leo Dubinski

STANDARD ELECTRIC TIME CO., THE
89 Logan St., Springfield, Mass. (Tel. REpublic 2-1142)
V. P.-Purch.: L. P. Marshall
Dir.-Sales: R. M. Warren

STANDARD ELECTROMAGNETICS DIV.-CORNELL DUBILIER ELECTRIC CORP.
Walkersville, Md. (Tel. VInewood 5-2921)
Asst. Purch. Agent: E. Scott
Div. Engr.: R. P. Bennett — M

STANDARD ELECTRONICS DIV., REEVES INSTRUMENT CORP.
Farmingdale, N. J. (Tel. WEbster 8-6671)
Purch. Agent: Felix
V. P.: W. H. Zillger
C. E.: A. R. Taylor — S, MS, G

STANDARD FELT CO.
29-115 S. Palm Ave., Alhambra, Calif. (Tel. ATlantic 2-5106)
Purch. Agent: K. Brunk — M

STANDARD MOLDING CORP.
1517 E. Third St., Dayton 9, Ohio (Tel. BA 2-8307)
Pres. & Dir.-Purch.: W. F. Oelman
Sales Mgr.: R. E. Myers

STANDARD OIL CO. OF INDIANA
910 S. Michigan Ave., Chicago 80, Ill. (Tel. HArrison 7-9200)
Res. Coordinator: Dr. N. Fragen
Asst. to Gen. Mgr., R&D: J. D. Nassley

STANDARD PRESSED STEEL CO.
Box 1105, Jenkintown, Pa. (Tel. TUmer 4-7300)
Dir.-Purch.: J. P. Moorhouse
Asst. Dir.-Purch.: R. C. Gibbs
Sales Mgr., Aircraft/Missile Div.: J. P. Villa — M

STANDARD RECTIFIER CORP.
620 E. Dyer Rd., Santa Ana, Calif. (Tel. KImberly 5-8241)

Purch. Agent: E. C. Fries
V. P.-Sales: J. R. Conto

STANDARD SAFETY EQUIPMENT CO.
431 N. Quentin Rd., Palatine, Ill. (Tel. FLanders 9-1400)
Purch. Agent: A. R. Bray
V. P.-Sales: George G. Dickson

STANDARD STEEL CORP.
Los Angeles 58, Calif.; Lowell, Mass.; Decatur, Ill.
Dir.-Purch.: Frank B. Mulford, Los Angeles
Purch. Agent: Joseph MacArdle
Purch. Agent: W. H. Reinholt (Tel. Decatur 8-2103)
Dir.-Sales: Kenneth Thies, Los Angeles
Dir.-Sales: C. N. Rees, Lowell **PS, MS**

STANDARD STEEL CORP., CAMBRIDGE DIV.
Industrial Park, Lowell, Mass. (Tel. GI 4-7881)
Purch. Agent: Joseph MacArdle
Sales Mgr.: William F. Dolke **PS, MS**

STANDARD STEEL WORKS, DIV.-BALDWIN-LIMA-HAMILTON CORP.
Burnham, Pa. (Tel. LEwistown 8-7871)
Purch. Agent: J. M. Olnick
Gen. Sales Mgr.: F. E. Greger **M**

STANDARD STEEL WORKS, INC.
16th & Howell St., N. Kansas City, Mo. (Tel. GRand 1-3200)
Purch. Agent: Paul Rankin
Asst. Purch. Agent: Edward Crenshaw
Buyer: Elmer Rosenbaugh
Dir.-Sales: H. H. White **MS**

STANDARD WINDING CO., INC.
44-62 Johnes St., Newburgh, N. Y. (Tel. JO 1-1541)
Purch. Agent: K. Van Wagner
Sales Mgr.: Roger S. Lynch **CT, TT**

STANDARD-THOMSON CORP., CLIFFORD MFG. CO. DIV.
152 Grove St., Waltham 54, Mass. (Tel. TWinbrook 4-7310)
Dir.-Purch.: Elmer F. Wilcox
Sales Mgr., Aircraft Div.: Gunnar G. Karlson **PS, MS**

STANDARD-TOCH CHEMICALS, INC.
2600 Richmond Terrace, Staten Island 3, N. Y. (Tel. GIbraltar 2-5300)
Pres.: Carl Bauer
Asst. Sales Mgr.: H. G. Bricka **M**

WILLIAM W. STANLEY CO. INC.
410 Hillside Ave., Hillside, N. J. (Tel. MUrdock 7-2211)
V. P.-Purch.: A. R. Peer
Treas.: S. H. Doggett, Jr.

STANLEY-JUDD DIV.-THE STANLEY WORKS
42 S. Cherry St., Wallingford, Conn. (Tel. COlony 9-3353)
Purch. Agent: Frank Karolshak
Comm. Sales Mgr.: Bradford M. Scott
Asst. Sales Mgr.: Warren H. Tarrant
Gen. Mgr.: H. Henry Martens

STANPAT CO.
150-42 12th Rd., Whitestone 57, N. Y. (Tel. FL 9-1693)
Purch. Agent: E. Nolan (Tel. FL 9-1611)

STANWYCK WINDING CO., INC.
137-151 Walsh Ave., Newburgh, N. Y. (Tel. NEwburgh 3360)
V. P.-Purch.: Nicholas Stanwyck
Pres.: Wm. J. Stanwyck **G, CT, TT**

STAR EXPANSION INDUSTRIES CORP.
Mountainville, N. Y. (Tel. KEllogg 4-2511)
Purch. Agent: Robert Schneider
Buyers: Donald Crocker & Jules Yanez
Gen. Sales Mgr.: Gordon M. Browne **M**

STAR PORCELAIN CO., THE
21 Muirhead Ave., Trenton, N. J. (Tel. EXport 2-3154)
V. P. & Dir.-Purch.: William C. Brenner
V. P. & Sales Mgr.: C. A. Lawton **M**

STAR STAINLESS SCREW CO.
655 Union Blvd., Totowa Boro, Paterson, N. J. (Tel. CLifford 6-2300)
Purch. Dir.: A. Jansen
Buyer: J. Passo
Mgr., Jobber & Sales: T. M. Callahan **S, M**

STARK TOOL CO.
Box 288, Ann Arbor, Mich. (Tel. HUnter 3-4233)
Purch. Agent: James V. Wood
Sales Mgr.: Harold Stark

L. S. STARRETT CO., THE
1-165 Crescent St., Athol, Mass. (Tel. CHurchill 9-3551)
Purch. Agent: C. B. McMillan
V. P.-Sales: C. O. Newton

STATE LABS., INC.
215 Park Avenue S., New York 3, N. Y. (Tel. ORegon 7-8400)
Dir.-Purch.: Mildred Schwartzberg
Purch. Agent: George Schindler
Asst. Purch. Agent: Philip Diamond
Natl. Sales Mgr.: Larry Farrar **M**

STATE TESTING LABORATORY INC.
226 Knowlton St., Bridgeport 8, Conn. (Tel. ED 4-4079)
Purch. Agent: E. B. Pickman
Dir.-Sales: M. J. Gellis **CT, RD**

STATES CO., THE
19 New Park Ave., Hartford 6, Conn. (Tel. ADams 3-6232)
Purch. Agent: William Steidel
Sales Mgr.: Howard N. Porter

STATHAM DEVELOPMENT CORP.
1845 Pontius Ave., Los Angeles 25, Calif. (Tel. BR 2-7528)
Asst. Gen. Mgr.: Glenn Sanders (Tel. BR 2-6861)
Purch. Agent: Jack Ogsborn (Tel. BR 2-6861)
Chief Engr.: Walter Drake
Sales Mgr.: Tom Donohue **G, CT, RD**

STATHAM INSTRUMENTS, INC.
12401 W. Olympic Blvd., Los Angeles 64, Calif. (Tel. BR 2-0371)
Purch. Agent: T. Beddoe
Dir.-Mktg.: A. R. Hunter **MS, G, CT**

STATIKIL, INC.
1220 W. 6th St., Cleveland 13, O. (Tel. CHerry 1-3939)
V. P.-Purch.: Donald J. Doyle **M**

STATOR ELECTRIC CORP.
22-14 40th Ave., Long Island City 1, N. Y. (Tel. EMpire 1-2880)
Chief Engr.: P. K. Studner **MS, G, RD**

STAUFFER CHEMICAL CO.
380 Madison Ave., New York 17, N. Y. (Tel. OXford 7-0600)
Dir.-Purch.: K. H. Allen
V. P.-Mktg.: S. S. Emison **M, RD**

STEARNS-ROGER MFG. CO., THE
P. O. Box 5888, 600 Bannock St., Denver 17, Colo. (Tel. AComa 2-8484)
Chief Purch. Engr.: R. W. Graeber
Asst. Chief Purch. Engr.: J. G. Constantine
Special Proj. Div. Mgr.: R. W. Akerlow **S, MS, M, RD**

HERMAN D. STEEL CO.
Lafayette Bldg., Philadelphia 6, Pa. (Tel. WA 5-2867)
Head-Purch. Dept.: P. N. Steel, Jr.
Head-Sales: W. W. Woolford

STEEL CITY TESTING MACHINES, INC.
8817 Lyndon Ave., Detroit 38, Mich. (Tel. WEbster 3-3500)
Purch. Agent: Jos. O'Brien
Pres.: Louis A. Welt **CT**

STEEL IMPROVEMENT & FORGE CO., THE
970 E. 64th St., Cleveland 3, Ohio (Tel. UTah 1-8600)
Purch. Agent: Ford Parkes
Steel Buyer: George Mahon
V. P.-Sales: H. A. Zimmerman **S, M**

STEEL PRODUCTS ENGRG. CO., DIV.-KELSEY-HAYES CO.
1205 W. Columbia St., Springfield, Ohio (Tel. FA 5-1541)
Purch. Agent: J. K. Brannan
Asst. Purch. Agent: W. W. Parsons
Sales Mgr.: J. S. Wilkerson **PS, G, TT, RD**

STEIN SEAL CO.
20th St. & Indiana Ave., Philadelphia 32, Pa. (Tel. BAldwin 3-3513)
Asst. Gen. Mgr.-Purch.: Lawrence Goldschmidt
Gen. Mgr.-Sales: P. C. Stein **PS**

STEINER-IVES CO.
Springfield Rd., Union, N. J. (Tel. MUrdock 8-7474)
Purch. Agent: E. P. Quick
Pres.: L. T. Ives
Dir.-Sales: R. W. Richards **S**

STELLARDYNE LABS., INC.
1525 Cuyamaca Rd., Gillespie Field, El Cajon, Calif. (Tel. HIckory 2-1693)
V. P. & Gen. Mgr.: Earnest M. Emory
Customer Relations Mgr.: James D. Finley **CT**

STENCEL AERO ENGRG. CORP.
Black Mountain Airport, U. S. Hwy. 70, P. O. Box 8228, Asheville, N. C. (Tel. NOrth 9-7826)
V. P. & Dir.-Purch.: T. M. Britton, Jr.
Pres. & Dir.-Sales: F. B. Stencel **RD**

STEPHENS TRUSONIC INC.
8538 Warner Drive, Culver City, Calif. (Tel. UP 0-6671)
Gen. Mgr.: E. J. Petre
Chief Engr.: P. Letl
Prod. Mgr.: J. Kalfsbeck
Sales Mgr.: R. Rose **MS, CT, RD**

STERLING GLASS CORP.
304 E. 116th St., Chicago, Ill. (Tel. PU 5-7462)
V. P.-Purch.: Blase Lazzara
Pres.: R. L. Cunningham **M, RD**

STERLING TRANSFORMER CORP.
510 Driggs Ave., Brooklyn 11, N. Y. (Tel. STagg 2-4200)
Purch. Agent: Coleman Sanders
Sales Mgr.: Eugene Martoccia **M**

STERLING-HOWARD CORP.
561 E. Tremont Ave., New York 57, N. Y. (Tel. CYpress 9-6400)
V. P.-Purch.: Irving M. Carr
Sales Mgr.: Harry Astor

A. T. STEVENS CO.
118 E. 28th St., New York 16, N. Y. (Tel. MUrray Hill 5-1877)
Purch. Agent: R. Duke Powell, Jr.

STEVENS CO. INC.
E. Aurora St., Waterbury, Conn. (Tel. PL 4-8886)
Pres.: Carlton R. Stevens
V. P.: Ralph C. Stevens
Supt.: Santo J. Borelli **M, RD**

GEO. STEVENS MFG. CO., INC.
6022 N. Rogers Ave., Chicago 46, Ill. (Tel. JUniper 8-1300)
Purch. Agent: Miss Irma Grosko
V. P. & Dir.-Sales: Jack Stevens **RD**

STEVENS MFG., CO., INC.
P. O. Box 1007 Annex, Mansfield, O. (Tel. TUxedo 4-1311)
Dir.-Purch.: L. C. Frasher
V. P.-Sales: G. H. Rouse

STEVENS PRODUCTS, INC.
86 Main St., E. Orange, N. J. (Tel. OR 2-2140)
V. P.: Ross S. Stevens
Sales Mgr.: John Thomson **M**

F. M. STEVENSON CO., INC.
1728 E. Mullikin St., Baltimore 31, Md. (Tel. EAstern 7-6500)
Treas. & Dir.-Purch.: James R. Hughes
V. P. & Dir.-Sales: George J. Huebschman, Jr. **MS, M, G, CT, TT, RD**

STEVENSON BRO. & CO.
110 Race St., Philadelphia 6, Pa. (Tel. MArket 7-0760)
Owner: J. H. Stevenson, Jr.
Sales Mgr.: Frank M. R. Fenimore **M**

M. C. STEWART
Ashburnham, Mass. (TA 7-5840)
Pres.: M. C. Stewart **G, RD**

STEWART ENGRG. CO.
467 Bean Creek Rd., Santa Cruz, Calif. (Tel. GArden 6-4100)
Purch. Agent: Oran T. Connolly
Dir.-Sales: I. Osgood, Jr.

STEWART & STEVENSON SERVICES, INC.
4516 Harrisburg St., Houston 11, Texas (Tel. CApitol 5-5341)
Purch. Agent: H. Barker
Asst. Purch. Agent: Dan Connolly
V. P.-Sales: Joe Manning **MS**

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

STEWART-WARNER CORP.
1826 Diversey Pkwy., Chicago, Ill. (Tel. LAkeview 5-6000)
Dir.-Purch., Stewart-Warner Corp., 1826 Pkwy., Chicago 14, Ill.: E. N. Osterberg
Dir.-Purch., Stewart-Warner Electronics, 1300 N. Kostner Ave., Chicago, Ill.: I. Blackberg (Tel. AL 2-1000)
Purch. Agent, Stewart-Die Casting Co., 4535 Fullerton Ave., Chicago, Ill.: E. L. Umfried (Tel. AL 2-5308)
Purch. Agent, Stewart-Warner Corp., 1514 Drover, Indianapolis, Ind.: P. Ostler
Purch. Agent, The Bassick Co., Bridgeport, Conn.: G. Raiselis

STEWART-WARNER CORP., ALEMITE DIV.
1826 W. Diversey Pkwy., Chicago 14, Ill. (Tel. LAkeview 5-6000)
Dir.-Purch.: E. N. Osterberg
Purch. Agent: R. J. Gorzynski
Gen. Mgr. & Dir.-Sales: E. N. Robinson

STEWART-WARNER ELECTRONICS DIV.
1300 N. Kostner Ave., Chicago 51, Ill. (ALbany 2-1000)
Purch. Agent: Iver Blackberg
Gen. Mgr. & Dir.-Sales: Donald A. Potter
M, G, CT, TT, RD

STILLMAN RUBBER CO.
P. O. Box 1097, Culver City, Calif. (Tel. UP 0-5535)
M

HERMAN H. STICHT CO., INC.
27 Park Place, New York 7, N. Y. (Tel. REctor 2-8163)
Chief Engr.: R. Sticht
Dir.-Sales: A. H. Volker

STODDART AIRCRAFT RADIO CO., INC.
6644 Santa Monica Blvd., Hollywood 38, Calif. (Tel. HOllywood 4-9292)
Purch. Agent: Glenn Fogg
Sales Mgr.: John R. Stevenson **RD**

F. J. STOKES CORP.
5500 Tabor Rd., Philadelphia, Pa. (Tel. CUmberland 9-0100)
Mgr.-Materials & Prod. Planning Dept.: W. T. Minnick
Buyers: D. Law, C. Roney, W. Schmucker & F. Urban
V. P.-Sales: A. A. Hutchings **S, M, CT**

A. U. STONE & CO., INC.
17 W. 60th St., New York, N. Y. (Tel. COlumbus 5-1350)
Purch. Agent: H. Grant
Pres.: Allan Stone **S, PS, MS, G, RD**

STONE CITY PRODUCTS CO.
1206 7th St., P. O. Box 351, Bedford, Ind. (Tel. BRowning 5-3373)
Owner: D. H. Rariden

STONE PAPER TUBE CO., DIV.-STONE STRAW CORP.
900 Franklin St., N. E., Washington 17, D. C. (Tel. NOrth 7-3100)
Purch. Agent: E. Sibley
Gen. Mgr.: J. J. Nelligan
Sales Mgr.: T. W. Steel **G**

STONHARD CO., INC.
401 N. Broad St., Philadelphia 8, Pa. (Tel. WAlnut 2-7400)
Purch. Agent: J. W. Laufer
Dir.-Sales: LLP. Hoag **S**

STOW MFG. CO.
464 Shear St., Binghamton, N. Y. (Tel. RA 3-6411)
Purch. Agent: F. O'Neil
V. P.-Sales: J. L. Dickinson **M**

STRAND ENGRG. CO.
1354 N. Main St., Ann Arbor, Mich. (Tel. NOrmandy 2-3127)
Controller: K. L. Leighton
V. P.-Engrg.: R. E. Miller **G, CT, TT, RD**

STRATFIELD CO., THE
434 Grand St., Bridgeport 4, Conn. (Tel. ED 5-7708)
Pres. & Dir.-Purch.: J. V. Logie
Sales Mgr.: T. T. Logie

***STRATOFLEX, INC.**
220 Roberts Cut-Off, Fort Worth 14, Texas (Tel. PErshing 8-6543)
Purch. Agent: J. W. Clayton
Buyers: E. E. Bradley & V. W. Seybold
Pres.: C. A. Thomas **MS**
*(See advertisement this issue)

STRATOS, DIV.-FAIRCHILD ENGINE & AIRPLANE CORP.
Orinoco Dr., Bay Shore, L. I., N. Y. (Tel. MOhawk 5-0100)
Purch. Agent: John A. L'Hommedieu
Gen. Sales Mgr.-Aviation Prods.: W. Thomas Stark
Western Branch: 1800 Rosecrans Ave., Manhattan Beach, Calif. (Tel. OSborne 5-9111)
Purch. Agent: F. S. Lakin

STRAT-O-SEAL MFG. CO.
3039 W. Fullerton, Chicago 47, Ill. (Tel. HUmboldt 9-1282)
Plant Mgr.: Howard O. Walsh
Sales Mgr.: E. D. Murphy **RD**

STROMBERG-CARLSON DIV.-GENERAL DYNAMICS CORP.
100 Carlson Rd., Rochester 3, N. Y. (Tel. HUbbard 2-2200)
Gen. Purch. Agent: John W. Averill
Purch. Agent, Electronics Div.: Miles G. Agon (Tel. FIllmore 2-8000)
Purch. Agent, Telecommunication Div.: Robert C. Stevens **G, CT, TT, RD**

STROMBERG-CARLSON, SAN DIEGO, GENERAL DYNAMICS CORP.
1895 Hancock St., San Diego 12, Calif. (Tel. CY 8-8331)
Purch. Agent: Robert R. Pierce
Sales Mgr.: George C. McGinley **TT, RD, HSE**

STRONG SCOTT MFG. CO., THE
451 Taft St., N. E., Minneapolis 13, Minn. (Tel. STerling 1-7461)
Purch. Agent: B. H. Hollen
Mgr., Contract Div.: M. G. Mutch

STRUCTURAL FIBERS, INC.
Fifth Ave., Chardon, Ohio (Tel. AVenue 6-4118)
Purch. Agent: H. C. Tolhurst
Gen. Mgr.-Special Prod. Div.: C. W. Thomas
S, M, RD

STRUTHERS-DUNN, INC.
Lamb's Rd., Pitman, N. J. (Tel. LUther 9-7500)
Purch. Agent: G. M. Herb
V. P.-Sales: G. B. Conger, Jr.

STRUTHERS WELLS CORP.
Franklin St., Titusville, Pa.
Purch. Agent: R. C. Steber
Mgr.-Welded Products Dept.: J. V. Sheridan **MS**

W. WHITNEY STUECK, INC.
Box 355 MR, Old Saybrook, Conn. (Tel. EV 8-9309)
Pres.: W. Whitney Stueck

P. A. STURTEVANT CO.
Addison, Ill. (Tel. ELmhurst, Ill.-TErrace 4-2000)
Purch. Agent: Joe Esposito
Sales Mgr.: Lee A. Sturtevant

H. W. SULLIVAN, LTD.
80 Shore Rd., Port Washington, N. Y. (Tel. PO 7-7700)
Dir.-Sales: Sy Bosworth

M. H. SULLIVAN FOUNDRY
28 N. Washington St., Plainville, Conn. (Tel. SHerwood 7-0277)
Owner: M. H. Sullivan **M**

SUMMERS GYROSCOPE CO.
2500 Broadway St., Santa Monica, Calif. (Tel. EXbrook 3-6711)
Mgr., Material: W. H. Hassler
Asst. Purch. Agents: T. L. Hald & W. W. Flee
Mgr., Mil. Relations: T. N. Kasabali **G, RD**

SUN DIAL CORP.
P. O. Box 326, Passaic Ave., Caldwell, N. J. (Tel. CApital 6-4334)
Office Mgr.: George J. Martin
Sales Mgr.: Cornelius Lokker **MS, G, CT, TT, RD**

SUN ELECTRIC CORP., AERONAUTICAL DIV.
Harlem & Avondales Aves., Chicago 31, Ill. (Tel. NEwcastle 1-6000)
Dir.-Purch.: R. E. Kane
V. P.-Dir., Aeronautical Div.: F. E. Draper
Sales Mgr.: G. W. Holly **MS, CT, TT, RD**

SUNAIR ELECTRONICS, INC.
Broward International Airport, Fort Lauderdale, Fla. (Tel. JAckson 5-1505)
Purch. Agent: John P. Archard
Asst. Purch. Agent: Norman E. Breeden
V. P. & Gen. Mgr.: E. J. Nilsson **M**

SUNDSTAND AVIATION DIV.
2421 11th St., Rockford, Ill. (Tel. WO 8-6811)
Mgr.-Purch. & Prod.: Quentin Bowen
Purch. Agent: Don Bredahl
Mgr.-Mktg. & Contracts: C. E. Capron **RD**

SUNDSTRAND-DENVER
2480 W. 70th Ave., Denver 21, Colo. (Tel. HArrison 9-1561)
Purch. Agent: Bert Swarthout
Mgr.-Mktg. & Contracts: John Thayer **RD**

SUNDSTRAND TURBO
2480 W. 70th St., Denver 21, Colo. (Tel. HA 9-1561); 10445 Glenoaks Blvd., Pacoima, Calif. (Tel. EM 6-8121)
Purch. Agent, Denver: E. W. Johnson
Buyer, Denver: Lou Harder
Mgr., Mktg., Denver: John Thayer
Purch. Agent, Pacoima: Robert Meyerson
Mgr., Sales, Pacoima: Robert Boyer **PS, MS, RD**

SUNSHINE SCIENTIFIC INSTRUMENT
1810 Grant Ave., Philadelphia 15, Pa. (Tel. ORchard 3-5600)
Purch. Agent: J. Chesler
Sales Mgr.: A. L. Stiles **RD**

SUPA INSULATIONS INC.
123 E. Bassett St., Rocky Mount, N. C. (Tel. GI 6-8155)
Plant Mgr.: J. Ettell **M**

SUPEREX ELECTRONICS CORP.
4 Radford Pl., Yonkers, N. Y. (Tel. YOnkers 5-6906)
Purch. Agent: D. Schulman
Sales Mgr.: Marvin L. Buchalter **MS, G, CT, TT**

SUPERIOR AIR PRODUCTS CO.
132 Malvern St., Newark 5, N. J. (Tel. MArket 3-5715)
Chief Engr.: L. E. Putman
Purch. Agent: Arthur L. Szalowski **MS, RD**

SUPERIOR CABLE CORP.
Box 480-A, Hickory, N. C. (Tel. DIamond 5-4161)
Purch. Agents: Manley Fuller & Brock Johnson
V. P.-Sales: J. H. Bowman

SUPERIOR CARBON PRODUCTS, INC.
9115 George Ave., Cleveland 5, O. (Tel. VUlcan 3-4880)
Purch. Agent: Raymond H. Kling
Sales Mgr.: Ted Liebert **MS, TT**

SUPERIOR ELECTRIC CO., THE
83 Laurel St., Bristol, Conn. (Tel. LUdlow 2-9561)
Purch. Agent: W. D. Crosby
Sales Mgr.: J. Louden **MS**

SUPERIOR FLUX & MFG. CO., THE
1536 ST. Clair Ave., Cleveland 14, O. (Tel. SUperior 1-9373)
Pres.: Robert R. Mendelson
V. P.-Purch.: R. E. Handler **M**

SUPERIOR GRAPHITE CO.
33 S. Clark St., Chicago 3, Ill. (Tel. RAndolph 6-7939)
V. P.: M. B. Joyce **M**

SUPERIOR INDUSTRIAL MACHINE CO.
521-23 E. Murdock St., Wichita 14, Kans. (Tel. AM 5-4825)
Owner: Floyd Schuette
Shop Foreman: John Kraft **S**

SUPERIOR PNEUMATIC & MFG., INC.
13800 Enterprise Ave., Cleveland 35, Ohio (Tel. 2-2533)
V. P. & Gen. Mgr.: W. I. Krewson
Sales Mgr.: K. Lang

SUPERIOR SPINNING & STAMPING CO.
4057-63 Fitch Rd., Toledo 13, O. (Tel. GReenwood 2-2175)
Secy.: L. G. Avery
Pres.: W. H. Schomburg **M**

SUPERIOR STEATITE & CERAMIC CORP.
83-91 W. Forest Ave., Englewood, N. J. (Tel. LOwell 8-4555)
Purch. Agent: A. Kent
Sales Mgr.: T. H. Church **M**

SUPERIOR STEEL DIV., COPPERWELD STEEL CO.
Carnegie, Pa. (Tel. WA 1-4130)
Purch. Agent: John C. Zuk
Asst. Purch. Agent: James L. Fickinger
Buyer: Richard Schroeder
Gen. Mgr.-Sales: William M. Cowles

SUPERIOR TUBE CO.
Box 191, Norristown, Pa. (Tel. BRoadway 5-2070)
Dir.-Purch.: Elmer W. Hayes
Purch. Agent: Leroy Buckwalter
Buyer: Ralph Esser
Gen. Mgr.-Sales: Henry B. Brown, Jr. **M**

SUPREME INDUSTRIAL PRODUCTS CO.
367 N. Karlov Ave., Chicago 24, Ill. (Tel. NEvada 8-0633)
V. P.: F. D. Conger

SURFACE COMBUSTION DIV., MIDLAND-ROSS CORP.
2375 Dorr St., Toledo 1, Ohio (Tel. JEfferson 6-4611)
Purch. Agent: C. E. Rosene
Sales Mgr., Standard Equip.: A. H. Koch
Sales Mgr., Heat Treat Div.: G. J. Langenderfer
S, RD

SURPRENANT MFG. CO.
172 Sterling St., Clinton, Mass. (Tel. EMpire 5-6331)
V. P. & Gen. Mgr.: George E. Forsberg
Gen. Sales Mgr.: Richard Surprenant
Sales Mgr.: Paul V. Tessier **MS, M, G, CT, TT**

SWANE, ROBINSON & CO.
200 Main St., Richmond, Ind. (Tel. 2-4971)
Purch. Agent: Jo Sickmann
V. P.-Sales: C. K. Robinson, Jr. **S, MS, M**

SWEDLOW INC.
6986 Bandini Blvd., Los Angeles, Calif.; 394 N. Meridan Rd., Youngstown, Ohio (Tel. RAmond 3-3211)
Dir.-Purch.: R. H. Affeld
Buyer: J. Ruth
Dir.-Contracts: W. H. Face **S, M**

B. K. SWEENEY MFG. CO.
6300 E. 44th Ave., Denver 16, Colo. (Tel. FLorida 5-2355)
Purch. Agent: E. Salwasser
Pres.: John F. Sweeney
V. P.-Sales: A. C. Linburg **CT, RD**

SWEETLAND ENGRG. CP.
940 N. Fair Oaks Ave., Pasadena, Calif. (Tel. MUrray 1-8157)
Purch. Agent: I. Beeman
Sales Mgr.: Jack Oakley

SWIFT TEXTILE METALIZING & LAMINATING CORP.
10 Love Lane, Hartford 1, Conn. (Tel. JAckson 2-1181)
Purch. Agent: Anthony Boni
Pres.: M. A. Swift **M**

SWISS JEWEL CO.
Lafayette Bldg., Philadelphia 6, Pa. (Tel. WA 5-2867)
Purch.: P. N. Steel, Jr.
Sales Mgr.: W. W. Woolford

SWITCHCRAFT, INC.
5555 N. Elston Ave., Chicago, Ill. (Tel. SPring 4-1515)
Purch.: Bjorn Hestad
Sales: W. L. Larson **S, MS, G, CT, TT, RD**

SWITLIK PARACHUTE CO., INC.
1325 E. State St., Trenton, N. J. (Tel. JUniper 7-3300)
Purch. Agent: Edward Scott
Sales Mgr.: John Borden **MS**

SWIFZER BROTHERS, INC.
4732 St. Clair Ave., Cleveland 3, Ohio (Tel. EXpress 1-7070)
V. P.-Purch.: Carl E. Henke
Purch. Agent: John B. Rosier
V. P.-Sales: Gordon D. Russell

SYLVANIA ELECTRIC PRODUCTS INC., CHEMICAL & METALLURGICAL DIV.
P. O. Box 70, Towanda, Pa. (Tel. ANdrews 5-2121)
Purch. Agent: T. R. Coyle
Buyers: W. F. Heatwole & D. D. Stafford
Gen. Mktg. Mgr.: R. Beatty **M**

SYLVANIA ELECTRIC PRODUCTS INC., SPECIAL TUBE OPERATIONS
500 Evelyn Ave., Mt. View, Calif. (Tel. YOrkshire 8-6211); 1891 E. Third St., Williamsport, Pa. (Tel. Williamsport 3-491)
Purch. Agent: A. F. Beazel, Mt. View
Purch. Agent: E. J. Millen, Williamsport
Mktg. Mgr.: Thomas D. Fuller **G, RD**

SYLVANIA ELECTRIC PRODUCTS INC, SYLVANIA ELECTRONIC TUBES DIV.
Seneca Falls, N. Y. (Tel. LOgan 8-5881)
Purch. Agent: Glen W. Victory
Purch. Agent: James M. Parish, Emporium, Pa. (Tel. EMporium 301)
Gen. Sales Mgr.: D. W. Gunn, 1740 Broadway, New York, N. Y. (JU 6-2424)

SYLVANIA ELECTRONIC SYSTEMS, DIV.-SYLVANIA ELECTRIC PRODUCTS INC.
1001 1st Ave., Waltham 54, Mass. (Tel. TWinbrook 3-9200)
Supvr.-Proc.: Arnold Finley
Purch. Agent: William Hanson
Chief Standards Buyer: John Cull
Mktg Mgr.: R. D. Griffiths **MS, CT, RD**

SYLVANIA SEMICONDUCTOR DIV., SYLVANIA ELECTRIC PRODUCTS INC.
100 Sylvan Rd., Woburn, Mass. (Tel. WEIls 3-3500)
Purch. Agent: John Taylor
Mktg. Mgr.: Ernest H. Ulm **G, TT**

SYLVANIA-CORNING NUCLEAR CORP.
P. O. Box 59, 208-20 Willets Point Blvd., Bayside, N. Y. (Tel. FAculty 1-1212); Cantiague Rd., Hicksville, L. I., N. Y. (Tel. WEIls 1-3500)
Mgr.-Purch.: W. Ruzicka (Tel. WEIls 1-3500)
Asst. Mgr.-Purch.: H. Apgar (Tel. WEIls 1-3500)
Dir.-Mktg.: Stanley B. Roboff **M, RD**

SYNTHANE CORP.
River Rd., Oaks, Montgomery Co., Pa. (Tel. GLendale 2-2211)
Purch. Agent: Charles H. Cox, Jr.
Gen. Sales Mgr.: Russell B. Galloway

SYNTRONIC INSTRUMENTS INC.
100 Industrial Rd., Addison, Ill. (Tel. KIngswood 3-6444)
V. P. & Dir.-Purch.: Robert Bank
Pres. & Dir.-Sales: Henry O. Marcy **M**

SYSTEMS INC.
P. O. Box 7726, 2400 Diversified Way, Orlando, Fla. (Tel. CH 1-1541)
Purch. Agent: R. H. Dickinson
Pres.: S. M. Kaplan **G, CT, TT, RD**

SYSTEMS LABS., DIV.-ELECTRONIC SPECIALTY CO.
5121 San Fernando Rd., Los Angeles 39, Calif. (Tel. CH 5-3771)
Purch. Agent: H. A. Venturino
Dir.-Program Dev.: E. Floyd Sherman **MS, G, CT, RD**

SYSTRON CORP.
950 Galindo St., Concord, Calif. (Tel. MUlberry 2-3659)
Purch. Agent: Mrs. Doris Torpacka
Dir.-Sales: James R. Cunningham **MS, CT, RD**

TA MFG. CORP.
4607 Alger St., Los Angeles 39, Calif. (Tel. CHapman 5-5768)
Purch. Agent: R. E. Felton
V. P.-Sales: R. Clyde Jordan **MS**

TMK ELECTRIC CORP.
820 Linden Ave., Rochester 10, N. Y. (Tel. LUdlow 6-8000)
Purch. Agent: R. A. Taylor
Pres.: A. B. Treman **MS**

T. O. D. MFG. CO. INC.
325 Duffy Ave., Hicksville, L. I., N. Y. (Tel. WEIls 8-0500)
Dir.-Purch.: M. P. Wolder
Purch. Agent: H. Johnson
Sales Mgr.: R. Klein

TRG, INC.
2 Aerial Way, Syosset, L. I., N. Y. (Tel. OVerbrook 1-6900)
Purch. Agent: John Rusinak
Contract Adm.: Julius Maiman
Dir.-Sales: Frederick N. Mayer **MS, M, G, TT, RD**

TABET MFG. CO., INC.
1336 Ballentine Blvd., Norfolk 12, Va. (Tel. MAdison 2-1973)
Pres.: Michael Tabet
Engrs.: Q. Holleman, W. L. Turner & J. Sakakini
Sales Mgr.: Donald Strasburger

TACTAIR VALVE DIV.-AIRCRAFT PRODUCTS CO.
400 Church Rd., Bridgeport, Pa. (Tel. BRoadway 5-1000)
Purch. Agent: T. M. Clemmency
Sales Mgr.: Frank Higgins **MS, G**

TAFFET ELECTRONICS, INC.
27-05 Brooklyn Queens Expwy. W., Woodwide 77, N. Y. (Tel. RAvenswood 1-3500)
Purch. Agent: H. Herfurth
V. P.-Sales: I. Taffet **CT**

TAFT-PIERCE MFG. CO., THE
32 Mechanic Ave., Woonsocket, R. I. (Tel. POplar 2-1000)
Purch. Agent: A. M. Robinson
Dir.-Mktg.: J. G. Zeiger

TALCO ENGRG. CO., THE
2685 State St., Hamden, Conn. (Tel. ATwater 8-1634)
Purch. Agent: F. DeMarco
Buyer: D. Pantera
Dir.-Sales: A. E. Ehlenberger

TALK-A-PHONE CO.
5013 N. Kedzie Ave., Chicago 25, Ill. (Tel. LAwndale 1-8414)
Sales Mgr.: Dan F. Kagan

TALLEY CORP., THE
101 Highway & Conejo Rd., Newberry Park, Calif. (Tel. HUdson 5-2121)
Purch. Agent: Larry Johnston
Buyers: Meade Davis & Dwight Haymond
V. P.-Sales: Norman Nicholson **MS, G, CT, TT, RD**

TALLEY REGISTER CORP.
1310 Mercer St., Seattle 9, Wash. (Tel. MAin 4-0760)

TALON, INC.
626 Arch St., Meadville, Pa. (Tel. 4-1281)
Mgr.-Purch.: F. V. Hanaway
Asst. Mgr.-Purch.: A. R. Young
V. P.-Sales: R. M. Evans

TAMAR ELECTRONICS, INC.
2045 W. Rosecrans Ave., Gardena, Calif. (Tel. DA 3-9110)
Purch. Agent: W. P. Smith
Dir.-Sales: Robert A. Parsons **MS, G, TT, RD**

TANSITOR ELECTRONICS, INC.
West Road, Bennington, Vt. (Tel. 5473-5474)
V. P.-Purch.: Gilbert E. Green
Pres.-Sales: Alfred F. Torrisi **RD**

TAP-A-LINE MFG. CO.
31 S. W. 5th Court, P. O. Box 563, Pompano Beach, Fla. (Tel. WE 3-3262)
Sales: Robert W. McFarlin **M**

TAPCO GROUP, THOMPSON RAMO WOOLDRIDGE INC.
23555 Euclid Ave., Cleveland 17, Ohio (Tel. IV 1-7500)
Mgr., Purch.: R. Bosch
Mgr., Sales & Mktg.: J. H. Shaffer
S, PS, MS, G, CT, TT, RD

TAPE CABLE CORP.
790 Linden Ave., Rochester 10, N. Y. (Tel. LUdlow 6-0330)
Purch.: G. E. Smith
Sales Mgr.: Bob Smith **M**

TAPERED AIR PRODUCTS CORP.
10890 Stanford Ave., Lynwood, Calif. (Tel. NEvada 6-9851)
Purch. Agent: Chester Stephens
Sales Mgr.: O, M. BELL **S**

TASK CORP.
1009 E. Vermont Ave., Anaheim, Calif. (Tel. PRospect 4-3100)
Dir.-Purch.: Carl M. Berg
Sales Mgr.: Joe A. Fryer, Jr.

TAURUS CORP.
8 Coryell St., Lambertville, N. J. (Tel. EXport 7-1570)
Pres.: John Kreuter
Chief Engr.: William Fisher
Prod. Mgr.: Bent Andresen **M, CT**

W. A. TAYLOR & CO.
7300 York Rd., Baltimore 4, Md. (Tel. VAlley 3-1573)
Gen. Purch. & Sales Mgr.: J. A. Lambrecht
Asst. Purch. Mgr.: J. C. Kirk, Jr.
Chief Chemist: F. R. McCrumb

TAYLOR DEVICES, INC.
188 Main St., N. Tonawanda, N. Y. (Tel. JAckson 3603)
Pres.: Paul H. Taylor
V. P.-Sales: Charles S. Shanks

TAYLOR ELECTRIC INC.
15400 Dale Ave., Detroit 23, Mich. (Tel. KEnwood 5-2500)
Sales: Bruce R. D. Taylor **M**

TAYLOR FIBRE CO.
Norristown, Pa. (Tel. GLendale 2-2811)
Purch. Agent: H. Fifer
V. P.-Sales: E. H. DaCosta **M**

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

TAYLOR-WINFIELD CORP.
1052 Mahoning Ave., N. W., Warren, Ohio (Tel. EX 2-2521)
Purch. Agent: H. Martin
Asst. Purch. Agent: G. Walchak
Chief Sales Engr.: J. H. Cooper M

TECHALLOY CO. INC.
Route 113, Rahns, Pa. (Tel. Norristown HUxley 9-7211)
Pres.: D. M. Schmid M

TECHNIC INC.
88 Spectacle St., Cranston, R. I. (Tel. STuart 1-6100)
Dir.-Purch.: Barney Reynolds
Dir.-Sales: Frank K. Smith M

TECHNICAL APPARATUS BUILDERS
109 Liberty St., New York 6, N. Y. (Tel. REctor 2-6249)
Purch. Agent: R. A. Lyons
Sales Mgr.: R. Bernstein

TECHNICAL APPLIANCE CORP.
1 Taco St., Sherburne, N. Y. (Tel. ORchard 4-2211)
V. P. & Dir.-Purch.: Harold Senkel
Exec. V. P.: Tore Lundahl TT

TECHNICAL DESIGN & DEVELOPMENT CO., INC.
465 Naugatuck Ave., Milford (Devon), Conn. (Tel. TRinity 8-0625)
Dir.-Purch.: John J. Edmonds
Pres. & Gen. Mgr.: Clinton S. Strong RD

TECHNICAL DEVELOPMENT CO.
305 S. Chester Pike, Glenolden, Pa. (Tel. LUdlow 3-3330)
Pres. & Purch. Agent: D. W. Botstiber
V. P.: N. S. Gable PS, MS

TECHNICAL ELECTRONICS CO., DIV.-CONSOLIDATED ELECTRONIC INDUSTRIES
4060 Ince Blvd., Culver City, Calif. (Tel. UPton 0-5461)
Purch. Agent: N. L. Stevenson
Sales Mgr.: W. A. Beswick CT

TECHNICAL MATERIEL CORP., THE
700 Fenimore Rd., Mamaroneck, N. Y. (Tel. OWens 8-4800)
Purch. Agent: J. J. Toman
Buyers: J. F. Hopkins & J. Brenton
Exec. V. P.: W. J. Galione TT

TECHNICAL PLY-WOODS SALES
6756 Crandon Ave., Chicago 49, Ill. (Tel. BU 8-1330)
Purch. Agent: A. H. Hackett
Dir.-Sales: James R. Fitzpatrick S, M

TECHNICAL PRODUCTS CO.
6670 Lexington Ave., Hollywood, Calif. (Tel. HO 4-8121)
Sales Mgr.: Robert L. Shafer MS, CT, TT, RD

TECHNICAL SALES CORP.
16599 Meyers Rd., Detroit 35, Mich.
Sales Mgr.: E. G. Reindel

TECHNICAL SERVICE CORP.
917-19 S. Third St., Louisville 3, Ky. (Tel. JUniper 7-8476)
Gen. Purch. Agent: L. H. Jones
Buyer: Robert E. Johnson
Sales Dept.: Mary Rose Snead

TECHNICAL TAPE CORP.
240 North Ave., New Rochelle, N. Y. (Tel. BEverly 5-1000)
V. P. Dir.-Disbursements: Max Peerce
Purch. Agent: B. McGuire
Asst. Purch. Agent: Mrs. D. Steiner
V. P. Gen. Sales Mgr.: M. R. Stohl

TECHNI-CAST CORP.
11455 Check Ave., Lynwood, Calif. (Tel. NEvada 6-0678)
V. P.-Purch.: Bryn Van Hiel

TECHNICRAFT, DIV.-ELECTRONIC SPECIALTY CO.
Thomaston-Waterbury Rd., Thomaston, Conn. (Tel. ATlas 3-4315)
Purch. Agent: Edwin A. Jacques
Sales Mgr.: Thomas P. Matthews M, G

TECHNIQUE ASSOCIATES DIV., DUNCAN ELECTRIC CO., INC.
1413 North Cornell Ave., Indianapolis 2, Ind. (Tel. MElrose 1-4904)
Dir.-Purch. & Sales: T. K. Millholland

TECHNITROL ENGRG. CO.
1952 E. Allegheny Ave., Philadelphia 34, Pa. (Tel. GArfield 6-9105)
Purch. Agent: James H. Kennedy
Buyer: David Adam
V. P.-Sales: T. Kite Sharpless MS, CT, TT

TECHNOGRAPH PRINTED ELECTRONICS, INC.
920 Northwest Blvd., Winston-Salem, N. C. (Tel. PArk 3-0767)
Purch. Agent: R. G. Vance RD

TECHNOLOGY INSTRUMENT CORP.
531 Main St., Acton, Mass. (Tel. COlonial 3-7711)
Purch. Agent: David M. Donaldson
V. P.-Sales: H. L. Gray, Jr. M, CT, RD

TECHNOPRODUCTS, INC.
P. O. Box 5293, Hamden 18, Conn. (Tel. ATwater 8-9966)
Pres.: D. N. Griffin CT, RD

TECHRON CORP.
20 Simmons St., Boston 20, Mass. (Tel. HIghlands 5-2150)
Purch. Agent: Thomas Fahey
Dir.-Sales: George Ganjian M

ROLAND TEINER CO. INC.
134 Tremont St., Everett 49, Mass. (Tel. DUnkirk 7-7800)
Dir.-Purch.: R. Tenaglia
V. P.-Prod.: N. Patterson
V. P.-Sales: K. L. Sowdon

TEKTRONIX, INC.
P. O. Box 831, Portland 7, Oregon (Tel. MItchell 4-0161)
Purch. Agent: Scott Foster
Mktg. Mgr.: Byron Broms CT

TELCON, INC.
P. O. Box 216, Pacific Palisades, Calif. (Tel. GLadstone 4-4043)
Pres.: V. G. Rumbellow M

TELECHROME MFG. CORP.
28 Ranick Dr., Amityville, N. Y. (Tel. LIncoln 1-3600)
Dir.-Purch.: B. Trimball
V. P.-Sales: H. Charles Riker CT, TT, RD

TELE COIL CO.
2733 Saunders St., Camden 5, N. J. (Tel. EMerson 5-7528)
Pres.: Samuel Feldman

TELECTRO INDUSTRIES CORP.
35-16 37th St., Long Island City 1, N. Y. (Tel. YEllowstone 2-8600)
Dir.-Purch.: Maxwell Ross
Sales Mgr.: Robert Donner M, TT, RD

TELE-DYNAMICS INC.
5000 Parkside Ave., Philadelphia 31, Pa. (Tel. TRinity 8-3000)
Purch. Agent: Walter S. Longbotton
Buyers: Howard S. Messick, William A. Porch, Philip Marder
Dir.-Mktg.: Edward H. Rosen GS, GH, GE, CO, TS, TR, RD

TELEFLEX INC.
Church Rd., P. O. Box 218, North Wales, Pa. (Tel. OXbow 9-4861)
Dir.-Purch.: T. H. Walton
Dir.-Sales: L. K. Black S, MS, RD

TELEMETER MAGNETICS, INC.
P. O. Box 329, Culver City, Calif. (Tel. UPton 0-8571)
Purch. Agent: Jack O. Hoffman
Buyers: Frank J. Butteri & Leonard Stephenson
Sales Mgr., Data Equip. Div.: R. D. Schmidt
Sales Mgr., Components Div.: D. Miner MS, RD

TELERAD MFG. CORP.
1440 Broadway, Nwe York 18, N. Y. (Tel. BRyant 9-0892)
Pres.: Charles George MS, M, TT

TELEVISION UTILITIES CORP., DIV.-NORD
300 Denton Ave., New Hyde Park, L. I., N. Y.
Pres.: E. Kron
V. P.-Sales: D. Sigler
Chief Engr.: C. Odom

TELEX, INC.
1633 Eustis St., St. Paul 1, Minn. (Tel. Midway 6-7211)
Dir.-Purch.: D. L. McNevin
Asst. Purch. Agent: T. K. Mark
Sales Mgr.: R. F. Buelow M

TEL-INSTRUMENT ELECTRONICS CORP.
728 Garden St., Carlstadt, N. J. (Tel. WEbster 3-1600)
Dir.-Purch.: A. R. Roemisch
Sales Mgr.: E. W. Brinkerhoff

TELKOR, INC.
N. Murray Ridge, P. O. Box 186, Elyria, Ohio (Tel. FA 2-8623)
V. P.-Purch. & Sales: Howard R. Roe
Engrs.: Robert Carneck & Elverton O. Roe G, CT

TELONIC INDUSTRIES, INC.
60 N. First St., Beech Grove, Ind. (Tel. STate 7-7241)
Purch. Agent: Jean Robinett
Sales Mgr.: L. W. Abbott M, CT

TEL VISION LABS. INC.
333 W. Mill St., Wauconda, Ill. (Tel. JAckson 6-2511)
Purch. Agent: Joseph Fayman
Pres.: Edward F. Classen G, CT, TT

TEMCO AIRCRAFT CORP.
P. O. Box 6191, Dallas 22, Texas (Tel. BRoadway 6-7111)
Materiel Mgr.: C. D. Collier
Purch. Agent: J. A. Pendleton
Mgr.- Sales, Missile & Aircraft Div.: E. F. Janesic S, PS, MS, G, CT, TT, RD

TEMPEL STEEL CO.
1939 Bryn Mawr Ave., Chicago 26, Ill. (Tel. ARdmore 1-8100)
Purch. Agent: H. W. Buerger
Sales Mgr.: F. A. Slaughter

TEMPERATURE ENGRG. CORP.
1700 Union Landing Rd., Riverton, N. J. (Tel. TAlmader 9-3880)
Pres.: S. H. Perlman
Sales Mgr.: Norman Bustein RD

TEMPIL CORP.
132 W. 22nd St., New York 11, N. Y. (Tel. ORegon 5-6610)
Purch. Agent: L. Fein
Dir.-Sales: D. R. Kasanof
Order Supply: J. Geiger M, CT, RD

TEMPLET INDUSTRIES INC.
701 Atkins Ave., Brooklyn 8, N. Y. (Tel. BRowning 2-7300)
Dir.-Purch.: Martin P. Krentzman
Dir.-Sales: Harry R. Twergo S, M

TEMPLETON, KENLY & CO.
16th & Gardner Rd., Broadview, Ill. (Tel. AUstin 7-0694)
Buyer: Donald Bertaut
V. P.-Sales: P. H. McManus

TEMPO INSTRUMENT INC.
Commercial St., P. O. Box 338, Hicksville, N. Y. (Tel. OVerbrook 1-2280)
Purch. Agent: H. Pinto
Sales Mgr.: G. J. Sbordone MS, G, CT, RD

TENNEY ENGRG., INC.
1090 Springfield Rd., Union, N. J. (Tel. MUrdock 6-7870)
Purch. Agent: Robert Hak
V. P.-Sales: Robert H. Brown CT, RD

TENSITRON, INC.
P. O. Box 185, Harvard, Mass. (Tel. MEdford 1-2300)
Dir.-Purch.: D. G. Keough
Buyer: John Heady
V. P.-Sales: G. W. Heller M

TENSOR ELECTRIC DEVELOPMENT CO., INC.
1873 Eastern Pkwy., Brooklyn 33, N. Y. (Tel. HY 5-9200)
Purch. Agent: Mrs. P. McFarland

TEPRO ELECTRIC CORP.
408A Burke Bldg., 5 St. Paul St., Rochester 4, N. Y. (Tel. BAker 5-0478)
Pres.: M. A. Thom
Prod. Mgr.: James E. Miller

TERADO CO.
1068 Raymond Ave., St. Paul 8, Minn. (Tel. Midway 6-2868)
Gen. Mgr.: D. G. Munson
Purch.: George Huff
Sales Mgr.: John J. Kaul MS, M, G

GEORGE A. TERRY CO.
356 S. Elmwood Ave., Buffalo 1, N. Y. (Tel. WA 0633)
Mgr.: George A. Terry
Asst. Mgr.: A. M. Dodge
Sales Mgr.: Harold A. Dodge

TETRAFLUOR, INC.
343 Hindry Ave., Inglewood 1, Calif. (Tel. ORegon 8-4056)
Purch. Agent: Jerry Riemer
Asst. Purch. Agent: Al Schachter
Sales Mgr.: Edward M. Young **M**

TEVCO INSULATED WIRE
108 Prospect Ave., Burbank, Calif. (Tel. VIctoria 9-5574)
Pres.: Nat B. Kaufman
V. P.: Rolland Trombley **M**

TEXAS INSTRUMENTS INC., METALS & CONTROLS DIV.
55 Forest St., Attleboro, Mass. (Tel. 2800)
Purch. Agents: L. Forman, Spencer Products E. Carpenter, General Plate Products
Mgr., Mktg.: B. O. Haun, Jr.

TEXAS INSTRUMENTS INC., METAL & CONTROLS DIV., GENERAL PLATE PRODUCTS
5565 Forest St., Attleboro, Mass. (Tel. AT 1-2800)
Purch. Agent: L. Gorman
Mgr., Mktg.: B. O. Haun

TEXAS INSTRUMENTS INC., METALS & CONTROLS DIV., SPENCER PRODUCTS
5565 Forest St., Attleboro, Mass. (Tel. AT 1-2800)
Purch. Agent: E. B. Carpenter
Mgr., Mktg.: B. O. Haun

TEXAS INSTRUMENTS INC.
6000 Lemmon Ave., Dallas 9, Texas (Tel. FLeetwood 7-5411)
V. P.-Mktg.: S. T. Harris
Purch. Agent-Apparatus Div.: Frank Wodrich
Purch. Agent-Semiconductor Components Div.: Don Nugent (Tel. ADams 5-3111)
Purch. Agent-Metals & Controls Div.: L. Gorman (Tel. ATtleboro 1-2800) **MS, M, G, CT, TT**

TEXSTAR PLASTICS, DIV.-THE TEXSTAR CORP.
1400 Henderson St., P. O. Box 1440, Forth Worth, Texas (Tel. ED 5-3214)
Buyers: Richard S. Long, Ray Goudeau, Donald M. Miles
Gen. Sales Mgr.: William K. McConnell, Jr. **S, M**

TEXTRAN CORP.
P. O. Box 9207, 4508 Burnet Rd., Austin 17, Texas (Tel. GL 3-8378)
Tech. Dir.: O. J. Baltzer **RD**

THAYER SCALE CORP.
1 Thayer Park, Pembroke, Mass. (Tel. TAylor 6-2373)

THERM, INC.
Hudson St., Ithaca, N. Y. (Tel. ITHaca 4-9501)
V. P.-Purch.: John E. Paige
V. P.-Sales: Harry A. Davis, Jr.
V. P.-Research: Alfred Ritter **PS, M, RD**

THERMADOR ELECTRICAL MFG. CO.
715 S. Raymond Ave., Alhambra, Calif. (Tel. CUmberland 3-8831)
Gen. Mgr. & Dir.-Purch.: J. R. Singleton
Dir.-Sales: M. B. Sawyer, Jr. **G, TT, RD**

THERMAL AMERICAN FUSED QUARTZ CO., INC.
15-19 Salem St., Dover, N. J. (Tel. FOxcroft 6-2807)
Purch. Agent: R. Doorman
Sales Mgr.: John F. von Sternberg **M, RD**

THERMAL DYNAMIC PRODUCTS DIV.-WALTHAM PRECISION INSTRUMENT CO.
38 W. 53rd St., New York 10, N. Y. (Tel. JUdson 2-8860)
V. P. & Gen. Mgr.: Gerard J. Wendelken
Dir.-Sales: Fred Burmann **RD**

THERMAL RESEARCH & ENG. CORP.
700 Brook Rd., Conshohocken, Pa. (Tel. TAylor 8-5400)
Factory Mgr.: David Cardis
Purch. Agent: A. M. Davis
Pres.: L. C. Peskin
V. P. & Sales Mgr.: W. K. Lombard **MS, CT, RD**

THERMAL WIRE OF AMERICA
Keeler's Bay, South Hero, Vt. (Tel. 241)
Pres.: Horace W. Corbin, Jr.
Sales Mgr.: Michael G. Ziter **G, CT, TT**

THERMAX WIRE CORP.
304 E. 45th St., New York 17, N. Y. (Tel. MUrray Hill 9-7120)
Purch. Dept.: Robert Prusak
Sales Mgr.: John E. Rattinger **M**

THERMECH ENGRG. CORP.
1773 Lincoln Ave., Anaheim, Calif. (Tel. KEystone 3-3183)
Gen. Mgr.: C. P. Ripley
Sales Mgr.: R. L. Harris **M**

THERMIONIC AERONAUTIC DIV.
Interhaven Ave., Plainfield, N. J. (Tel. PL 4-7616
Project Engr.: Thomas B. Malloy, Jr.
Prod. Engr.: Thomas Douglas
V. P.-Sales: Charles W. Brunstetter **S, M, RD**

THERMIONIC PRODUCTS CO.
Interhaven Ave., Plainfield, N. J. (Tel. PL 4-7616)
Purch. Agent: Mr. Kelly
Prod. Engr.: Mr. Ahouse
Chief Engr.: John Vogel
Pres.: Victor O. Allen **S, M, RD**

THERMO ELECTRIC CO., INC.
109 5th St., Saddle Brook, N. J. (Tel. HUbbard 9-5800)
Treas.: J. P. McKeon
Sales Mgr.: J. H. Collins **CT**

THERMO KING CORP.
314 W. 90th St., Minneapolis 20, Minn. (Tel. TUxedo 1-2601)
Dir.-Purch.: E. J. Brown
Mgr.-Govt. Sales: Miles Harvey

THERMOID DIV.-H. K. PORTER CO., INC.
200 Whitehead Rd., Trenton 6, N. J. (Tel. JUniper 7-3000)
Purch. Agent: T. J. Gorman, Tacony & Comly Sts., Philadelphia, Pa. (Tel. JEfferson 3-4800)
V. P.-Sales: J. R. Alexander **MS**

THERM-O-LAB CORP.
6940 Farmdale Ave., N. Hollywood, Calif. (Tel. TRiangle 7-7105)
Sales Dir.: Roy Smith

THERMON MFG. CO.
1017 Rosine St., Houston 6, Texas (Tel. JAckson 6-4448)
Sales Mgr.: R. L. Burdick
Research Engr.: James E. Bilbron **M**

THERMOSEN INC.
375 Fairfield Ave., Stamford, Conn. (Tel. DAvis 5-1324)
Sales Mgr.: S. P. Stiskin

THETA INSTRUMENT CORP.
520 Victor St., Saddle Brook, N. J. (Tel. HUbbard 7-3508)
Purch. Agent: Robert Barker
Sales Mgr.: S. Handelman

THIEBLOT AIRCRAFT CO., DIV.-VITRO CORP. OF AMERICA
Martinsburg, W. Va. (Tel. AMherst 3-3385)
Dir.-Purch.: Art Williams
V. P.-Sales: W. P. Maloney

THIOKOL CHEMICAL CORP.
P. O. Box 27, Bristol, Pa. (Tel. WIndsor 6-9150)
Purch. Agent (Redstone Div.): J. Lutz, (Huntsville, Ala.)
Purch. Agent (Longhorn Div.): W. L. Teutsch (Marshall Tex.)
Dept. Mgr. (Reaction Motors Div.): E. M. DeRome (Denville, N. J.)
Section Head (Elkton Div.): T. King (Elkton, Md.)
Dept. Head (Utah Div.): D. Young (Brigham City, Utah)

THIOKOL CHEMICAL CORP., HUNTER-BRISTOL DIV.
Bristol, Pa. (Tel. WIndsor 6-9150)
Supvr.-Purch.: William Westberg
Contracts Mgr.: John Miller **MS, CT, RD**

THIOKOL CHEMICAL CORP., REDSTONE DIV.
Huntsville, Ala. (Tel. JE 6-4411)
Purch. Mgr.: R. B. Crow
Dir., Proj. Management Staff: D. B. Myers
Acting Chief, Subcontract.: H. R. Hope
Purch. Agent: J. P. Lutz **PS**

A. S. THOMAS, INC.
355 Providence Hwy., Westwood, Mass. (Tel. DAvis 9-9200)
Dir.-Purch.: D. C. Culpin **M, RD**

THOMAS & BETTS CO., INC., THE
336 Butler St., Elizabeth 1, N J. (Tel. ELizabeth 4-4321)
Dir.-Purch.: H. S. Berry
V. P.-Sales: E. Hewitt

THOMAS ELECTRONICS, INC.
118 Ninth St., Passaic, N. J. (Tel. GRegory 3-4040)
Mgr.-Purch.: Carl Tepel
Sales Mgr., Indsl.-Mil. Products: Jess E. Dines **M**

THOMAS FLEXIBLE COUPLING CO.
Maine Ave. & Biddle St., Warren, Pa. (Tel. RA 3-6600)
Purch. Agent: E. Hagenlocher
Asst. Purch. Agents: H. C. Wright & R. Nelson
Sales Mgr.: L. R. Gibson **PS, MS, C, TT, RD**

THOMAS INSTRUMENT CO.
41 Silver Rock, Phoenix, N. Y. (Tel. OWen 5-5134)
Sales H Prod. Mgr.: S. M. Thomas **PS**

THOMAS MOLD & DIE CO,
Box 126, Wooster, Ohio (Tel. HOward 2-5911)
Purch. Agent: L. Thomas
Sales Mgr.: W. M. Patterson **S, G, TT**

H. I. THOMPSON FIBER GLASS CO.
1733 Cordova St., Los Angeles 7, Calif. (Tel. REpublic 3-9161)
Purch. Agent: Dean Welsh
Buyer: D. Higham
V. P.-Sales: W. E. Benke **S, PS, MS, M, RD**

JOHN I. THOMPSON & CO.
Box 3531, Washington 7, D. C. (Tel. FE 6-4200)
Asst. Dir.-Engrg: George R. Pielmeier **S, M, CT, RD, HSE**

THOMPSON & CO.
1085 Allegheny Ave., Oakmont, Allegheny Co., Pa. (Tel. OAkmont 3800)
Dir.-Purch.: E. K. Chaffey
Purch. Agent: G. H. Overhult
V. P.-Sales: M. D. Phelps

THOMPSON RAMO WOOLDRIDGE INC.
23555 Euclid Ave., Cleveland 17, Ohio (Tel. IVanhoe 1-7500)
Dir.-Purch.: G. N. Hackett
Mgr., Purch. & Traffic: R. Bosch
V. P.-Customer Requirements: B. W. Chidlaw
Mgr.-Material: R. Westerfield, Los Angeles, Calif. (Tel. Diamond 6-6000) **S, PS, MS, M, G, CT, TT, RD**

THOMPSON RAMO WOOLDRIDGE PRODUCTS CO., THE
202 N. Canon Dr., Beverly Hills, Calif. (Tel. BRadshaw 2-8892)
Gen. Mgr.: Dr. J. J. Manildi
Dir.-Engrg.: Dr. Montgomery Phister, Jr. **CT**

THOMSON, JUDSON L.
Sawyer Rd., Waltham 54, Mass. (Tel. TW 3-0857)
G. Robert Cox **S**

THOR CERAMICS, INC.
225 Belleville Ave., Bloomfield, N. J. (Tel. PIlgrim 3-7797)
Purch. Agent: Laurence E. O'Rourke
Pres. & Sales Mgr.: Harry Thaw **M**

THOR POWER TOOL CO.
175 N. State St., Aurora, Ill. (Tel. TWinoaks 2-7601)
Purch. Agent: G. C. Wicks
Asst. Purch. Agents: H. G. Snyder & B. C. Wulf
V. P.-Sales: D. C. Smith **S, PS, MS, CT, TT, RD**

THOMPSON-BREMER & CO., DIV.-AMERICAN MACHINE & FOUNDRY CO.
228 N. La Salle St., Chicago 1, Ill. (Tel. FRanklin 2-6858)
V. P.-Purch.: William G. Evans
Sales Mgr.: Gail M. Rutledge **M**

ARTHUR TICKLE ENGRG. WORKS, INC.
21 Delevan St., Brooklyn 31, N. Y. (Tel. MAin 5-4200)
Purch. Agent: William Doyle
Sales Mgr.: Nicholas P. Harvey

TIMES WIRE & CABLE CO., INC.
358 Hall Ave., Wallingford, Conn. (Tel. COlony 9-3381)
Sales Mgr.: Robert Burton **M**

TIMKEN ROLLER BEARING CO., THE
1835 Deuber Ave., S. W., Canton, Ohio (Tel. GL 3-4511)
Dir.-Purch.: Paul Young
V. P.-Sales: P. J. Reeves **MS, M**

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

E. F. TIMME & SON INC.
1 Park Ave., New York 16, N. Y. (Tel. MU 3-2580)
V. P., Indsl. Div.: H. Arnold Giles
Asst. to V. P., Indsl. Div.: Joseph A. Krist **M**

TINGSTOL CO.
1340 W. Fullerton Ave., Chicago 14, Ill. (Tel. WEllington 5-4422)
Purch. Agent: J. Machina
V. P.-Sales: John P. Zopp **M**

TINIUS OLSEN TESTING MACHINE CO.
Easton Rd., Willow Grove, Pa. (Tel. OSborne 5-7100)
Purch. Agent: C. H. Keyser
Sales Mgr.: E. M. Redstreake **CT**

TINNERMAN PRODUCTS, INC.
Dept. 16, P. O. Box 6688, Cleveland 1, Ohio (Tel. SHadyside 1-9300)
Dir.-Purch.: R. F. Merriam
Dir.-Sales L. H. Flora **S**

TINSLEY LABS., INC.
2526 Grove St., Berkeley, Calif. (Tel. THofnwall 3-6836)
Purch. Agent: Robert J. Johnson
Pres.: Harvey L. Morton

TITAN METAL MFG. CO., DIV.-CERRO DE PASCO CORP.
Bellefonte, Pa. (Tel. EL 5-4712) (Also Newark, Calif.)
V. P.-Purch.: M. J. Rothrock
Gen. Purch. Agent: B. R. Tingue
Tech. Asst. to Gen. Purch. Agent: R. H. Eiser
V. P.-Sales: R. H. Lightner **M**

TITANIUM METALS CORP. OF AMERICA
233 Broadway, New York 7, N. Y. (Tel. WOrth 4-7620)
Dir.-Mktg.: T. W. Lippert
Sales Mgr.: Robert S. Nycum **M**

TITEFLEX, INC.
603 Hendee St., Springfield 4, Mass. (Tel. REpublic 9-5631)
Dir.-Purch.: A. B. Coburn
Buyer: R. Brennan
V. P.-Mktg.: E. M. Ramberg **PS, MS, RD**

TOBER ELECTRONIC CORP.
180 Linden Ave., Westbury, N. Y. (Tel. EDgewood 4-6504)
Purch. Agent: W. C. Herbert
Buyers: W. Schrof & H. Westland
Pres.: W. G. Todd **S, MS, G**

TOCCO DIV., THE OHIO CRANKSHAFT CO.
3800 Harvard Ave., Cleveland 5, Ohio (Tel. Diamond 1-2300)
Dir.-Purch.: B. Seidel
Asst. Gen. Mgr.: L. S. Schweitzer

TOLEDO COMMUTATOR CO.
1101 S. Chestnut St., Owosso, Mich. (Tel. SAratoga 5-8192)
Purch. Agent: M. A. Brush
Buyer: P. Durai
V. P.-Sales: E. R. Bisard

TOPATRON, INC.
942 E. Ojai Ave., Ojai, Calif. (Tel Milton 6-1600)
Purch. Agent: M. O. Olson
Sales Mgr.: L. H. Appleman **G, CT, TT, RD**

TOPFLIGHT CORP.
160 E. 9th Ave., York, Pa. (Tel. 8-1541)
Purch. Agent: Frank Buttorff
Sales Dir.: R. M. Dent

TOPPER MFG. CO., INC.
84-56 Parsons Blvd., Jamaica 32, N. Y. (Tel. AXtel 7-5742)
Dir.-Purch.: J. A. Stancey
Dir.-Sales: Fred Greil **M, CT, RD**

TORIT MFG. CO.
1133 Rankin St., St. Paul, Minn. (Tel. Midway 8-0391)
Purch. Agent: George Huna
V. P.-Sales: Frank Chase **M**

TORK TIME CONTROLS, INC.
1 Grove St., Mount Vernon, N. Y. (Tel. MO 4-3542)
Dir.-Purch.: Edward H. Klein, Jr.
Dir.-Sales: Dorset J. White

C. W. TORNGREN CO., INC.
236 Pearl St., Somerville 45, Mass. (Tel. MOnument 6-3250)
Purch. Agent: Wm. DeCain
Dir.-Sales: Kenneth A. Casavant **S, PS**

TORRINGTON CO., THE
59 Field St., Torrington, Conn. (Tel. HUnter 2-4441)
Dir. Purch.: W. V. Viering
Purch. Agent: F. W. Sanders
Sales Mgr.: R. G. O'Connell **PS, MS, G, TT, RD**

TORRINGTON MFG. CO. INC., THE, SPECIALTY BLOWER DIV.
100 Franklin Drive, Torrington, Conn. (Tel. HUnter 2-4422)
Purch. Agent: R. J. Geiger
Sales: A. M. Wilczenski **MS, G, CT, RD**

TORSION BALANCE CO., THE
35 Monhegan St., Clifton, N. J. (Tel. GRegory 3-6900)
Purch. Agent: C. Wesley
Div. Sales Mgr.: E. H. Enberg **CT**

TORWICO ELECTRONICS, INC.
1095 Morris Ave., Union, N. J. (Tel. ELizabeth 4-5650)
Purch. Agent: H. G. Riche
Pres. & Sales Mgr.: George Kantra **MS, G, TT, RD**

TOWACO ELECTRONICS
Pine Brook Rd., Towaco, N. J. (Tel. DE 4-4443)
Pres.: Samuel I. Cory, Jr. **TT**

TOWER CONSTRUCTION CO.
2700 Hawkeye Drive, Sioux City, Iowa (Tel. 5-7653)
Purch. Agent: J. R. Edwards
Asst. Sales Mgr.: G. S. Chesen
Gen. Mgr.: C. A. Wright **S**

TOWER MFG. CORP.
158 Pine St., Providence, R. I. (Tel. GAspee 1-2061)
Gen. Mgr.: Louis J. Shatkin **CT**

TRACERLAB INC.
1601 Trapelo Rd., Waltham 54, Mass. (Tel. TW 4-6600)
Chief Purch. Agent: John A. Klumpe
V. P.-Mktg.: Homer S. Myers **RD**

TRAID CORP.
17136 Ventura Blvd., P. O. Box 648, Encino, Calif. (Tel. TRiangle 3-3373)
Purch. Agent: A. J. DeMarco
Pres.: Fred G. Roberts, Jr. **TT**

TRAILMOBILE INC.
31st & Robertson Sts., Cincinnati 9, Ohio (Tel. REdwood 1-2323)
Dir.-Purch.: Wm. H. French
V. P.-Sales: Harry Eyler **S, MS, M**

TRANE CO., THE
2nd & Cameron Ave., La Crosse, Wisc. (Tel. 2-8000)
V. P.-Purch: R. H. Pearse
V. P.-Sales: A. C. Menke

TRANS ELECTRONICS, INC.
7349 Canoga Ave., Canoga Park, Calif. (Tel. Diamond 0-3333)
Purch. Agent: J. V. Ritenour
Sales Mgr.: R. Andrew Phillips

TRANSCO PRODUCTS, INC.
12210 Nebraska Ave., Los Angeles 25, Calif. (Tel. BRadshaw 2-5687)
Purch.: Hugh P. Rice
Buyer: William Wookey
Gen. Sales Mgr.: Nathaniel Davis **MS, CT, TT, RD**

TRANSFORMER DESIGN, INC. OF MILWAUKEE
7377 North 76th St., Milwaukee 23, Wisc. (Tel. FLagstone 3-8017)
Pres.: Howard S. Knopow
V. P.: Rubin B. Lesgold

TRANSFORMER SPECIALTY CO.
1400 Mill Creek Rd., Gladwyne, Pa. (Tel. Midway 9-4360)
Pres.: H. D. Hosier **MS, TT**

TRANSFORMERS, INC.
200 Stage Rd., Vestal, N. Y. (Tel. Pioneer 8-3311)
Purch. Agent: F. Bleyer
Sales Coordinator: J. D. Brady **S, CT, RD**

TRANSICOIL DIV.-DAYSTROM INC.
Trooper Rd., Worcester, Pa. (Tel. JUno 4-2421)
Purch. Agent: Pete Toscano
Dir.-Sales: John J. Gattoline

TRANSISTOR DEVICES INC.
626 Schuyler Ave., Kearny, N. J. (Tel. WY 8-8108)
Chief Engr.: Walter I. Weiss
Sales Mgr.: Joseph D. Ezechel, Jr.

TRANSISTOR ELECTRONICS CORP.
3357 Republic Ave., Minneapolis 26, Minn. (Tel. WEst 9-6754)
Purch. Agent: H. J. Peterson
V. P.-Sales: R. C. Skoe
Sales Mgr.: W. H. Rock **MS, CT**

TRANSITRON ELECTRONIC CORP.
168 Albion St., Wakefield, Mass. (Tel. CRystal 9-4500)
Purch. Agent: Ralph Young
Sales Mgr.: H. T. Neavitt **G, CT, TT**

TRANS-SIL CORP.
55 Honeck Street, Englewood, N. J. (Tel. LOwell 7-1720)
Pres.: Louis J. Grennell
Purch. Agent: Thomas Wells
V. P.-Sales: Irwin Weinstein **MS, M**

TRANS-SONICS, INC.
P. O. Box 328, Lexington 73, Mass. (Tel. BRowning 2-1000)
Purch. Agent: Robert L. Meader
Gen. Sales Mgr.: Sheldon W. Kennedy **MS, CT, TT**

TRANSUE & WILLIAMS STEEL FORGING CORP.
1300 Ely, Alliance, Ohio (Tel. TAlbot 1-5741)
Purch. Agent: H. C. Martin
Asst. Purch. Agent: R. H. Cost
Sales Mgr.-Stamping Div.: C. J. Brunn
Sales Mgr.-Forge Div.: J. W. Ament **PS, MS**

TRANS-WESTERN ELECTRONICS
P. O. Box 1473 Ventura, Calif. (Tel. MIller 2-4219)
Purch. Agent: G. Reins
Sales Mgr.: M. M. Neer **CT**

TRANTER MFG., INC.
735 E. Hazel, Lansing, Mich. (Tel. IV 4-4531)
Purch. Agent: M. C. Nolen
Sales Mgr.: S. J. Stowell **M**

TRENT TUBE CO.
498 S. Church St., East Troy, Wisc. (Tel. Midway 2-7321)
Purch. Agent: S. R. Erickson
Sales Mgr.: F. W. Beitner **M**

TRENTON TRANSFORMER CORP.
P. O. Box 568, Trenton, N. J. (Tel. OWen 5-3451)
V. P.-Purch.: E. S. Washburn **M**

TREPAC CORP. OF AMERICA
30 W. Hamilton Ave., Englewood, N. J. (Tel. LOwell 7-3810)
Pres.: H. S. Weaver
Mgr.-Purch.: C. E. Dolan
Sales Mgr.: L. White **MS, M, G, CT, TT**

TRESCO, INC.
3824 Terrace St., Philadelphia 28, Pa. (Tel. IV 3-1383)
Purch. Agent: Stanley Fisher
Sales: Stan Auerbach

TRIAD TRANSFORMER CORP.
4055 Redwood Ave., Venice, Calif. (Tel. EXmont 7-2145)
Purch. Agent: G. L. Howard
Sales Mgr.-Jobber: Ernest Clover
Sales Mgr.-Industrial: Edmund Shimbel
M, CT, TT, RD

TRICRAFT PRODUCTS CORP.
1124 W. Newport Ave., Chicago 13, Ill. (Tel. WEllington 5-5383)
Pres.: Frank J. Klancnik
Gen. Mgr.: E. A. Goncoe **RD**

TRI-EX TOWER CORP.
127 E. Inyo St., Tulare, Calif. (Tel. MU 6-3411)
Gen. Mgr.: Louis V. Tristao
Plant Supt.: Harold Holscher **S, RD**

TRIMOUNT INSTRUMENT CO.
3119 W. Lake St., Chicago 12, Ill. (Tel. NEvada 2-3747)
Purch.: F. R. Arens
Sales Mgr.: D. E. Haines **CT, RD**

TRINDL PRODUCTS, LTD.
1807-11 S. Clark St., Chicago 16, Ill. (Tel. Victory 2-7716)
V. P.-Purch.: Joseph H. Trindl, Jr.

TRINITY EQUIPMENT CORP.
Rt. 281, Cortland, N. Y. (Tel. SKyline 6-7535)
Purch. Agent: Thomas G. Meares
Asst. Purch. Agent: Roger C. Harris, Jr.
Pres. & Gen. Sales Mgr.: George R. Feeley **MS, G, TT**

TRIO CHEMICAL WORKS, INC.
341 Scholes St., Brooklyn 6, N. Y. (Tel. HYacinth 7-3595)
Purch.: Harold Blank
Sales: M. M. Blank

TRIO LABORATORIES, INC.
Plainview, L. I., N. Y. (Tel. OVerbrook 1-0400)
Purch. Agent: Thomas M. Curry
Sales Mgr.: Jay S. Salz — MS, CT, RD

TRIPLETT ELECTRICAL INSTRUMENT CO.
Harmon Rd., Bluffton, Ohio (Tel. 323-W)
Purch. Agent: P. W. Stauffer
V. P.-Sales: N. A. Triplett — CT

TRI-POINT PLASTICS INC.
175 I. U. Willets Rd., Albertson, L. I., N. Y. (Tel. MAyfair 1-5800)
Purch. Agent: Sid Kipnes
Dir.-Sales: Pat Ruggieri — PS, MS, M, G, CT, RD

TROMBETTA SOLENOID CORP.
329 N. Milwaukee St., Milwaukee, Wisc. (Tel. BRoadway 1-8347)
Gen. Mgr.: Panfilo Trombetta — MS

TRU-CONNECTOR CORP.
416 Union St., Lynn, Mass. (Tel. LY 8-9379)
Gen. Mgr.: James J. O'Neil, Jr.
Purch. Agent: Robert F. Hoff
Sales Mgr.: Robert A. Peters — M

TRUE ALLOYS INC.
284 S. Summit St., Detroit 9, Mich. (Tel. VInewood 2-8686)
Pres.: J. P. Carritte

TRU-OHM PRODUCTS DIV.-MODEL ENG. & MFG., INC.
2800 N. Milwaukee Ave., Chicago 18, Ill. (Tel. EVerglade 4-2646)
Purch. Agent: Robert Riley
Dir.-Sales: Mel M. Jones

TUBE DISTRIBUTORS CO., INC.
1415 Kellum Place, Garden City, N. Y. (Tel. Pioneer 7-5000)
Purch. Agent: Albert Salis
Exec. Asst. to Pres.: Alan Seligson — M

TUBE METHODS INC.
Depot & Rambo Sts., Bridgeport, Pa. (Tel. BRoadway 9-7700)
Exec. V. P.: Paul V. Fly
Sales Mgr.: John E. MacNamara — M

TUBE REDUCING CORP.
520 Main Ave., Wallington, N. J. (Tel. PRescott 7-3700)
Purch. Agent: E. P. McMahon
V. P.-Sales: R. L. Tannehill — M

TUBESALES
2211 Tubeway, Los Angeles 22, Calif. (Tel. RAymond 3-7781)
Mgr.-Pricing & Proc.: J. H. Van Uden
Mgr.-Sales: W. C. Tagmyer
V. P.-Sales: H. P. Curtis — M

TUBE-TURNS DIV., CHEMETRON CORP.
224 E. Broadway, Louisville 2, Ky. (Tel. JUniper 7-7551)
Purch. Agent: R. J. Dilger
Buyer, Raw Material: Thomas Baugher
V. P.-Sales: John E. Chumbley, Jr. — PS

TUCSON INSTRUMENT CORP.
1050 E. Valencia Rd., P. O. Box 11247, Tucson 2, Ariz. (Tel. MAin 2-1092)
Pres.: F. R. Perier
V. P.-Sales: Louis A. Wilson, Jr. — MS, CT, RD

TUNG-SOL ELECTRIC, INC.
1 Summer Ave., Newark 4, N. J. (Tel. HU 4-8500); 200 Bloomfield Ave., Bloomfield, N. J. (Tel. PIlgrim 8-8700)
Chief Purch. Agent: E. Garretson (Bloomfield)
Purch. Agents: R. Darling & T. Rayment (Bloomfield)
Mgr.-Prod. Mktg.: H. S. Evander (Bloomfield) — G

TUR-BO JET PRODUCTS CO., INC.
424 S. San Gabriel Blvd., San Gabriel, Calif. (Tel. CUmberland 3-5191)
Pres.: Otto N. Bloom
Mgr.: Charles A. Sprowl

TURBOCRAFT, INC.
492 E. Union St., Pasadena, Calif. (Tel. MUrray 1-5253)
Pres. & Gen. Mgr.: Clifford R. Crusan
Eng. Mgr.: Frank A. Mondok — MS, RD

TURCO PRODUCTS, INC.
24600 S. Main St., Wilmington, Calif. (Tel. SPruce 5-2111)
Dir.-Purch.: R. J. Sheridan
Los Angeles, Purch.: D. W. Eckroad
V. P.-Mktg.: Dan T. Buist
Gen. Sales Mgr.: A. K. Beard — M, RD

H. W. TUTTLE & CO.
805 S. Evans St., Tecumseh, Mich. (Tel. 1008)
Purch. Agent: L. H. Hardesty
Pres.: M. K. Tuttle
V. P.: H. W. Tuttle, Jr.
Sales Mgr.: M. E. Bailey

TWIN COACH CO., AIRCRAFT-MISSILES
P. O. Box 2507, Buffalo 25, N. Y. (Tel. PLaza 5150)
Materials Mgr.: E. E. Rhoads
V. P.-Contracts Admin.: G. R. Hecht
Purch. Mgr.: R. I. Condon
Purch. Agent: F. W. Mayer — S, MS, RD

TWIX MFG. CO., INC.
40-09 21st St., Long Island City 1, N. Y. (Tel. STillwell 4-0530)
Dir.-Purch.: B. Pilmer
Purch. Agent: R. Quinn
Asst. Purch. Agent: M. Meyers
V. P.-Sales: J. Albert — S, MS

E. F. TWOMEY CO., INC.
728 W. 10th Pl., Los Angeles 15, Calif. (Tel. RI 9-9451)
Secy.-Treas.: E. F. Twomey, Jr. — M

TYPHOON AIR CONDITIONING DIV., HUPP CORP.
505 Carroll St., Brooklyn 15, N. Y. (Tel. ULster 8-0800)
Purch. Agent: George W. Weinberg
Asst. Purch. Agent: T. E. Krawetz
V. P.-Sales: John A. Gilbreath

U B S CHEMICAL CO., DIV.-A. E. STALEY MFG. CO.
491 Main St., Cambridge, Mass. (Tel. UN 4-7300)
Dir.-Purch.: C. M. Kopatch
Dir.-Sales: J. C. Smith — M

U. E. ELECTRONICS CORP.
285 Warren St., Lyndhurst, N. J. (Tel. GEneva 8-2400)
Purch. Agent: John McElroy
Sales Mgr.: Stephen Horbach — MS

UDYLITE CORP., THE
Detroit 11, Mich. (Tel. WA 1-3500)
Dir.-Purch.: V. E. Zobel
Sales Mgr.: L. J. Mimbiole — M, RD

UEHLING INSTRUMENT CO.
473 Getty Ave., Paterson, N. J. (Tel. SHerwood 2-8710)
Purch. Agent: J. W. Riccobene
Sales Mgr.: P. J. Riccobene

GEORGE ULANET CO.
413 Market St., Newark 5, N. J. (Tel. MArket 2-4876)
Sales: H. Ulanet — M

ULLMAN DEVICES CORP.
Danbury Rd., Ridgefield, Conn. (Tel. IDlewood 8-6577)
Dir.-Prod.: John Patella
Dir.-Sales: Edward Ullman

ULTRA ELECTROFORMING & MFG. CO.
110 Cedar Ave., Pitman, N. J. (Tel. LUther 9-7666)
Treas.: E. P. Carter

ULTRADYNE, INC.
2630 San Mateo, N. E., Albuquerque, N. M. (Tel. AMherst 8-2431)
Mgr.-Tech. Sales: Edward L. Amonette — MS, G, CT, TT

ULTRASONIC ENGRG. CO.
618 Lake St., Maywood, Ill. (Tel. FI 4-8814)
Pres.: H. R. Hall — CT

ULTRA-VIOLET PRODUCTS, INC.
5114 Walnut Grove Ave., San Gabriel, Calif. (Tel. CUmberland 3-3193)
Factory Supt.: Melvin D. Hershey
Sales Mgr.: T. S. Warren — CT

UNDERWOOD ELECTRIC & MFG. CO., INC.
4926 W. Grand Ave., Chicago, Ill. (Tel. NAtional 2-9450)
Purch.: Edward J. Meier
Sales: Robert G. Futterer

UNGAR ELECTRIC TOOLS, DIV.-ELDON IND.
4101 Redwood Ave., Los Angeles 66, Calif. (Tel. EXmont 8-5718)
Purch. Mgr.: Frank Hurd
Gen. Mgr.: William L. Nehrenz

UNHOLTZ-DICKIE CORP.
2994 Whitney Ave., Hamden 18, Conn. (Tel. ATwater 8-3358)
Pres.: John A. Dickie
V. P.: Karl Unholtz — CT

UNIFIED INDUSTRIES, INC.
10939 Vanowen St., North Hollywood, Calif. (Tel. TRiangle 7-5647)
Prod. Coordinator: Walter McHugh
Mil. Liaison: William Carl (Tel. PO 6-1411) — S, MS, CT, RD

UNI-FLEX MFG. & ENGRG. INC.
5545 E. Slauson Ave., Los Angeles 22, Calif. (Tel. OV 5-8070)
Chief, Est.: Verne Perry
Sr. V. P.-Sales: John Conley — S, MS

UNIFORM HOOD LACE CO.
633 E. St. Clair St., Indianapolis 2, Ind. (Tel. ME 1-9177)
Purch. Agent: B. S. Anthony
Sales Mgr.: James R. Anthony — M

UNIFORM TUBES, INC.
Level Rd., Collegeville, Pa. (Tel. HUxley 9-7276)
Purch. Agent: Gordon Hattersley
Sales Mgr.: D. T. MacNair — M

UNIMAX SWITCH DIV., THE W. L. MAXSON CORP.
Ives Rd., Wallingford, Conn. (Tel. COlony 9-8701)
Purch. Agent: J. Osias
Sales Mgr.: J. Martinez
Asst. Sales Mgr.: J. Jacobs — MS, G, CT, TT, RD

UNION ASBESTOS & RUBBER CO.
1111 W. Perry St., Bloomington, Ill. (Tel. 3-8081)
Purch. Agent: L. Vicha
Sales Mgr.: E. T. Plummer — M

UNION CARBIDE METALS CO., DIV.-UNION CARBIDE CORP.
30 E. 42nd St., New York 17, N. Y.

UNION CARBIDE PLASTICS CO.
30 East 42nd St., New York 17, N. Y. (Tel. MUrray Hill 7-8000)
Dir.-Purch.: S. V. Clarke
Purch. Dept.: C. W. Goodman & W. J. Hann
V. P.-Sales: J. D. Benedito — M

UNION SWITCH & SIGNAL DIV.-WESTINGHOUSE AIR BRAKE CO.
Braddock Ave., Pittsburgh 18, Pa. (Tel. CHurchill 2-5000)
Mgr.-Purch.: H. I. McKeever
Sr. Buyer: C. S. Paxon
Mgr.-Gen. Apparatus: P. K. Eckhardt — MS

UNISON PRODUCTS, INC.
705 W. Savidge St., Spring Lake, Mich. (Tel. VIking 2-1349)
Pres.: M. Bakels
Sales Mgr.: Raymond Berwald — MS, G, RD

UNIT CRANE & SHOVEL CORP.
6411 W. Burnham St., Milwaukee, Wisc. (Tel. Mitchell 5-8840)
Asst. to Pres. & Works Mgr.: A. B. Py
Purch. Agent: W. F. Ellingson
V. P.-Sales: A. R. Corbett
Sales Mgr.-Electric Cranes: V. S. Barnes
Sales Mgr.-Mechanical Cranes: J. Lenahan — MS

UNIT PROCESS ASSEMBLIES, INC.
61 E. 4th St., New York 3, N. Y. (Tel. SPring 7-1398)
Purch.: C. Cirilli
Sales Mgr.: S. U. Lieber — CT

UNITED AIRCRAFT PRODUCTS, INC.
1116 Bolander Ave., Dayton 8, Ohio (Tel. BAldwin 4-3841)
Purch. Agent: Les Trew
V. P.-Sales: Frank A. Ryan — PS, MS, CT

UNITED CARBON PRODUCTS CO.
1318 N. Madison St., Bay City, Mich. (Tel. TWinbrook 3-4575)
Purch. Agent: M. D. Sordyl
Sales Mgr.: E. J. Musinski

CODING

Structures	S
Propulsion System	PS
Missile Support	MS
Materials	M
Guidance	G
Checkout & Testing	CT
Tracking & Telemetering	TT
Research & Development	RD
Human Space Engineering	HSE

UNITED CONTROL CORP.
4540 Union Bay Pl., Seattle 5, Wash. (Tel. LAkeview 5-9200)
Purch. Agent: Hugh LaVille
Components Buyers: George Jensen & Earl Carp
Mgr.-Sales Dept.: John M. Mix **MS**

UNITED ELECTRIC CONTROLS CO.
85 School St., Watertown 72, Mass. (Tel. WAlnut 6-1000)
Purch. Agent: R. Rando
Asst. Purch. Agent: M. Tutunjian
V. P.-Sales: S. Tinerr **PS, MS, CT**

UNITED ELECTRONIC MFG. CORP.
542 39th St., Union City, N. J. (Tel. UNion 5-4452)
Dir.-Sales: Charles M. Wolf **M**

UNITED MFG. CO., THE
5250 Dobeckmun Ave., Cleveland 2, Ohio (Tel. OLympic 1-6310)
Purch. Agent: Harold L. Murphy
Sales Mgr.: W. R. Albrecht **MS, M, RD**

UNITED MFG. CO. DIV., W. L. MAXSON CORP.
41 Haig St., Hamden 14, Conn. (Tel. New Haven-CH 8-4491)
Purch. Agent: C. W. Redmond
V. P.-Sales: V. A. Stancliff **MS, CT**

UNITED MINERAL & CHEMICAL CORP.
16 Hudson St., New York 13, N. Y. (Tel. BEekman 3-8870)
Purch. Agent: Terry D. Koncelik
Sales: Herbert M. Rosenthal
Mgr.-Metals Dept.: Alexander Imich **M**

UNITED PLATING WORKS, INC.
4118 N. Mingo Rd., Tulsa 15, Okla. (Tel. TEmple 5-4683)
Purch.: S. A. Bergman
V. P.-Sales: Meredith L. Sutton

UNITED SENSOR & CONTROL CORP.
122 Naubuc Ave., Glastonbury, Conn. (Tel. ME 3-2867)
Purch. Agent: G. W. Hughes **CT**

UNITED SHOE MACHINERY CORP.
140 Federal St., Boston 7, Mass. (Tel. LIberty 2-9100)
Dir.-Purch.: H. F. Pfaff
Purch.: R. J. Carroll, George E. Bowen
V. P.: C. R. Todd **RD**

UNITED SMELTING & ALUMINUM CO., INC.
P. O. Box 1910, New Haven, Conn. (Tel. MA 4-2181)
Pres.: R. E. Lapides
Gen. Supt.: F. A. Merliss
Exec. V. P.-Sales: Milton E. Rosenthal

U. S. A.C. TRANSPORT, INC.
457 W. Fort St., Detroit, Mich. (Tel. WOodward 3-7913)
Dir.-Cust. Rel.-Sales: J. Wade Jacobson **S, PS, MS, M, G, CT, TT, RD, HSE**

U. S. COMPONENTS INC.
454-462 E. 148th St., New York 55, N. Y. (Tel. CYpress 2-6525)
V. P.-Purch. & Sales: B. A. Jackson
Chief Engr.: S. Nalbantian **PS, MS, G, CT, TT, RD, HSE**

U. S. ELECTRICAL MOTORS
Box 2058, Terminal Annex, Los Angeles 54, Calif. **M, CT**

U. S. ELECTRICAL TOOL CO.
3640 Llewellyn St., Cincinnati, Ohio (Tel. MUlberry 1-3410)
V. P.-Purch.: G. D. Behlen
Dir.-Sales: P. D. Schneider

U. S. GEAR CORP.
81 Bay State Rd., Wakefield, Mass. (Tel. CRystal 6-4900)
Pres.: Robert A. Sayce
V. P.-Engrg.: A. P. Cotreau
V. P.-Sales: David M. Abbot

U. S. INDSL. CHEMICALS CO., DIV.-NATIONAL DISTILLERS & CHEMICAL CORP.
99 Park Ave., New York 16, N. Y. (Tel. OX 7-0700)
V. P.-Purch.: R. E. Hennessy
V. P.-Sales: A. R. Ludlow, Jr. **M**

U. S. INDUSTRIES, INC.
250 Park Ave., New York, N. Y. (Tel. OXford 7-4141)
Sales: T. Petrides **S, MS, M, G, CT, RD**

U. S. PIPE & FOUNDRY CO., STEEL & TUBES DIV.
E. Pearl St., Burlington, N. J. (Tel. DUdley 6-1850)
Sales Mgr.: John D. Lewis
Purch. Agent: H. E. Cross, 3300 First Ave., North Birmingham, Ala. (Tel. AL 2-3161)
Asst. Purch. Agent: J. D. Dantzler (Tel. AL 1-3161) **PS, M**

U. S. PLASTIC MOLDING CORP.
130 Carlton St., Wallingford, Conn. (COlony 9-4426)
Purch. Agent: H. Schenck
Sales Mgr.: A. Johnson **MS**

U. S. RELAY-ELECTRONICS, DIV.-A.S.R. PRODUCTS CORP.
717 N. Coney Ave., Azusa, Calif. (Tel. EDgewood 4-8206)
Purch. Mgr.: S. J. Astrican
Asst. Purch. Mgr.: Ben Marks
Sales Mgr.: Lyle D. Bunce

U. S. SCIENCE CORP., DIV.-TOPP INDUSTRIES, INC.
5221 W. 102nd St., Los Angeles 45, Calif. (Tel. SPring 6-0450)
Dir. Materiel: W. B. Miller
Buyers: W. J. Steffy, G. H. Wood
Mgr.-Cust. Rel.: M. A. Pahlavan **MS, M, CT, RD**

U. S. SEMICONDUCTOR PRODUCTS DIV.-UNITED INDUSTRIAL CORP.
3540 W. Osborn Rd., Phoenix, Arizona (Tel. BRowning 2-1341)
Purch. Agent: Raymond W. Delor
V. P.-Sales: Joseph C. Worth, Jr. **RD**

U. S. SONICS CORP.
625 McGrath Hwy., Somerville 45, Mass. (Tel. MOnument 6-8781)
Dir.-Purch. & Sales: Merrill Callum **M**

U. S. STEEL SUPPLY DIV., UNITED STATES STEEL CORP.
208 S. LaSalle St., Chicago 4, Ill. (Tel. CEntral 6-9200)
Mgr.-Material Cont.: J. E. Grant
V. P.-Sales: K. P. Rindfleisch

UNITED STATES CHEMICAL MILLING CORP.
1700 Rosecrans Ave., Manhattan Beach, Calif. (Tel. ORegon 8-4041)
Purch. Agents: J. H. Vincent, Jr., Gomar M. Adams & Glenn F. Heck
Asst. Dir.-Contracts: R. S. Stevens
Gen. Purch. Agent: R. V. McCulloch, 12915 Weber Way, Hawthorne, Calif. (Tel. ORegon 8-4015) **S, M, RD**

UNITED STATES GRAPHITE CO., THE, DIV.-THE WICKES CORP.
1621 Holland Ave., Saginaw, Mich. (Tel. PLeasant 5-0441)

UNITED STATES INSTRUMENT CORP.
P. O. Box 1191, Charlottesville, Va. (Tel. 3-5153)

UNITED STATES PLASTIC ROPE, INC.
2581 Spring St., Redwood City, Calif. (Tel. EMerson 8-1461)
Gen. Mgr.: James G. Allio **M**

UNITED STATES PLYWOOD CORP.
55 W. 44th St., New York 36, N. Y. (Tel. MU 2-1900)
Dir.-Purch.: William Tietgen
V. P.-Sales: Monroe W. Pollack **S, M, RD**

UNITED STATES RADIUM CORP.
P. O. Box 246, Morristown, N. J. (Tel. JEfferson 9-4000)
Purch. Agent: R. Van Epps
Asst. Purch. Agent: D. Weaver
V. P.-Sales: C. W. Walhausen **MS, M, G, CT, TT**

UNITED STATES RUBBER CO.
1230 Ave. of the Americas, New York, N. Y. (Tel. CIrcle 7-5000)
Dir.-Purch.: S. W. MacKenzie
Asst. Dir.-Purch.: W. H. Spratling
Govt. Dept.-Sales: Douglas K. Bonn, Mgr., 1700 K Street, N. W., Washington, D. C. **PS, MS, M, RD**

UNITED STATES STEEL CORP.
525 William Penn Place, Pittsburgh 30, Pa. (Tel. EXpress 1-2345)
V. P.-Purch.: R. C. Moffitt
Purch. Agent-Raw Materials: E. G. Barrett
Purch. Agent-Prod. Supplies: S. Parey
Purch. Agent-Equip.: R. F. Dyson
Dir.-Sales: R. F. Sentner **S, PS, MS, M**

UNITED STATES TESTING CO., INC.
1415 Park Ave., Hoboken, N. J. (Tel. SWarthmore 2-2400)
Purch. Agent: R. C. Holmes
Sales Mgr.: A. F. Maxfield **CT, RD, HSE**

UNITED STATES TIME CORP., THE, GYRO DIV.
375 Park Ave., New York 22, N. Y. (Tel. PLaza 9-5665)
Sales Mgr.: H. D. Armstrong
Sales Engr.: C. D. Stalker
Purch. Agent: E. Hull, Waterbury 20, Conn. (Tel. PLaza 8-2444) **G, RD**

UNITED STATES WIRE & CABLE CORP.
Progress & Monroe Sts., Union, N. J. (Tel. MUrdock 8-1100)
Purch. Agent: Herman Goldrum
Sales Mgr.: Richard A. Hyer **M**

UNITED SUPPLY CO.
3676 S. Broadway Pl., Los Angeles 7, Calif. (Tel. ADams 3-4384)
Pres.: Harry L. Guss
Mgr.-Contracts: Morris C. Guss
Sales Mgr.: Arthur C. Brownell **M**

UNITED TECHNOLOGY CORP.
1944 University Ave., Palo Alto, Calif. (Tel. DA 1-5510); P. O. Box 365, Menlo Park, Calif. (Tel. DA 1-2550)
Dir.-Purch.: H. A. Crawford (Tel. DA 1-2550)
Asst. Purch. Agent: Hugh Stanton (Tel. DA 1-2550)
Buyer: Ruth Pasca (Tel. DA 1-2550) **PS, M, RD**

UNITED WIRE & SUPPLY CORP.
1497 Elmwood Ave., Providence 7, R. I. (Tel. STuart 1-3000)
Purch. Agent: Hector A. Soucy
Gen. Sales Mgr.: J. G. Landrigan

UNIVERSAL CIRCUIT CONTROLS
3610 Oakton St., Skokie, Ill. (Tel. ORchard 5-2620)
Gen. Mgr.: Sander B. Friedman
Sales Mgr.: Earl R. Sayre

UNIVERSAL CONDENSER CO.
3435 N. Kimball Ave., Chicago 18, Ill. (Tel. CO 7-3933)
Pres.: A. S. Ridgway (Tel. CO 7-1877)
Chief Engr.: E. S. Ridgway

UNIVERSAL-CYCLOPS STEEL CORP.
Executive Offices, Bridgeville, Pa. (Tel. CAnal 1-8000)
V. P. & Gen. Mgr.: F. A. Kaufman
V. P.-Sales: W. J. Long **M, RD**

UNIVERSAL DRAFTING MACHINE CORP.
7960 Lorain Ave., Cleveland 2, Ohio (Tel. OL 1-4747)
Purch. Agent: D. DeVito
V. P.-Sales: S. W. Hoover

UNIVERSAL DYNAMICS CORP.
P. O. Box 9814, 1441 N. 19th St., Arlington 9, Va. (Tel. JAckson 5-4541)
Purch. Agent: David L. Watson
Sales Mgr.: Kirk L. Burns **MS, CT, RD**

UNIVERSAL ELECTRIC CO.
300 E. Main St., Owosso, Mich. (Tel. SAratoga 5-7174)
Dir.-Purch.: Gerald Hoddy
Dir.-Sales: A. E. Kerscher **MS, M**

UNIVERSAL ELECTRONICS CO.
1720 22nd St., Santa Monica, Calif. (Tel. EXbrook 3-9219)
Purch. Agent: Wilbert Kemp

UNIVERSAL MFG. CO., INC.
1168 Grove St., Irvington 11, N. J. (Tel. ESsex 4-9800)
Purch. Agent: W. E. Arends
Sales Engr.: Anthony O. Vicari

UNIVERSAL MOULDED PRODUCTS CORP.
Commonwealth Ave., Bristol, Va. (Tel. NO 9-1181)
Dir.-Proc. T. F. Morrell
Buyer-Plastic Div.: Charles Fagan
Buyer-Cabinet Div.: J. G. Barnes
V. P.-Sales: C. L. Meteer **S, MS, RD**

UNIVERSAL TOROID COIL WINDING, INC.
171 Coit St., Irvington 11, N. J. (Tel. ESsex 4-9806)
Purch. Agent: Irene B. Cardino
Sales Mgr.: Anthony O. Vicari

UNIVERSAL TRANSISTOR PRODUCTS CORP.
36 Sylvester St., Westbury, N. Y. (Tel. EDgewood 3-3304)
Purch. Agent: Stanley Palaski
Dir.-Sales: Albert Schneider **MS**

UNIVERSAL UNLIMITED, INC.
Pratt Oval, Glen Cove, N. Y. (Tel. ORiole 6-4600)
Purch. Agent: Henry J. Belmont
Sales Mgr.: Mark L. Steiner **TT**

UNIVERSITY LOUDSPEAKERS, INC.
80 S. Kensico Ave., White Plains, N. Y. (Tel. WHite Plains 6-7700)
Purch. Agent: Rocco Di Rico
Sales Mgr.: Charles Ray **RD**

UTILITY BRASS & COPPER CORP.
116 King St., Brooklyn 31, N. Y. (Tel. ULster 8-9400)
Buyer: R. Andersen
Sales Mgr.: G. E. Martin **M, RD**

V & H RADIO & ELECTRONICS
2053 Venice Blvd., Los Angeles 6, Calif. (Tel. RE 5-0215)

VACAP CORP.
1905 Summit Ave., Union City, N. J. (Tel. UNion 7-6699)
V. P.-Purch. & Sales: L. Dolinko **M, CT, RD**

VAC-HYD PROCESSING CORP.
116 Manchester, Highland Park 3, Mich. (Tel. TO 9-6333)
Pres.: Robert F. Gunow
V. P.: L. E. Oliphant
Factory Mgr.: W. A. Coulter **S, PS**

VACO PRODUCTS CO.
317 E. Ontario St., Chicago 11, Ill. (Tel. WH 4-2340)
Purch. Agent: Jack Morozinc
V. P.-Sales: Roy Vetzner **M**

VACUUM RESEARCH CO.
420 Market St., San Francisco 11, Calif. (Tel. YUkon 2-3565)
Purch.: H. F. Perezone, 1929 Williams St., San Leandro, Calif. (Tel. LOckhaven 8-1252)
Sales: Larry Wright, San Francisco

VACUUM SPECIALTIES CO., INC.
34 Linden St., Somerville 43, Mass. (Tel. MOnument 6-5450)
Pres.: William DiPietro
Gen. Mgr.: George DiPietro
Purch. Agent: Betty Nichols
Sales Mgr.: George W. Carr **M**

VACUUM TUBE PRODUCTS DIV., HUGHES AIRCRAFT CO.
2020 Short St., Oceanside, Calif. (Tel. SAratoga 2-2101)
Purch. Agent: John Grasso
Mktg. Mgr.: A. Earle Fisher **RD**

VALCOR ENGRG. CORP.
565 Carnegie Ave., Kenilworth, N. J. (Tel. CHestnut 5-1665)
Purch. Agent: M. A. Kreitchman
Gen. Sales Mgr.: Murray Maslow **PS, MS, RD**

VALOR INSTRUMENTS, INC.
13214 Crenshaw Blvd., Gardena, Calif. (Tel. FAculty 1-2280)
Purch. Agent: E. Kurchak
Prod. Mgr.: R. Cook
Pres.: T. J. Johnson
V. P.-Sales: W. T. Burns **G, CT, TT**

VALPEY CRYSTAL CORP.
1244 Highland St., Holliston 1, Mass. (Tel. GArden 9-4851)
Dir.-Purch.: Robert W. Valpey
V. P.: T. S. Valpey, Jr.
Sales Mgr.: Nelson B. Piper, Jr. **M, RD**

VALVERDE LABS.
252 Lafayette St., New York 12, N. Y. (Tel. WAlker 5-6742)
Owner: Robert Valverde **CT**

VAN DER HORST CORP.
1645 East State Rd., Olean, N. Y. (Tel. 3173)
Purch. Agent: A. B. Roop
Sales Mgr.: Frank Jorstad

VAN KEUREN CO.
176 Waltham St., Watertown 72, Mass. (Tel. WAtertown 4-4394)
Pres.: R. T. Parsons
Sales Mgr.: William Mark **G**

VAN NORMAN MACHINE CO., DIV.-VAN NORMAN INDUSTRIES, INC.
3640 Main St., Springfield 7, Mass. (Tel. REpublic 7-4721)
Purch. Agent: Ralph H. Grefer
V. P. & Sales Mgr.: George P. Burns
V. P. & Chief Engr.: Francis P. Healy **MS, M**

VAN WAGNER CO.
101 W. Allendale Ave., Allendale, N. J. (Tel. DAvis 7-2112)
Dir.-Purch.: L. A. Van Wagner
Purch. Dept.: L. M. Wittemer **CT**

VAN ZELM ASSOCIATES, INC.
7803 Pulaski Hwy., Baltimore 6, Md. (Tel. MUrdock 7-1414)
Purch. Mgr.: Gordon Sinclair
Business Mgr.-Sales: Gerald McBride **RD**

VANADIUM CORP. OF AMERICA
420 Lexington Ave., New York 17, N. Y. (Tel. LE 2-3580)
Dir.-Purch.: F. W. Thomas
V. P.: R. H. Filsinger, Jr.

VANADIUM-ALLOYS STEEL CO.
Latrobe, Pa. (Tel. KEystone 7-5551)
Purch. Agent: Lewis M. Potter
Asst. Purch. Agent: Alex B. Smith
V. P.-Sales: R. Burns George **M**

VANGUARD ELECTRONICS CO.
3384 Motor Ave., Los Angeles 34, Calif. (Tel. UPton 0-6721)
Pres.-Purch.: Simon A. Golbert

VANTON PUMP & EQUIPMENT CORP.
201 Sweetland Ave., Hillside, N. J. (Tel. WA 6-2435)
Purch. Agent: R. Tillsley (Tel. MU 8-4120)
Sales Mgr.: S. F. Cooper

VAP-AIR AERONAUTICAL PRODUCTS DIV., VAPOR HEATING CORP.
80 E. Jackson Blvd., Chicago 4, Ill. (Tel. WAbash 2-5160)
Purch. Agent: Robert W. Currer
Buyers: Ronald R. Krenek & Frank Slapak
V. P.-Sales: L. H. Gillick **MS, RD**

VAPOR BLAST MFG. CO.
3025 W. Atkinson Ave., Milwaukee 9, Wis. (Tel. CUster 3-6500)
Purch. Agent: A. Odehnal
Sales Mgr.: H. F. Patin **MS**

VARFLEX CORP.
512 W. Court St., Rome, N. Y. (Tel. 7200)
Purch.: Merrick Drummond
Sales: J. H. Finnegan **M**

VARIAN ASSOCIATES
611 Hansen Way, Palo Alto, Calif. (Tel. DAvenport 6-4000)
Chief-Purch.: Hamilton Shutts
Sales Mgr.: W. M. Silhavy, Tube Div.
Sales Mgr.: Emery Rogers, Instrument Div.
Sales Mgr.: Paul I. Corbell, Radiation Div.

VARIETY AIRCRAFT CORP.
2901 W. 3rd St., Dayton, Ohio (Tel. AM 3-2664)
Gen. Mgr.: C. A. Coppock
Ch. Engr.: W. H. Kuntz

VARI-L CO., INC.
207 Greenwich Ave., Stamford, Conn. (Tel. FIreside 8-0091)
Pres.: J. L. Kiser **TT**

VAR-LAC-OID CHEMICAL CO.
116 Broad St., New York 4, N. Y. (Tel. WHitehall 4-0348)
Purch. Agent: Martin G. Brent
Sales Mgr.: Irvin E. Behrman **M**

VARO MFG. CO., INC.
2201 Walnut St., Garland, Tex. (Tel. BRoadway 6-6141)
Purch. Agent: Brad Riggs
Buyers: Gene Grubbs & Marvin Meyers
Mgr.-Customer Relations: J. R. Gilmer **MS, G, CT, TT, RD**

VASCOLOY-RAMET CORP.
800 Market St., Waukegan, Ill. (Tel. ON 2-5220)
Purch. Agent: L. R. Paluska
Sales Mgr.: B. F. Naden

VECTOR ELECTRONIC CO., INC.
1100 Flower St., Glendale 1, Calif. (Tel. CHapman 5-1076)
Purch. Agent: P. R. McQuade
Asst. Purch. Agent: E. L. Buck
Sales Mgr.: F. L. Hill

VECTOR MFG. CO.
5616 Lawndale St., Houston 23, Texas (Tel. WA 6-8821)
Purch. Agent: L. M. Coombs
V. P.: K. W. McLom
Sales Mgr.: M. D. Vandusen
Prod. Supvr.: L. D. Zepernick **CT, TT**

VEECO VACUUM CORP.
86 Denton Ave., New Hyde Park, L. I., N. Y. (Tel. Pioneer 6-1161)
Purch. Agent: E. Potter
V. P.-Sales: William R. Meoli

VEEDER-ROOT INC.
70 Sargeant St., Hartford 2, Conn. (Tel. JAckson 7-7201)
Purch. Agent: R. I. Bond
Sales Mgr.: C. C. Lombardi

VEET INDUSTRIES
25753 Groesbeck Hwy., E. Detroit, Mich. (Tel. PRescott 6-3000)
Pres. & Gen. Mgr.: R. C. Vait **PS**

VELCRO SALES CORP.
681 Fifth Ave., New York 22, N. Y. (Tel. PLaza 1-2144)
V. P.: J. C. Frankel **M**

VEMALINE PRODUCTS CO.
P. O. Box 222, Hawthorne, N. J. (Tel. MUlberry 4-4688)
Purch. Agent: Wm. Venema

VENDORLATOR MFG. CO.
2550 S. Railroad Ave., Fresno, Calif. (Tel. AMhert 6-9401)
Purch. Agent: O. J. McMillin
Asst. Purch. Agent: Howard Henry
Sales: E. E. Brown (West Coast) Bert Schwartz (East Coast) **MS**

VERNISTAT DIV., THE PERKIN-ELMER CORP.
772 Main Ave., Norwalk, Conn. (Tel. VIctor 7-0411)
Div. Purch.: A. Cummings
Sales Mgr.: Lionel Robbins

VERNON CHEMICAL & MFG. CORP.
220 E. 42nd St., New York 17, N. Y. (Tel. YUkon 6-1133)
Purch. Agent: Gordon R. Keyes
Dir.-Tech. Service: Cliff Roher
Customer Service Dept.: Harold Sussman
Gen. Sales Mgr.: William F. Carlson **M**

VERSA PRODUCTS CO., INC.
150 Coolidge Ave., Englewood, N. J. (Tel. LOwell 7-2820)

VERSON ALLSTEEL PRESS CO.
9342 S. Kenwood Ave., Chicago 19, Ill. (Tel. REgent 4-8200)
Dir.-Purch.: H. Wiggins
Sales Mgr.: P. C. Kjelstrom **S, M, RD**

VIBRATION ISOLATION PRODUCTS
116 W. Elm Court, Burbank, Calif. (Tel. THornwall 6-2388)
Gen. Mgr.: Pat Dean
Chief Engr. & Sales: Duff Dean **MS, M, CT, TT**

VICKERS INC.
172 E. Aurora St., Waterbury 20, Conn. (Tel. PLaza 6-3681)
Purch. Mgr.: R. L. Gabers
Sales Mgr.: R. J. Mitchell **MS, CT, RD**

VICKERS INC., ELECTRIC PRODUCTS DIV.
1815 Locust St., St. Louis 3, Mo. (Tel. CEntral 1-5830)
Dir.-Purch.: Tom Waller **MS, G**

VICKERS, INC., MICH.
Maple & Crooks Rd., P. O. Box 302, Detroit 32, Mich. (Tel. LI 9-1122)
V. P.-Purch.: R. McCabe
Gen. Purch. Agent: R. B. Sharkey
Gen. Sales & Service Mgr.: J. T. Burns
Purch. Agent: W. Joyce, Torrance, Calif. (Tel. DA 6-8550) **PS, MS, G, CT, RD**

VICKERS INC., DIV.-SPERRY RAND CORP.
Administrative & Engrg. Ctr., Detroit 32, Mich. (Tel. Royal Oak—LIberty 9-1122)
Gen. Purch. Agent: R. V. Sharkey
Gen. Sales Mgr.: J. T. Burns **MS, G, CT, RD**

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

VICKERS INC., MARINE & ORDNANCE DEPT., MACHINERY HYDRAULICS DIV.
172 E. Aurora St., Meriden, Conn. (Tel. PL 6-3684)
Purch. Agent: Harold Carberry
Sales Mgr.: R. J. Mitchell

VICON CORP., SUB.-INSUL-8-CORP.
1369 Industrial Rd., San Carlos, Calif. (Tel. LYtell 3-8003)
V. P. & Gen. Mgr.: Winston Boone
Asst. Sales Mgr.: John Baker
V. P.-Engrg.: George Sleeper MS, RD

VICTOR ELECTRIC WIRE & CABLE CORP.
618 Main St., West Warwick, R. I. (Tel. VAlley 1-1700)
Purch. Mgr.: David Krakowsky
Sales Mgr.: Norman Brill

VICTOR MFG. & GASKET CO.
5750 W. Roosevelt Rd., Chicago 50, Ill. (Tel. AUstin 7-6180)
Gen. Purch. Agent: Harold G. North
Purch. Agent: R. G. Stovicek
Buyer: E. F. Balcar
V. P.-Indsl. Sales: Albert J. Aukers PS, M

VICTOR R. F. & MICROWAVE CO.
36 W. Water St., Wakefield, Mass. (Tel. CRystal 9-4472)
Gen. Mgr.: George P. Victor MS, G, RD

VICTOR TOOL & MFG., INC.
Route 9, Saybrook Rd., Higganum, Conn. (Tel. Diamond 5-4521)
Purch. Agent & Dir.-Sales: Joseph G. Marek RD

VICTOREEN INSTRUMENT CO.
5806 Hough Ave., Cleveland 3, Ohio (Tel. ENdicott 1-6200)
Purch. Agent: S. J. Rosa
Buyers: A. Burkhart & R. Tucker
Sales Mgr.: William A. McCarthy M, RD

VICTORY ENGRG. CORP.
P. O. Box 373, Springfield Rd., Union, N. J. (Tel. Murdock 8-7150)
Purch. Agent: R. W. Blimm
Sales: W. B. Huston

VIDEO INSTRUMENTS CO., INC.
3002 Pennsylvania Ave., Santa Monica, Calif. (Tel. EXbrook 3-1244)
Purch. Agent: Darlene Thompson
Prod. Mgr.: Bob Cobery
V. P. & Gen. Mgr.: Peter Pohl CT, TT

VIEWLEX, INC.
35-01 Queens Blvd., Long Island City 1, N. Y. (Tel. EXeter 2-0100)
Pres.: L. A. Peirez
Sales Engr.: H. Walter
Sales Mgr.: M. R. Abrams
Purch. Agent: J. Friedland MS, RD

VIKING INDUSTRIES INC.
21343 Roscoe Blvd., Canoga Park, Calif. (Tel. Diamond 7-8500)
Purch. Agent: W. Wright
Sales Mgr.: F. V. Criswell

VIKING PUMP CO.
4th & Jarvis Sts., Cedar Falls, Iowa (Tel. COlfax 6-1741)
Purch. Agent: H. L. Willson
V. P.-Sales: Stanley E. Petersen

VILTER MFG. CO., THE
2217 S. First St., Milwaukee 7, Wisc. (Tel. SHeridan 4-0111)
Mgr.-Purch.: L. E. Loos
V. P.-Sales: A. O. Vogel

VINCO CORP.
9111 Schaefer Hwy., Detorit 28, Mich. (Tel. WEbster 3-4350)
Dir.-Purch.: E. L. Camen S, MS, G

VINSON MFG. CO. INC.
8044 Woodley Ave., Van Nuys, Calif. (Tel. TRiangle 3-3510)
Factory Mgr.: G. Scott
Sales: William A. Goodman MS, RD

VIRGINIA ELECTRONICS CO., INC.
5203 River Rd., Washington 16, D. C. (Tel. OLiver 4-6680)
Purch. Agent: Edward Schwartz
Sales Mgr.: Albert Cohen G, CT, RD

VIRGINIA PLAK CO.
270 Madison Ave., New York 16, N. Y. (Tel. MUrray Hill 3-9516)
Gen. Mgr.: S. N. Weis

VITA-VAR CORP.
10 Commerce Court, Newark 2, N. J. (Tel. MArket 3-0860)
Purch. Agent: Alton G. Tremper
Sales Mgr.: R. A. Pearce M

VITRAMON, INC.
P. O. Box 544, Bridgeport 1, Conn. (Tel. AMherst 8-1656)
Purch. Agent: William Murphy
Asst. Purch. Agent: Mrs. Marjorie Dubac
Sales Mgr.: Clifford H. Tuttle, Jr.

VITRO CORP. OF AMERICA
261 Madison Ave., New York, N. Y. (Tel. MUrray Hill 2-5700)
Purch. Agent: E. S. Fowler
Exec. V. P.-Sales: W. A. Bain

***VITRO LABS.**
200 Pleasant Valley Way, West Orange, N. J. (Tel. REdwood 1-3400)
Procurement Mgr.: J. E. Eaton
New Proj. Mgr.-Sales: W. L. Slover
*(See advertisement this issue)

VLCHEK TOOL CO.
3001 E. 87th St., Cleveland 4, Ohio (Tel. GA 1-2480)
Purch. Agent: F. J. Tkach
V. P.-Sales: L. F. Storie M

VLIER ENGRG. CORP.
8900 Santa Monica Blvd., Los Angeles 46, Calif. (Tel. OLeander 5-6540)
Purch. Agent: T. Bavin
Buyers: S. M. Bresett & S. Lemaster
Sales Mgr.: H. Wrigley M

VOCALINE CO. OF AMERICA INC.
Coulter St., Old Saybrook, Conn. (Tel. EV 8-3414)
Pres.: Carroll T. Cooney
Treas.: Robert Cooney M, RD

VOI-SHAN ELECTRONICS
13259 Sherman Way, North Hollywood, Calif. (Tel. TRiangle 7-9952)
Prod. Mgr.: W. Cahill
Gen. Sales Mgr.: Donald M. Worden MS, G, CT, RD

VOI-SHAN MFG. CO., DIV.-VOI-SHAN INDUSTRIES, INC.
8463 Higuera St., Culver City, Calif. (Tel. VErmont 8-2131); 3562 Eastham Dr., Culver City, Calif.
Dir.-Materiel: G. W. Hausman
Gen. Sales Mgr.: Thomas F. Spoehr

VORAC CO., THE
147 Meadow Rd., Rutherford, N. J. (Tel. WEbster 3-1000)
Dir.-Purch.: Robert Geist
Dir.-Sales: D. E. Hartman

WAAGE ELECTRIC, INC.
720 Colfax Ave., Kenilworth, N. J. (Tel. CHestnut 5-9363)
Pres. & Engr.: Clark A. Waage
V. P.: Curtis Frantz M

WACLINE, INC.
35 S. St. Clair St., Dayton 2, Ohio (Tel. BAldwin 8-5161)
Pres.: W. A. Charbonneaux
Dir.-Materiel: R. G. Swanson
V. P.: M. E. Goll MS, G, CT, RD

WACO AIRCRAFT CO.
Peters Ave., Troy, Ohio (Tel. FE 2-1234)
Purch. Agent: John D. Potterbaugh
Sales Solicitor: C. M. Moffitt MS

WAH CHANG CORP.
233 Broadway, New York 7, N. Y. (Tel. COrtlandt 7-0887)
V. P.-Sales: K. C. Li, Jr. M, RD

WAHLGREN MAGNETICS, DIV.-MARSHALL INDUSTRIES
1900 Walker Ave., Monrovia, Calif. (Tel. MUrray 1-8456)
Purch. Agent: Joseph Ustica
Gen. Mgr.: L. W. Moede
Sales Mgr.: T. Rainey

WAIMET ALLOYS CO.
5320 Oakman Blvd., Dearborn, Mich. (Tel. LUzon 1-7200)
Materials Mgr.: John Fritz
Technical Mgr.: William P. James
Pres. & Gen. Mgr.: R. F. Waindle
Sales Mgr.: Roger J. Metzler M

WAKEFIELD ENGRG. CO.
P. O. Box 471, Coeur d'Alene, Idaho (Tel. MUrray 5-5541)
V. P.: D. Bresnan CT

WAKEFIELD ENGRG., INC.
11 Broadway, Wakefield, Mass. (Tel. CRystal 6-5200)
Pres. & Dir.-Sales: Thomas D. Coe
Purch. Agent: Irving Burwen

WALBAR MACHINE PRODUCTS INC.
74 Maple St., Stoneham 80, Mass. (Tel. SToneham 6-3035
Dir.-Purch.: James W. Gallagher
Sales Mgr.: William J. Caveney PS, MS, M

WALDES KOHINOOR, INC.
47-16 Austel Place, Long Island City 1, N. Y. (Tel. EXeter 2-3100)
Dir.-Purch.: H. M. VanCleaf
Gen. Sales Mgr., Truarc Div.: James C. Darby

WALDICK ENGRG. CO.
P. O. Box 398, Huntington Station, N. Y. (Tel. HAmilton 7-6780)
Dir.-Purch.: A. Lawrence
Gen. Mgr.: Walter H. Dickman S, MS

WALES STRIPPIT INC.
Akron, N. Y. (Tel. LH 2-5441)
Purch. Agent: George MacFadyen
Gen. Sales Mgr.: Norman F. Weyland

WALKIRT CO.
141 W. Hazel St., Inglewood 3, Calif. (Tel. ORegon 8-4814)
Purch.: L. Wilgus
Gen. Mgr.-Sales: Wes L. Kirchoff

P. WALL MFG. CO.
Erie St., Grove City, Pa. (Tel. 910)
Pres. & Dir.-Purch.: E. G. Oppenheimer
Purch. Agent: Paul Northcott
V. P.-Sales: M. A. Silverman M, RD

WALL COLMONOY CORP.
19345 John R St., Detroit 3, Mich. (Tel. TWinbrook 3-3800)
Gen. Mgr.: G. A. Barris
V. P.: R. L. Peaslee PS, M, RD
Sales Mgr.: F. Cruse

WALL TUBE & METAL PRODUCTS CO.
P. O. Box 330, Newport, Tenn. (Tel. 2391)
Purch. Agent: James P. Masters
V. P. & Gen. Sales Mgr.: Frank L. Dempsey

WALLACE & TIERNAN INC.
25 Main St., Belleville 9, N. J. (Tel. PLymouth 9-8000)
Purch. Agent: I. Gordon
Asst. Purch. Agent: T. A. Moore
V. P.-Sales: T. T. Quigley CT

WALLINGFORD STEEL CO., THE
Valley St., Wallingford, Conn. (Tel. COlony 9-3361)
Purch. Agent: D. Norton Williams
Asst. Purch. Agent: William Dennison
V. P.-Sales: G. J. Griffin S, PS, MS, M, RD

WALLSON ASSOCIATES, INC.
912 Westfield Ave., Elizabeth, N. J. (Tel. FLanders 1-0700)
Purch. Agent: S. S. Roston
Sales Mgr.: A. S. Jaffe

WALTHAM ELECTRONICS CORP.
751 Main St., Waltham 54, Mass. (Tel. TWinbrook 4-7810)
Purch. Agent: Irving Kadesh
Asst. Purch. Agent: Helen Cooney
Dir.-Sales: David Nadel, 1108 Beacon St., Newton Highlands 61, Mass. (Tel. WO 9-9150)
MS, CT, TT, RD

WALTHAM PRECISION INSTRUMENT CO.
221 Crescent St., Waltham, Mass. (Tel. TWinbrook 3-4000)
Purch. Agent: Donald Lyons
Pres.: Louis R. Ripley
Gen. Sales Mgr.: Fred M. Burmann G, RD

WALTHAM SCREW CO.
77 Rumford Ave., Waltham 54, Mass. (Tel. TWinbrook 3-5830)
Pres.: Daniel F. Viles
Treas.: Sheldon Viles M

WANG LABS., INC.
12 Huron Dr., Natick, Mass. (Tel. OLympic 3-3910)
Pres.: A. Wang RD

WARD LaFRANCE TRUCK CORP.
E. 11th St. & Grand Central Ave., Elmira Hgts., N. Y. (Tel. REgent 3-5631)
Purch. Agent: John J. Valego
Dir.-Sales: P. A. Jenks MS

WARREN COMPONENTS, DIV.-EL-TRONICS, INC.
S. Irvine St., Warren, Pa. (Tel. RA 3-6200)
Purch. Agent: Richard Swanson
Material Control: Harry Anderson
Sales Mgr.: MacBain Sears M

WARREN WIRE CO.
Pownal, Vt. (Tel. VAlley 3-7321)
V. P.-Sales: F. W. Kunzelmann

WARREN-KNIGHT CO.
136 N. 12th St., Philadelphia 7, Pa. (Tel. LOcust 7-3984)
Prod. Mgr.: Harry W. Fatkin
V. P.-Sales: John H. Warren, Jr. MS, CT, TT

WASHINGTON ALUMINUM CO., INC.
Pennsylvania RR & Knecht Ave., Baltimore 29, Md. (Tel. CIrcle 2-1000)
Purch. Agent: Bruner Dicus
Sales Mgr.: Vincent Freeman S, RD

WASHINGTON MACHINE & TOOL WORKS, INC.
13111 Wayzata Blvd., Minneapolis 26, Minn. (Tel. LIberty 5-5611)
Purch. Agent: Bruce Smith
Prod. Mgr.: F. Lowell Pike
Pres. & Gen. Mgr.: E. W. Kulesh G

WASHINGTON STEEL CORP.
Woodland & Griffith Ave., Washington, Pa. (Tel. BAldwin 2-8000)
Purch. Agent: H. R. Fulton
Sales Mgr.: John C. Richards M

WASHINGTON TECHNOLOGICAL ASSOCIATES, INC.
979 Rollins Ave., Rockville, Md. (Tel. HAzelwood 7-7550)
Chief Purch. Agent: Ernest Tingle
Asst. Purch. Agent: John McPherson

WASLEY PRODUCTS, INC.
College Highway, Plainville, Conn. (Tel. SHerwood 7-2784)
V. P.-Purch. & Sales: A. Justin Wasley

WASSCO ELECTRIC PRODUCTS CORP.
2032 2nd Ave., S., St. Petersburg 12, Fla. (Tel. ORange 1-2948)
Pres.: Henry G. Wasserlein

WASTE KING CORP., TECHNICAL PRODUCTS DIV.
5550 Harbor St., Los Angeles 22, Calif. (Tel. RAymond 3-9601)
Chief-Materiel: D. W. McMaster
Buyers: R. F. Swan & Lucille Cheek
Mgr.-Customer Relations: Frank L. Spencer MS, G, RD

WATER COOLING CORP.
71 Nassau St., New York 38, N. Y. (Tel. COrtlandt 7-2264)
Purch. Agent: A. B. Tappen
Dir.-Sales: Robert Miller RD

WATERBURY COMPANIES, INC.
835 S. Main St., Waterbury, Conn. (Tel. PL 6-5551)
Purch. Agent: F. Johnson
Asst. Purch. Agent: J. F. Brennan
Dir.-Sales: G. A. Walker

WATERMAN HYDRAULICS CORP.
725 Custer Ave., P. O. Box 391, Evanston, Ill. (Tel. GReenleaf 5-7045)
Purch. Agent: R. Rhoney
V. P.-Sales: H. Hedland PS, MS, CT

WATERMAN PRODUCTS CO., INC.
2445 Emerald St., Philadelphia 25, Pa. (Tel. GArfield 6-8600)
Purch. Agent: S. Marritz CT

WATERS MFG., INC.
Boston Post Rd., Wayland, Mass. (Tel. ELmwood 8-2777)
Purch. Agent: M. P. Brown
Gen. Sales Mgr.: W. W. Bartell

WATERTOWN DIV., THE NEW YORK AIR BRAKE CO.
Starbuck Ave., Watertown, N. Y. (Tel. SUnset 2-7000)
Mgr.-Purch.: W. F. Slook
Purch. Asst.: H. A. Hardman
Buyers: K. R. Sawyer & R. H. Madden
Gen. Mgr.-STRATOPOWER, Aircraft Equipment Sales: H. R. Doughty MS, G

WAUGH ENGRG. CO
7842 Burnet Ave., Van Nuys, Calif. (Tel. TR 3-1055)
Purch. Agent: Joseph Stevens
Mktg. Mgr.: Robert E. Day

WAUKESHA FOUNDRY CO.
Lincoln Ave., Waukesha, Wisc. (Tel. LIberty 2-6657)
Purch. Agent: Joseph C. Kehoss
V. P.: John W. Weaver

WAVEGUIDE, INC.
1769 Placentia, Costa Mesa, Calif. (Tel. MAdison 8-7786)
Purch. Agent: N. C. Glass
Sales Mgr.: John J. Bodley

WAVELINE, INC.
P. O. Box 718, W. Caldwell, N. J. (Tel. CApitol 6-9100)
Purch. Agent: Walter Specht
Gen. Mgr.: Robert H. Koenig
Sales Mgr.: Louis R. Trummel G, CT

WAYNE FOUNDRY & STAMPING CO.
3100 Hubbard, Detroit 10, Mich. (Tel. TAshmoo 5-8226)
Purch. Agent: James Spadafore
Sales Mgr.: C. D. Todd, Jr.

WAYNE PUMP CO., THE, DIV.-SYMINGTON WAYNE CORP.
Herbert, Riverbend & Griffin Sts., Ft. Wayne 4, Ind. (Tel. EAstbrook 4664)
Purch. Agent: V. O. Pontius
Dir.-Sales: R. L. Burke, Jr.

WAYNE-GEORGE CORP.
588 Commonwealth Ave., Boston 15, Mass. (Tel. COpley 7-8425)
Buyer: R. MacDonald
V. P. & Dir.-Sales: D. G. Hunt MS, TT, RD

***WEATHERHEAD CO., THE**
300 E. 131st St., Cleveland 8, Ohio (Tel. GLenville 1-5200)
Purch. Mgr.: D. Leutz
Sales Mgr.: P. W. Morse
Special Products Div., Eastern Aircraft Products Div., 300 E. 131st St., Cleveland 8, Ohio
Sales Mgr.: P. W. Morse
Western Div., 1736 Standard Ave., Glendale 1, Calif.
Gen. Mgr.: S. C. Howell PS, MS, RD
*(See advertisement this issue)

WEAVER MFG. CO., DIV.-DURA CORP.
2171 S. 9th St., Springfield, Ill. (Tel. 2-8861)
Purch. Agent: O. W. Ellis
Asst. Purch. Agents: Tom Lawless & Mrs. Anna Dowell S

WEBA, INC.
1301 Fourth Ave., New Hyde Park, N. Y. (Tel. FLoral Park 2-3900)
Purch. Agent: Joseph Spinella
Sales Mgr.: Joseph Reddy S

WEBBER ENGRG. CORP.
P. O. Box 217, Indianapolis 6, Ind. (Tel. MElrose 2-1378)
Purch. Agent: V. L. Fagin
Pres. & Sales Mgr.: Robert C. Webber CT, RD

WEBBER MFG. CO., INC.
P. O. Box 217, Indianapolis 6, Ind. (Tel. MElrose 2-1378)
Purch. Agent: V. L. Fagin
Pres. & Dir.-Sales: Robert C. Webber CT, RD

WEBCOR, INC., ELECTRONICS DIV.
816 N. Kedzie Ave., Chicago 51, Ill. (Tel. NEvada 2-3425)
Dir.-Purch.: C. S. Wybran
Dir.-Customer Relations: S. W. Tarnoff MS, TT, RD

WEBCOR, INC., GOVERNMENT DIV.
816 N. Kedzie Ave., Chicago 51, Ill. (Tel. NEvada 2-3425)
Dir.-Purch.: C. S. Wybran
Buyers: G. L. Scheel, P. S. Kibler & J. F. Frisby RD

WEBER AIRCRAFT CORP.
2820 Ontario St., Burbank, Calif. (Tel. VIctoria 9-1181)
Dir.-Materiel: F. A. Good
Purch. Supvrs.: R. E. Fulbright & J. W. Culbertson
Dir.-Sales: Harold G. Johnson S, MS, CT, RD, HSE

WECKESSER CO.
5701 Northwest Hwy., Chicago 46, Ill. (Tel. RO 3-6688)
Gen. Mgr.: Harry A. Ewalt
Sales Mgr.: Mrs. Mary Kay

WEEMS SYSTEM OF NAVIGATION, INC.
229 Prince George St., Annapolis, Md. (Tel. COlonial 3-6700)
Pres.: P. V. H. Weems
Exec. V. P.: Paul Miller
V. P.: G. D. Dunlap G

WEIGHING & CONTROL COMPONENTS, INC.
Industrial Park, E. County Line Rd., Hatboro, Pa. (Tel. OSborne 5-0901)
Purch. Agent: Alfred Krieg
Sales Mgr.: Henry J. Oursler, Jr. CT

WEKSLER INSTRUMENTS CORP.
195 E. Merrick Rd., Freeport, L. I., N. Y. (Tel. MAyfair 3-0100)
Exec. V. P.: A. Marks
Purch. Agent: Milford Himmel
V. P.-Sales: F. J. Pla CT

A. W. WELCH MFG. CO., INC.
509 E. 29th St., Indianapolis 8, Ind. (Tel. WA 5-7878)
Pres.: A. W. Welch
Sales Mgr.: Jim Hutchison

W. M. WELCH SCIENTIFIC DIV., W. M. WELCH MFG. CO.
1515 Sedgwick St., Chicago 10, Ill. (Tel. MIchigan 2-2000)
Purch. Dept.: William Wolf, W. Feckler & R. Beilin
Dir.-Sales: J. Gutsmiedl M

WELDED CONSTRUCTION INC.
2320 W. 15th Place, Cleveland 13, Ohio (Tel. MAin 1-0103)
Purch. Agent: John Dufenetz
Sales: Joseph A. Thayer MS, RD

WELDMATIC, DIV.-UNITEK CORP.
950 Royal Oaks Dr., Monrovia, Calif. (Tel. ELliott 9-8361)
Purch. Agent: Bob Mahoney
Sales Mgr.: Ott Sailer

WELLER ELECTRIC CORP.
601 Stone's Crossing Rd., Easton, Pa. (Tel. BLackburn 3-3521)
Purch. Agent: T. Hester
Asst. Purch. Agent: E. Murphy
V. P.-Sales: C. R. Robertson

S. K. WELLMAN CO., THE
200 Egbert Rd., Bedford, Ohio (Tel. BEdford 2-2400)
Purch. Agent: Frank C. Yehl
V. P.-Sales: W. E. Canfield M

WELLMAN BRONZE & ALUMINUM CO.
9401 Woodland Ave., Cleveland 4, Ohio (Tel. SWeetbriar 1-6900)
Purch. Agent: B. E. Weimer
V. P.-Chg. Sales: Glenn F. Ihrig S, PS, MS, G, RD

WELLS INDUSTRIES CORP.
6880 Troost Ave., North Hollywood, Calif. (Tel. TRiangle 7-3353)
Dir.-Purch.: H. Russel Stamp
Chief Engr.-Hub Pot Div.: Robert H. Mellor
Chief Engr.-Basic Electronic Controls Div.: Stewart Tongret
V. P.-Engrg. & Sales: Ernest O. Gibson, Jr. S, MS, CT, RD, HSE

WENZLAU ENGRG. CO.
410 Solano Ave., Los Angeles 12, Calif. (Tel. CApital 2-3151)
Sales Mgr.: William D. Wenzlau MS, M

ALBERT WESLING & SONS INC.
2912 W. Lake St., Chicago 12, Ill. (Tel. KEdzie 3-2850)
V. P.-Sales: A. H. Wesling

WELTRONIC CO.
19500 W. Eight Mile Rd., Southfield, Mich. (Tel. KEnwood 2-2800)
Dir.-Purch.: R. S. Johnston
Gen. Sales Mgr.: L. R. Broniak

CODING
Structures S
Propulsion System PS
Missile Support MS
Materials M
Guidance G
Checkout & Testing CT
Tracking & Telemetering TT
Research & Development RD
Human Space Engineering HSE

WESREP CORP.
2022 S. Sepulveda Blvd., Los Angeles 25, Calif. (Tel. BRadshaw 2-3757)
Pres.: Dudley V. Cassard
Sales Mgr.: Robert A. Hager **S, PS, MS, M, G**

WEST COAST ELECTRICAL MFG. CORP.
233 W. 116th Place, Los Angeles 61, Calif. (Tel. PLymouth 5-1138)
Purch. Agent: Erle Seal **MS, G**

WESTBERG MFG. CO.
Box 239, Napa, Calif. (Tel. BA 6-5218)
Purch. Agent: R. R. Westberg
Dir.-Sales: V. L. Westberg **CT, RD**

WESTERN AUTOMATIC MACHINE SCREW CO. DIV.-STANDARD SCREW CO.
377 Woodward Ave., Elyria, Ohio (Tel. FAirfax 3-3341)
Purch. Agent: A. Steller
V. P.-Chg. Sales: M. R. Sorensen **M**

WESTERN COATING CO.
P. O. Box 598, Oakridge Station, Royal Oak 3, Mich. (Tel. JUniper 8-3311)
Dir.-Prod.: Franklin B. Evans
Pres. & Head-Sales: Arthur Aaron, 85 W. Union St., Pasadena, Calif. (Tel. MUrray 1-7828)
Western Sales Mgr.: L. W. Pickens, Jr. **M**

WESTERN COIL & ELECTRICAL CO.
215 State St., Racine, Wisc. (Tel. ME 2-4741)
Pres.: W. T. Lewis

WESTERN CONTROL CORP.
2533 S. West St., Wichita, Kans. (Tel. WHitehall 3-4238)
Purch. Agent: Henry A. Guerrero
Pres.: L. C. Smith **M**

WESTERN DESIGN, DIV.-U. S. INDUSTRIES, INC.
7701 Telegraph Rd., Montebello, Calif. (Tel. RAymond 3-2611)
Materials Mgr.: Fred Kupel
Purch. Agents: Barney Frohn & Gene Largent
Dir.-Sales: H. J. Fitzpatrick **S, PS, MS, M, RD**

WESTERN DESIGN DIV.-U.S. INDUSTRIES, INC.; SANTA BARBARA DIV.
Santa Barbara Airport, Goleta, Calif. (Tel. WOodland 7-4571)
Purch. Agent: L. E. Saterstrom
Dir.-Mktg.: W. W. Harris

WESTERN DEVICES INC.
600 W. Florence Ave., Inglewood 1, Calif. (Tel. ORegon 8-7827)
Sales Engr.: N. L. Vonlderstein
Sales Liaison: Bill Donelson **MS, G, CT, TT, RD, HSE**

WESTERN DIV., AEROQUIP CORP.
3015 Winona Ave., Burbank, Calif. (Tel. THornwall 5-1551)
Purch. Agent: L. J. Finley
Gen. Sales Mgr.: C. W. Sowhill **S, PS, MS, CT, RD**

WESTERN ELECTRIC CO., INC.
120 Broadway, New York, N. Y. (Tel. WOrth 4-2100)
Radio Div.: C. R. Smith

WESTERN ELECTRONIC PRODUCTS CO.
2420 N. Lake Ave., Altadena, Calif. (Tel. SYcamore 4-6379)
Sales Mgr.: A. P. Schreiber **M**

WESTERN FELT WORKS & ACADIA SYNTHETIC PRODUCTS DIV.
4021-4139 Ogden Ave., Chicago 23, Ill. (Tel. CRawford 7-8000)
Purch. Agent: L. W. Heide
Prod. Control: Gene Wojcik
Sales Mgr.: R. H. Butz **M**

WESTERN GEAR CORP.
P. O. Box,182, Lynwood, Calif. (Tel. NEvada 6-0911)
Purch. Agent: Dave Shlemmer
Mktg. Mgr.: Ron Hinman
Sales Mgr.: Dick Worl

WESTERN GEAR CORP., PRECISION PRODUCTS DIV.
2600 E. Imperial Hwy., Lynwood, Calif. (Tel. NEvada 6-0911)
Purch. Agent: J. R. Fortune
Buyers: Milton Gray & H. J. Mayser
Sales Mgr.: R. B. Worl **PS, MS, RD**

WESTERN GOLD & PLATINUM
525 Harbor Blvd., Belmont, Calif. (Tel. LYtell 3-3121)
Purch. Agent: Michael D. McKinney
Sales Mgr.: Harry Mason **M**

WESTERN INSULATED WIRE CO.
2425 E. 30th St., Los Angeles 58, Calif. (Tel. LUdlow 7-7103)
Mgr.-Purch.: Phil Ramos
V. P. & Gen. Mgr.: Ed Kanner
Asst. Sales Mgr.: R. O. Pollin

WESTERN IRON & FOUNDRY CO., INC.
702 E. Second St., Wichita 2, Kansas (Tel. HObart 4-2311)
V. P.-Purch.: G. L. Dobler
Pres. & Gen. Mgr.: E. E. Urban **S, M**

WESTERN PNEUMATIC TUBE CO.
P. O. Box 487, Kirkland, Wash. (Tel. VAndyke 2-2214)
Purch. Agent: N. E. Ludington
V. P.-Sales: Carson Eckmann **M**

WESTERN SEALANT OF CONN.
50 Isaac Pl., Norwalk, Conn. (Tel. TEmple 8-5446)
Purch. Agent: John Harding
Dir.-Sales: K. E. Middlebrook **M**

WESTERN SKY INDUSTRIES
21301 Cloud Way, Hayward, Calif. (Tel. JE 7-1334)
V. P.: A. T. Lundgren
Plant Supt.: Jack Douglass **M, CT**

WESTERN SKY INDUSTRIES, HYDRAULIC ACTUATION DIV.
416 N. Glendale Ave., Glendale 6, Calif. (Tel. CHapman 5-6867)
Managing Dir.: Richard D. Maystead

WESTERN TOOL & MFG. CO. INC.
1620 E. Pleasant St., Springfield, Ohio (Tel. FA 3-9151)
Pres.: Clark E. Patton
Sales Engr.: Edward J. Phelan **M, RD**

WESTERN UNION TELEGRAPH CO., THE
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Company_____

Address_____

City_____ Zone____ State_____

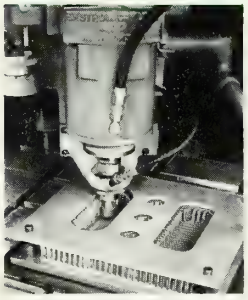
MISSILE PRODUCT DIRECTORY



New Materials for Missiles

PROGRESS REPORT

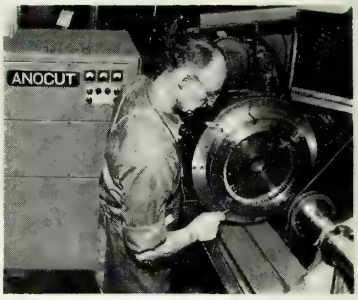
NOW Anocut Electrolytic Machining for CAVITY-SINKING as well as ROTATING-WHEEL applications



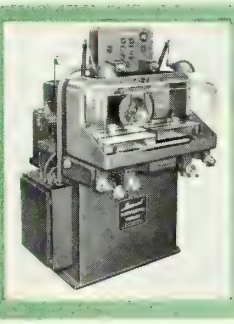
MACHINING POCKETS IN FRAGILE STAINLESS STEEL HONEYCOMB FREE OF LAYOVER AND BURR. PHOTO COURTESY EKSTROM, CARLSON & CO.

Rotating-Wheel Anocut

is used for metals which are (1) hard, (2) tough, (3) heat sensitive or (4) easily burred wherever an open surface is to be machined to high accuracy and high finish. It will produce surfaces which are flat or curved (inside or outside) or continuous forms, as in form grinding. Wherever a rotating wheel can be applied this method offers tremendous savings in time and abrasive cost.



MOUNTING STATOR RING FOR ELECTROLYTIC MACHINING OF VANE TIPS TO ACHIEVE PRECISE CONCENTRICITY AND SIZE. OPERATION IS FAST AND ELIMINATES DEBURRING, SAVING LABOR COSTS AND REDUCING SCRAP.



MODEL EG-12 ELECTROLYTIC OSCILLATING GRINDER WITH TWO AIR-OPERATED TILTING TABLES. DESIGNED FOR PRODUCTION WORK ON FLAT SURFACES OF JET ENGINE AND ROCKET ENGINE COMPONENTS AND OTHER TOUGH OR HARDENED STEEL PARTS. DOVE-TAIL OR CIRCULAR FORM TOOLS, ETC. PHOTO COURTESY HAMMOND MACHINERY BUILDERS, INC.

AUTOMATIC ELECTROLYTIC FACE MILL GRINDER. VARIABLE SPEED MOVABLE RAM CAN BE ADJUSTED TO SHARPEN COMPLETE CUTTER IN ONE REVOLUTION OF TABLE, REMOVING .005" TO .020" FROM EACH TOOTH. FORTY-FOUR TOOTH CUTTER, 16" DIAMETER, SHARPENED IN 22 MINUTES, REMOVING .012" FROM EACH TOOTH, GRINDING CARBIDE AND STEEL SIMULTANEOUSLY. PHOTO COURTESY OLIVER INSTRUMENT CO.



NEW MACHINE - SAME PRINCIPLE

Plunge-Electrode Anocut sinks a shaped electrode into hard or tough metals by the same electrochemical principle as rotating-wheel Anocut. Unlike electro-discharge spark machines it has high removal capacity, no electrode wear, and is therefore intended for repetitive production jobs.



MODEL HCS-59 ELECTROLYTIC CAVITY-SINKER. APPLIES SAME BASIC ELECTROLYTIC PRINCIPLE TO THE SINKING OF IRREGULAR HOLES AND SHAPES FOLLOWING THE CONTOUR OF THE ELECTRODE MADE FOR THE PURPOSE. THE ELECTRODE IS SIMPLY PLUNGED LINEARLY INTO THE WORK MATERIAL.



HEXAGONAL HOLE 1" DEEP, 1/4" ACROSS FLATS, IN UDIMET 700. NOTE STRAIGHTNESS AND SHARPNESS OF WALLS WHERE ELECTRODE BROKE THROUGH. CONICAL TIP IN BOTTOM OF BLIND HOLE CAN BE ELIMINATED. INTERIOR-COATED ELECTRODE USED FOR ROUND HOLES IN BACKGROUND.



SEVEN INCH LONG, .078" DIAMETER HOLE ELECTROLYTICALLY "DRILLED" IN UDIMET 700. ROD HAS BEEN SURFACE GROUND TO EXAMINE STRAIGHTNESS OF HOLE. NO WEAR ON ELECTRODE.



ELECTROLYTIC TREPANNING. DESIRED FORM EXTENDS INTO INTERIOR OF SHAPED ELECTRODE. NOTE HIGH FINISH ON BLADE FORM.

ANOCUT T.M. Reg.

ENGINEERING COMPANY

631 WEST WASHINGTON BLVD. • CHICAGO 6, ILL. • PHONE STATE 2-5480

Circle No. 61 on Subscriber Service Card.

MISSILE PRODUCT DIRECTORY

Listed below are some 3200 parts and products used in the missile industry. The products are listed alphabetically with the companies which manufacture these items also appearing alphabetically under each product. For the company address, telephone number, key purchasing and sales personnel, please refer to the MISSILE PURCHASING DIRECTORY which begins on page 85 of this issue.

ABSORBERS

American Felt Co.
Anaconda Metal Hose Div., The American Brass Co.
Barnebey-Cheney Co.
Bemis Bro. Bag Co.
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bjorksten Research Labs. for Industry, Inc.
DBM Research Corp.
Demornay-Bonardi
Dryomatic Corp.
Dudwallen Mfg. Co., Inc., The
Emerson & Cuming, Inc.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
General Logistics Div., Aeroquip Corp.
B. F. Goodrich Co., The
B. F. Goodrich Sponge Products
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Hahn & Clay
Haskel Engrg. & Supply Co.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Hydra-Power Corp.
Industrial Acoustics Co., Inc.
K. W. Johnson & Co., Inc.
Kahn & Co., Inc.
Kemp Aero Products
Lear, Inc.
MSA Research Corp.
Mc Millan Companies, The
Mc Millan Lab., Inc.
Nooter Corp.
Northrop Corp.
Pittsburgh Corning Corp.
Radar Design Corp.
Rose Mfg. Co.
Rubbercraft Corp. of California
Ray A. Scharer & Co.
Southwest Research Institute
Stearns-Roger Mfg. Co., The
Sun Electric Corp., Aeronautical Div.
Taylor Devices, Inc.
A. S. Thomas, Inc.
Titeflex, Inc.
Topper Mfg. Co., Inc.
Tracerlab Inc.
Vibration Isolation Products
Western Design, Div.-U. S. Industries, Inc.
Western Felt Works & Acadia Synthetic Products Div.
Young Development Div., Hercules Powder Co.

ACCELERATORS, PARTICLE

Allis-Chalmers
Applied Radiation Corp.
Bethlehem Steel Co.
Cosmic Instruments Inc.
General Electric Co., X-Ray Dept.
Haskel Engrg. & Supply Co.
High Voltage Engrg. Corp.
Radiation Dynamics, Inc.
*RADIO CORP. OF AMERICA
Technoproducts, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.

ACCUMULATORS

American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
American Instrument Co., Inc.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Arnolt Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bethlehem Steel Co.
Bruce Engrg. Co.
Capital City Mfg. Co., Inc.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Electrol Inc.
Frick Co.
Gabriel Co., Rocket Power-Talco
General American Transportation Corp.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Hahn & Clay
Haskel Engrg. & Supply Co.
Herlo Corp.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Interstate Electronics Corp.
Interstate Engrg. Corp.
Kemp Aero Products
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Menasco Mfg. Co.
National Tube Div.-United States Steel Corp.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
Nooter Corp.
Norris-Thermador Corp.
Oil-Dyne, Inc.
Parker-Hannifin Corp.
Peacock Engrg. & Mfg. Co.
Pressed Steel Tank Co.
Ravenna Metal Products, Div.-Standard Screw Co.
Ronson Hydraulic Units Corp.
S-P Mfg. Corp., The
Simmonds Aerocessories, Inc.
Skytronics, Inc.
Standard Steel Corp., Cambridge Div.
Telex, Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Weatherhead Co., The
Westholt Mfg. Inc.
Young Development Div., Hercules Powder Co.

ACCUMULATORS, HYDRAULIC

Actuation Research Corp.
*AEROJET-GENERAL CORP.
Arnolt Corp.
Belfab Corp., The
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bethlehem Steel Co.
Bowser, Inc.
Bruce Engrg. Co.
Cadillac Gage Co.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Electrol Inc.
General American Transportation Corp.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Hahn & Clay
Haskel Engrg. & Supply Co.
Herlo Corp.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Hydra-Power Corp.
Integral Corp.
Interstate Electronics Corp.
Interstate Engrg. Corp.
Kelsey-Hayes Co.
Kemp Aero Products
Martin Machine Works, Inc.
McDowell-Wellman Companies, The
Menasco Mfg. Co.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
Oil-Dyne, Inc.
Ozone Metal Products Corp.
Parker Hydraulics Div., Parker-Hannifin Corp.
Parker-Hannifin Corp.
Peacock Engrg. & Mfg. Co.
Pyles Industries, Inc.
Randall Engrg. Corp.
Ravenna Metal Products, Div.-Standard Screw Co.
Redco Corp.
Ronson Hydraulic Units Corp.
S-P Mfg. Corp., The
Simmonds Aerocessories, Inc.
Skytronics, Inc.
C. M. Smillie & Co.
Standard Steel Corp., Cambridge Div.
Sweetland Engrg. Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Taylor Devices, Inc.
Thompson Ramo Wooldridge Inc.
Vickers Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Vinson Mfg. Co. Inc.
Weatherhead Co., The
Western Design, Div.-U. S. Industries, Inc.
Westholt Mfg. Inc.
Wickfield, Inc.
Young Development Div., Hercules Powder Co.

ACTUATORS

a. Electric
b. Hydraulic
c. Linear
d. Pneumatic
e. Rotary

Acme Industrial Co., **b.**
Actuation Research Corp., **a, b, d.**
Actuator Products Div., Geartronics Corp., **a thru e.**
Adel Precision Products of Calif., Div.-General Metals Corp., **b.**
Aeroflex Labs. Div., Aeroflex Corp., **e.**
Airborne Accessories Corp., **a, c, e.**
Aircraft Accessory Turbine Dept.-General Electric Co., **c, d, e.**
*AiRESEARCH MFG. OF ARIZONA, **d.**
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., **a, c, d, e.**
Alco Valve Co., **a, b.**
Allied International Corp., **a.**
Allison Div., General Motors Corp., **a thru e.**
American Electronics, Inc., **c.**
American Measurement & Control, Inc., **b.**
*ANNIN CO., THE, **a, b.**
Arkwin Industries, Inc., **b thru e.**
Armament Div.-Universal Match Corp., **c, e.**
Arnolt Corp., **b, d.**
Barber-Colman Co., **a, c, d, e.**
Beaver Precision Products Inc., **a, b, c, e.**
Bellofram Corp., **b, c, d.**
Belock Instrument Corp., **a, e.**
Benbow Mfg. Corp., **b, d.**
Bendix Aviation Corp., **a thru e.**
*BENDIX AVIATION CORP., HAMILTON DIV., **b, e.**
Bendix Aviation Corp., Montrose Div., **e.**
Bendix-Pacific Div., Bendix Aviation Corp., **a thru e.**
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., **a, b, d.**
Bendix Utica Div., Bendix Aviation Corp., **d.**
Bobrick Aero Missile Products, **b, d.**
Bowser, Inc., **b, d.**
Breeze Corporations, Inc., **a, b, c, e.**
Bruce Engrg. Co., **b.**
Bruning Co., The, **b, d.**
Cadillac Gage Co., **b thru e.**
Chalco Engrg. Corp., **b, d.**
Chance Vought Aircraft, Inc., **a thru e.**
Clark Equipment Co., **b.**
Clevite Ordnance, Div.-Clevite Corp., **a, b.**
Compudyne Corp., **a, b.**
Conoflow Corp., **a, d.**
Consolidated Controls Corp., **b thru e.**

Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **d.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **a, c.**
James Cunningham Son & Co., Inc., **c.**
Curtiss-Wright Corp., Electronics Div., **e.**
Custom Component Switches Inc., **b, d.**
George W. Dahl Co., Inc., **d.**
Dalmo Victor Co., Div.-Textron, Inc., **a thru e.**
Joe Davidson & Associates, **a, c, e.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **a, e.**
*DEL MAR ENGRG. LABS., **a, c.**
Dukes Co., Inc., **b.**
Dynamic Controls Corp., **b, d.**
Eastern Industries Inc., **b.**
Electric Autolite Co., The, **a, c, e.**
Electro Precision Corp., **e.**
Electrol Inc., **b thru e.**
Electronic Specialty Co., Eemco Div., **a, c, e.**
Electro-Seal Corp., **e.**
*EXCELCO DEVELOPMENTS INC., **a thru d.**
Ex-Cell-O Corp., **b, d, e.**
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp., **b, c.**
Fisher Governor Co., **a, d.**
Ford Instrument Co., Div.-Sperry Rand Corp., **a, e.**
Futurecraft Corp., **b, d.**
Gabriel Co., Rocket Power-Talco, **c, e.**
Galland-Henning Mfg. Co., Nopak Div., **b, d.**
Garwin, Inc., **a, c, e.**
General American Transportation Corp., **b, c.**
General Aniline & Film Corp., Ansco Div., **e.**
General Controls Co., **a.**
General Electro-Mechanical Corp., **a, e.**
General Regulator Corp., **a, b, d.**
Gilfillan Bros. Inc., **a thru e.**
Gorn Electric Co., Inc., Aircraft Controls Div., **b.**
Gray Mfg. Co., The, **c.**
Great Lakes Mfg. Corp., **b, d.**
Guided Missile Div., The Firestone Tire & Rubber Co., **d.**
B. H. Hadley, Inc., **a thru e.**
Hamilton Standard, Div.-United Aircraft Corp., **d.**
George E. Harris & Co., Inc., **a, c, e.**
Haskel Engrg. & Supply Co., **b thru e.**
A. W. Haydon Co., The, **a, e.**
Herlo Corp., **a, b, d.**
Hickok Electrical Instrument Co., The, **a.**
Hoefner Corp., **b, d.**
Hoffman Electronics Co., **a.**
Hoover Electric Co., **a, c, e.**
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., **b, d, e.**
Houdaille Industries, Inc., Buffalo Hydraulics Div., **b, c, e.**
Huyck Systems Co., **a thru e.**
Walter J. Hyatt Co., The, **a, b, d, e.**
Hydra-Power Corp., **b thru e.**
Hydro-Aire Co., Div.-Crane Co., **a, c, e.**
Hydromatics, Inc., **a, b, d.**
Integral Corp., **b, d.**
Interstate Electronics Corp., **b.**
Interstate Engrg. Corp., **b thru e.**
Jack & Heintz, Inc., **a, b, c, e.**
Janitrol Aircraft Div.-Midland-Ross Corp., **d.**
Jordan Controls Inc., **a, c, e.**
*KEARFOTT DIV., GENERAL PRECISION, INC., **b, c, e.**
Kelsey-Hayes Co., **b thru e.**
Kemp Aero Products, **a thru e.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **d.**
Kieley & Mueller, Inc., **a, b, d.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **e.**
Langley Corp., **b, d.**
Lear, Inc., **a thru e.**
Leetronics, Inc., **a, e.**
G. H. Leland, Inc., **e.**
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lundy Mfg. Corp., **a, b, c, e.**
M-D Blowers, Inc., **d.**
Magtrol, Inc., **a, e.**
Marquardt Corp., The, **a thru e.**
Martin Machine Works, Inc., **c.**
Mason Electric Corp., **e.**
Mason-Neilan, **a, b, d.**
McDowell-Wellman Companies, The, **b, d.**
Mechanics Research Div., American Machine & Foundry Co., **d.**
Menasco Mfg. Co., **b thru e.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **d.**
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc., **b, d, e.**
New York Air Brake Co., The, Watertown Div., **b.**
Oil-Dyne, Inc., **b, d.**
Ortman-Miller Machine Co., Inc., **b, d.**
Overload Control Co., **a, e.**
Ozone Metal Products Corp., **b thru e.**
Pacific Scientific Co., **d.**
Parker-Hannifin Corp., **b, d.**
Peacock Engrg. & Mfg. Co., **b, d.**
Pegasus Labs., Inc., **b, c.**
Pesco Products Div.-Borg-Warner Corp., **b.**
Phillips Control Corp., **a.**
Piqua Engrg. Inc., **a, b.**
Pressed Steel Tank Co., **d.**
Randall Engrg. Corp., **b, c, d.**
Ravenna Metal Products, Div.-Standard Screw Co., **b, d, e.**
Regent Jack Mfg. Co., Inc., **b.**
Republic Mfg. Co., **b.**
Research, Inc., **b.**
J. R. Robbins Co., **b, d.**
Robot Industries Inc., **a, b, d, e.**
Ronson Hydraulic Units Corp., **b, d.**
S-P Mfg. Corp., The, **b thru e.**
Sancor Corp., **b.**
Sanders Associates, Inc., **b.**
Sargent Engrg. Corp., **b thru e.**
Servo-Tek Products Co., **e.**
Sier-Bath Gear & Pump Co., Inc., **c, e.**
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., **a, b, d.**
Sigma Instruments, Inc., **a, e.**
Simmonds Aerocessories, Inc., **b, d.**
Singer Military Products Div.-The Singer Mfg. Co., **e.**
Sirvalco Systems Corp., **b, d, e.**
Skytronics, Inc., **a, b, c, e.**
Skyvalve, Inc., **a, b, d.**
C. M. Smillie & Co., **b, d.**
South Wind Div., Stewart Warner Corp., **a.**
Southwest Research Institute, **c, e.**
Southwestern Industries, Inc.
Sperry Farragut Co., Div.-Sperry Rand Corp., **e.**
Spiroid Div., Illinois Tool Works, **a, c, e.**
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co., **a, b, c, e.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **d.**
Summers Gyroscope Co., **a thru e.**
Sun Electric Corp., Aeronautical Div., **b thru e.**
Sundstrand Turbo
Sweetland Engrg. Co., **b, d.**
Talley Corp., The, **a thru e.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, e.**
Task Corp., **a thru e.**
Thompson Ramo Wooldridge Inc., **a, b, e.**
Transco Products, Inc., **a, e.**
United Aircraft Products, Inc., **b, c, d.**
United Control Corp., **a, e.**
United Mfg. Co., The, **a, b.**
U. S. Gear Corp., **c, e.**
U. S. Industries, Inc., **b, d.**
United States Chemical Milling Corp., **a, b, d.**
Vacuum Research Co., **d.**
Valcor Engrg. Corp., **a.**
Vap-Air Aeronautical Products Div., Vapor Heating Corp., **d.**
Vickers Inc., Div.-Sperry Rand, **b, c, e.**
Vickers Inc., Electric Products Div., **a.**
Vickers, Inc., Mich., **b, c, e.**
Vinson Mfg. Co. Inc., **b, d.**
Waste King Corp., Technical Products Div., **a, c.**
Weatherhead Co., The, **b, d.**
Weber Aircraft Corp., **a, c, e.**
Western Design, Div.-U. S. Industries, Inc., **b, c, d.**
Western Gear Corp.-Precision Products Div., **a, c, e.**
Western Sky Industries, **b.**
Westinghouse Air Brake Co., Industrial Products Div., **d.**
Westinghouse Electric Corp., **a.**
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., **b, c, d.**
Whiton Machine Co., The, **b, d.**
Whittaker Controls, Div.-Telecomputing Corp., **a, b, d, e.**
Wickfield, Inc., **b.**

ADAPTERS

a. Air
b. Battery
c. Crystal
d. Field Sequential
e. Foreign
f. Lamp Socket
g. Line & Dot Sequential
h. Phase
i. Plug
j. Test
k. Tube
l. Tube Socket

Accessory Products Co., Div.-Textron Inc., **a.**
Aeroquip Corp., Jackson Div., **k.**
Air Filter Corp., **a.**
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., **b.**
Alden Products Co., **j, k, l.**
American Instrument Co., Inc., **j.**
Anaheim Electronics Div.-Electronic Engrg. Co. of Calif., **j.**
Barnes Development Co., **j.**
Belmar Wheel & Machine Co., Inc., **b.**
Bendix Aviation Corp., Cincinnati Div., **h, j.**
Birnbach Radio Co., Inc., **i.**
Cable Electric Products Inc., **f, i.**
Cal Connector Co., **i.**
Chase Brass & Copper Co., Inc., **k.**
Coaxial Connector Co. Inc., **c, g, i.**
Cole Electric Co., **b, d, i, j.**
Collins Mfg. Corp., **k.**
Diamond Antenna & Microwave Corp., **c.**
Dill Mfg. Co., The, **a.**
Dumont Engrg. Co., **k.**
Eagle Electric Mfg. Co. Inc., **e, f, i.**
Electronic Tube Corp., **l.**
Farwest Mfg. Div., Inc. **b, f, h, i, j.**
G-C Electronics Co., **i, l.**
General Radio Co., **i.**
B. H. Hadley, Inc., **a.**
Haskel Engrg. & Supply Co., **a.**
Herlo Corp., **j.**
Hoke Inc., **k.**
Huyck Systems Co., **h.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **f, i, j.**
Keystone Electronics Corp., **b.**
Kings Electronics Co., Inc., **i.**
Kulka Electric Corp., **e, f, i.**
Lab-Tronics, Inc., **i thru l.**
Langley Corp., **a.**
Leviton Mfg. Co., Inc., **f, i.**
Livingston Electronic Corp., **l.**
*MARTIN CO., THE, DENVER DIV., **a, b, h, i, j.**
Martin Machine Works, Inc., **i, l.**
Meridian Metalcraft, Inc., **c.**
James Millen Mfg. Co. Inc., **c.**
Molded Insulation Co., **f, i.**
Frank W. Morse Co., **e, f.**
Norrich Plastics Corp., **h, i, l.**
Norrich Screw Machine Products, **g, h, k.**
Paul Nurches Co., **c, i thru l.**
Paco Electronics Co., Inc., **j, k.**
Parker Fittings & Hose Div., Parker-Hannifin Corp., **k.**
Piasecki Aircraft Corp., **b, f, i thru l.**
Pomona Electronics Co., Inc., **i, j, k.**
Precision Apparatus Co., Inc., **j.**
Precision Equipment Co., Inc., **k.**
Royal Electric Corp., **i.**
Sage Labs., Inc., **c.**
Simpson Electric Co., **j.**
C. M. Smillie & Co., **a.**
Theta Instrument Corp., **h.**
Varo Mfg. Co., Inc., **h.**
Vector Electronic Co., Inc., **j, l.**
Virginia Electronics Co., Inc., **i, j.**
Warren Components, Div.-El-Tronics, Inc., **l.**
Weatherhead Co., The, **a.**
Western Div., Aeroquip Corp., **k.**
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida, **a, b.**

ADHESIVES, HIGH TEMPERATURE

Adhesive Engrg. Div.-Hiller Aircraft Corp.
Ambroid Co. Inc.
American Latex Products Corp.
Aries Laboratories, Inc.
Armstrong Cork Co.
Avondale Co., The
Bjorksten Research Labs. for Industry, Inc.
Bloomingdale Rubber Co.
Borden Chemical Co.
Carborundum Co., The
Connecticut Hard Rubber Co., The
Corning Glass Works
Daubert Chemical Co.
Dayton Rubber Co., The
Dennis Chemical Co.
Dow Corning Corp.
Duracote Corp.
Emerson & Cuming, Inc.
Epoxy Products, Inc., Div.-Joseph Waldman & Sons
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics, Inc.
B. F. Goodrich Industrial Products Co.
Hastings Plastics, Inc.
Instrumentation Associates, Inc.
Johns-Manville Sales Corp.
Kish Industries, Inc.
Lam-Ply, Inc.
Lebec Chemical Corp.
Lord Mfg. Co.
Marblette Corp., The
*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-ADHESIVES, COATING & SEALERS DIV.
Mitchell Rand Mfg. Corp.
Monsanto Chemical Co.
Morningstar-Paisley, Inc.
C. P. Moyen Co.
Narmco Materials Div., Narmco Industries, Inc.

Norrich Plastics Corp.
Norrich Screw Machine Products
Permacel
Permatex Co., Inc.
Philadelphia Quartz Co.
Protex-A-Cote, Inc.
Raybestos-Manhattan, Inc.
Rezolin, Inc.
Rubber & Asbestos Corp.
Sauereisen Cements Co.
Silicone Products Dept., General Electric Co., Dept. C.
Thermon Mfg. Co.
Topper Mfg. Co., Inc.
United Shoe Machinery Corp.
United States Plywood Corp.
United States Rubber Co.
Wasley Products, Inc.
Wesrep Corp.
Xylos Rubber Co., Div.-The Firestone Tire & Rubber Co.

ADHESIVES, METAL TO METAL

Adhesive Engrg. Div.-Hiller Aircraft Corp.
Aeronca Mfg. Corp.
American Latex Products Corp.
American Products Mfg. Co.
Aries Laboratories, Inc.
Armstrong Cork Co.
Armstrong Products Co.
Avondale Co., The
Bacon Industries, Inc.
Carl H. Biggs Co.
Bjorksten Research Labs. for Industry, Inc.
Bloomingdale Rubber Co.
Borden Chemical Co.
Carboline Co.
Cordo Chemical Corp.
Cox & Co., Inc.
Daubert Chemical Co.
Dayton Rubber Co., The
Dennis Chemical Co.
Emerson & Cuming, Inc.
L. W. Ferdinand & Co. Inc.
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics, Inc.
B. F. Goodrich Aviation Products
B. F. Goodrich Industrial Products Co.
Grant-Lehr Corp.
Hastings Plastics, Inc.
Honeycomb Co. of America, Inc.
Horsey, Robson & Co. Inc.
Hughes Tool Co., Aircraft Div.
Johns-Manville Sales Corp.
Kish Industries, Inc.
Lam-Ply, Inc.
Lebec Chemical Corp.
Leffingwell Chemical Co.
Lord Mfg. Co.
Maas & Waldstein Co.
Marblette Corp., The
*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-ADHESIVES, COATING & SEALERS DIV.
Morningstar-Paisley, Inc.
C. P. Moyen Co.
Narmco Materials Div., Narmco Industries, Inc.
New England Tape Co., Div.-United-Carr Fastener Corp.
Permacel
Pioneer Industries Div., Almar-York Co., Inc.
Plastic Film Co., Inc.
Portland Copper & Tank Works Inc.
Protex-A-Cote, Inc.
Ravenna Metal Products, Div.-Standard Screw Co.
Raybestos-Manhattan, Inc.
Rezolin, Inc.
Rubber & Asbestos Corp.
Sauereisen Cements Co.
Silicone Products Dept., General Electric Co., Dept. C.
Smooth-On Mfg. Co.
Sylvania-Corning Nuclear Corp.
Thermon Mfg. Co.
Topper Mfg. Co., Inc.
U B S Chemical Co., Div.-A. E. Staley Mfg. Co.
United States Plywood Corp.
Vorac Co., The
Wasley Products, Inc.
X-Pando Corp.
Xylos Rubber Co., Div.-The Firestone Tire & Rubber Co.

AFTERBURNERS

Allison Div., General Motors Corp.
B. H. Aircraft Co., Inc.
Budd Co., The
A. M. Byers Co.
Calcor Corp.
Crane Co., Special Products Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
ITE Circuit Breaker Co., Special Products Div.
Kaiser Fleetwings, Inc.
*LAVELLE AIRCRAFT CORP.
Lycoming Div., Avco Corp.
Marquardt Corp., The
McGregor Mfg. Corp.
Portland Copper & Tank Works Inc.
Solar Aircraft Co.
Southwest Research Institute

AFTERCOOLERS

*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
B. H. Aircraft Co., Inc.
Crane Co., Special Products Div.
Griscom-Russell Co., The
ITE Circuit Breaker Co., Special Products Div.
Joy Mfg. Co.
Manning & Lewis Eng. Co.
Marlo Coil Co.
McGregor Mfg. Corp.
Modine Mfg. Co.
Portland Copper & Tank Works Inc.
Rome-Turney Radiator Co., The
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Struthers Wells Corp.
Whitlock Mfg. Co., The
Worthington Corp.

AIR CONDITIONING EQUIPMENT

ACF Industries Inc.
Accessory Controls & Equipment Corp.
Air Filter Corp.
Airaterra
*AiRESEARCH MFG. OF ARIZONA
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Alco Valve Co.
Amco Engrg. Co.
American Air Filter Co., Defense Products Div.
American Electronics, Inc.
American Standard Industrial Div.
Barber-Colman Co.
Barnebey-Cheney Co.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Blowers Inc.
Budd Lewyt Electronics, Inc.
A. M. Byers Co.
Calcor Corp.
California Stamping & Mfg. Co.
Cambridge Filter Corp.
Carrier Corp.
Consolidated Diesel Electric Corp.
Crane Co., Special Products Div.
Joe Davidson & Associates
Dean & Benson Research, Div.-Benson Mfg. Co.
Desomatic Products, Inc.-Anders-Driline
Drayer Hanson Div.-Crane Co.
Drico Industrial Corp.
Dryomatic Corp.
Dunham-Bush Inc.
Ellis & Watts Products, Inc.
Ellison Draft Gage Co., Inc.
Frick Co.
Great Lakes Mfg. Corp.
Gremco, Inc.
Hallicrafters Co., The
Hamilton Standard, Div.-United Aircraft Corp.
George E. Harris & Co., Inc.
Highland Engrg. Co.
C. G. Hokanson Co., Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Hunter Mfg. Co.
Hydro-Aire Co., Div.-Crane Co.
Janitrol Aircraft Div.-Midland-Ross Corp.
Koppers Co., Inc., Metal Products Div.
Marlo Coil Co.
*MARTIN CO., THE, DENVER DIV.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Modine Mfg. Co.
Monrovia Aviation Corp.
On Mark Couplings, Inc.
D. W. Onan & Sons Inc.
Philco Corp.-Govt. & Industrial Group
Pioneer Industries Div., Almar-York Co., Inc.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Pyle-National Co., The
Ready-Power Co., The
Recony Div.-Vinco Corp.
Roylyn Inc.
Shaw Burner Co.
Solar Aircraft Co.
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Surface Combustion Div.-Midland-Ross Corp.
Task Corp.
Thermo King Corp.
Thermon Mfg. Co.
Tober Electronic Corp.
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
Trane Co., The
Typhoon Air Conditioning Div., Hupp Corp.
United Control Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Universal Dynamics Corp.
Vilter Mfg. Co., The
Wells Industries Corp.
Wenzlau Engrg. Co.
Westinghouse Electric Corp.
Worthington Corp.
York Div., Borg-Warner Corp.

AIR INLET GUIDE VALVES

Accessory Products Co., Div.-Textron Inc.
Capital City Mfg. Co., Inc.
Consolidated Controls Corp.
Ex-Cell-O Corp.
Futurecraft Corp.
B. H. Hadley, Inc.
Hoefner Corp.
Hydra-Power Corp.
Jarvis Corp.
Kelsey-Hayes Co.
Kemp Aero Products
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lundy Mfg. Corp.
Ozone Metal Products Corp.
Ravenna Metal Products, Div.-Standard Screw Co.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Sirvalco Systems Corp.
Solar Aircraft Co.
Southwestern Valve Corp.
Talley Corp., The
United States Chemical Milling Corp.

AIR INLET SCREEN SUPPORTS

Allison Div., General Motors Corp.
B. H. Aircraft Co., Inc.
Beacon Steel Corp.
Calcor Corp.
Kentucky Metal Products Co.
Talley Corp., The

AIRBORNE LANDING SYSTEMS

All American Engrg. Co.
Allied International Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
Broadview Research Corp.
Brooks & Perkins, Inc.
A. M. Byers Co.
Calcor Corp.
Decker Corp., The
Edgerton, Germeshausen & Grier, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Gabriel Co., Rocket Power-Talco
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
Kemp Aero Products
Lab. for Electronics Inc
Lear, Inc.
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola, Inc.
Northrop Corp.
Ozone Metal Products Corp.
Radalab Inc.
Radio Condenser Co.
*RADIO CORP. OF AMERICA
Republic Aviation Corp., Missile Systems Div.
Skiatron Electronics & Television Corp.
Stromberg Carlson Div. General Dynamics Corp
Transco Products, Inc.
V & H Radio & Electronics
Western Design, Div.-U. S. Industries, Inc.

ALARM SYSTEMS

American District Telegraph Co.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
American Instrument Co., Inc.
Arnoux Corp.
Avien, Inc.
Bell & Gossett Co.
Bendix Aviation Corp., Cincinnati Div.

Briggs Associates, Inc.
***BRISTOL CO., THE**
Budd Co., The
Budd Lewyt Electronics, Inc.
Compudyne Corp.
Consolidated Controls Corp.
Joe Davidson & Associates
Daystrom, Inc., Control Systems Div.
Decker Corp., The
Devco Engrg. Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electronic Control Corp.
Electro-Seal Corp.
Ellison Draft Gage Co., Inc.
Fenwal Inc.
General Devices, Inc.
Illinois Testing Laboratories, Inc.
Interstate Electronics Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Leach Corp.
Lenkurt Electric Co., Inc.
Leslie Co.
***MARTIN CO., THE, DENVER DIV.**
Miller Associates
Mine Safety Appliances Co.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Moore Associates, Inc.
Motorola, Inc.
National Electronics
Notifier Corp.
Photobell Co., Inc.
Production Research Corp., Sub.-Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Santa Barbara Research Center
Schaevitz Engrg.
H. H. Scott, Inc.
Scott Aviation Corp.
Secode Corp.
Southwestern Industrial Electronics Co.
Special Products Dept., Melpar, Inc.
Spectra Electronics Corp.
Telkor, Inc.
Thermo Electric Co., Inc.
Tracerlab Inc.
Trepac Corp. of America
United Control Corp.
United Electric Controls Co.
Vap-Air Aeronautical Products Div., Vapor Heating Corp.
Varo Mfg. Co., Inc.
Wells Industries Corp.
Western Union Telegraph Co., The
Wheelock Signals Inc.

ALARMS, AUTO

Advanced Electronics, Inc.
Avien, Inc.
***BRISTOL CO., THE**
California Plasteck Inc.
Consolidated Controls Corp.
Instrument Div., The Budd Co.
Leach Corp.
Leslie Co.
Photobell Co., Inc.
***RADIO CORP. OF AMERICA**
United Electric Controls Co.
Wells Industries Corp.

ALLOYS, HIGH PERMEABILITY

American Smelting & Refining Co.
Arnold Engrg. Co., The
Avco Corp., Nashville Div.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical Chemical Co.
Carpenter Steel Co., The
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Crucible Steel Co. of America
Driver-Harris Co.
Electric Steel Foundry Co.
Hamilton Watch Co.-Industrial Div.
Hydroforming Co. of America Inc.
Metals Div., Kelsey-Hayes Co.
Springfield Brass Co., Inc.
Techalloy Co. Inc.
Telcon, Inc.
Universal-Cyclops Steel Corp.
Var-Lac-Oid Chemical Co.
Vascoloy-Ramet Corp.
Wallingford Steel Co.
Westinghouse Electric Corp.

ALNICO

Aluminum Co. of America
Arnold Engrg. Co., The
Barker Sales Co.
Bram Metallurgical Chemical Co.
Crucible Steel Co. of America
General Magnetic Corp.
Hamilton Watch Co.-Industrial Div.
Permanent Magnet Co., Inc., The
Var-Lac-Oid Chemical Co.
Westinghouse Electric Corp.

ALTERNATORS

***AEROJET-GENERAL CORP.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Corp.
Allis-Chalmers
Allison Div., General Motors Corp.
American Electronics, Inc.
Bendix Aviation Corp.
Consolidated Diesel Electric Corp.
Joe Davidson & Associates
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Eicor Div.-Scranton
Electric Motors & Specialties, Inc.
General Electric Co., Apparatus Sales Div.
Genisco, Inc.
Georator Corp.
Paul E. Gerst & Co.
George E. Harris & Co., Inc.
Hal-Gar Mfg. Corp.
Hoover Electric Co.
William I. Horlick Co., Inc.
Induction Heating Corp.
Jack & Heintz, Inc.
Leach Corp.
Leece-Neville Co., The
Leland Airborne Products, Div.-American Machine & Foundry Co.
Motor Generator Corp.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
D. W. Onan & Sons Inc.
Pesco Products Div.-Borg-Warner Corp.
Radio Development & Research Corp.
Talley Corp., The
Task Corp.
U. S. Industries, Inc.
V & H Radio & Electronics
Varo Mfg. Co., Inc.
Westinghouse Electric Corp.
Worthington Corp.

ALTIMETERS, BAROMETRIC PRESSURE

***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Avco Corp., Crosley Div.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
A. Biederman, Inc.
Bulova Research & Development Labs., Inc.
Colvin Labs., Inc.
Consolidated Controls Corp.
Daystrom Inc., Pacific Div.
Decker Corp., The
Garwin, Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hickok Electrical Instrument Co., The
E. Vernon Hill & Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
A. Lietz Co., The
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Mitchell Camera Corp.
New England Scientific Instruments Co.
Newark Controls Co.
Patterson Moos Research, Div.-Leesona Corp.
Rosemount Engrg. Co.
Servomechanisms, Inc.
Southwest Research Institute
Specialties, Inc.
Wallace & Tiernan Inc.
Wang Labs., Inc.

ALTIMETERS, RADIO & RADAR

Advance Industries, Inc.
Allied International Corp.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
Avco Corp., Crosley Div.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bergen Labs., Inc.
Bruno-New York Industries Corp.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fla. Aircraft Radio & Marine
Gray Mfg. Co., The
Hickok Electrical Instrument Co., The
Hoffman Electronics Co.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Intercontinental Electronics Corp.
Lab. for Electronics, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The
Motorola, Inc.
Northrop Corp.
Radalab Inc.
Sanders Associates, Inc.
Skiatron Electronics & Television Corp.
Stewart-Warner Electronics Div.
Taffet Electronics, Inc.
Texas Instruments Inc.
V & H Radio & Electronics

ALUMINUM

Aluminium Limited Sales, Inc.
Aluminum Co. of America
American Smelting & Refining Co.
Artra Aluminum Foundry & Mfg. Co. Inc.
Belmont Smelting & Refining Works, Inc.
Bohn Aluminum & Brass Corp.
Bond Metal Surplus Co.
Bridgeport Brass Co.
Calcor Corp.
Chase Brass & Copper Co., Inc.
Custom Tool & Mfg. Co.
Dow Chemical Co., The
Electronic Parts Mfg. Co., Inc.
Hamilton Watch Co.-Industrial Div.
Harvey Aluminum
Hydroforming Co. of America Inc.
Walter K. Jaros Aircrafters
Earle M. Jorgensen Co.
Kaiser Aluminum & Chemical Sales, Inc.
Morris P. Kirk & Son, Inc.
Light Metals, Inc.
Metalphoto Corp.
Olin Mathieson Chemical Corp.-Metals Div.
Olin Mathieson Chemical Corp., N. Y.
R. H. Osbrink Mfg. Co.
F. H. Paul & Stein Brothers, Inc.
Pioneer Aluminum Inc.
Ravenna Metal Products, Div.-Standard Screw Co.
Revere Copper & Brass Inc.
Reynolds Metals Co.
Reynolds Metals Co., Sheffield Missile Plant
Rodney Metals Inc.
Scovill Mfg. Co.
South River Metal Products Co., Inc.
Southwire Co.
Springfield Brass Co., Inc.
United Smelting & Aluminum Co., Inc.
U. S. Steel Supply Div., United States Steel Corp.
Wyman-Gordon Co.

AMMETERS

Allen Electric & Equipment Co.
Assembly Products, Inc.
Bendix Aviation Corp., Cincinnati Div.
***BRISTOL CO., THE**
Calvert Electronics Inc.
Columbia Electric Mfg. Co.
Daystrom Inc., Weston Instruments Div.
Dejur-Amsco Corp., Electronic Sales Div.
Electric Design & Mfg. Co.
Electro Instruments, Inc.
Epic, Inc.
Esterline-Angus Co., The
General Electric Co., Apparatus Sales Div.
Greibach Instruments Corp.
Hammett-Mercury-Rex Div.
Hewlett-Packard Co.
Hickok Electrical Instrument Co., The
Hoyt Electrical Instrument Works, Inc., Burton Rogers Co.
Ideal Precision Meter Co., Inc.
International Instruments Inc.
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co.
Meters Inc.
National Electronics
New England Scientific Instruments Co.
Pace Electrical Instruments Co., Inc.
Phaostron Instrument & Electronic Co.
Q. V. S. Inc.
Rochester Mfg. Co. Inc.
Rochester Mfg. Co. Inc. of Calif.
Sensitive Research Instrument Corp.
Simpson Electric Co.
Stewart-Warner Corp., Alemite Div.
Sun Electric Corp., Aeronautical Div.
Sunshine Scientific Instrument
Triplett Electrical Instrument Co.
Wacline, Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.
Westinghouse Electric Corp.

AMPLIDYNES

Allis-Chalmers
Diehl Mfg. Co.
General Electric Co., Apparatus Sales Div.
Hoover Electric Co.

AMPLIFIERS

a. Antenna
b. Audio Subminiature
c. Booster
d. Cathode Follower
e. Compressor
f. Computer
g. Control
h. Data Recording
i. DC
j. Decade, Audio
k. Development
l. Differential
m. Distribution, Audio
n. Distribution, RF & IF
o. Encapsulated
p. Instrumentation
q. Integrating
r. Intermediate Frequency
s. Isolation
t. Limiting
u. Line
v. Line, Audio
w. Logarithmic
x. Magnetic
y. Microphone
z. Microwave
a-1. Mixing, Audio
b-1. Mixing, RF
c-1. Monitoring, Audio
d-1. Monitoring, RF
e-1. Noise-Suppressing
f-1. Operational
g-1. Oscilloscope
h-1. Parametric
i-1. Peak Limiting
j-1. Photocell
k-1. Plug-In
l-1. Power
m-1. Power, Special Service
n-1. Printed Circuit
o-1. Pulse
p-1. Recorder
q-1. Servo
r-1. Single-Sideband
s-1. Stabilizing
t-1. Strain Gage
u-1. Tone Control
v-1. Transistor
w-1. Ultrasonic
x-1. Vibration Pickup
y-1. Wideband, Audio
z-1. Wideband, RF

ACDC Electronics, Inc., x.
ACF Industries Inc., b, g, i, l, o, p, u, x, k-1, n-1, o-1, q-1, v-1, z-1.
Acme Electric Corp., f, h, k, o, x, n-1.
Acromag Inc., q, x, q-1, t-1.
Acton Laboratories Inc., j, l-1, m-1, y-1.
Actuation Research Corp., k, x.
Adage, Inc., f, i, l, s, f-1, n-1.
Adler Electronics, Inc., z, l-1.
Advance Industries, Inc., f thru i, k, l, n thru r, x, z, n-1, o-1, q-1, v-1.
Advance Instrument Corp., q-1.
Advanced Electronics, Inc., x-1.
Aeroflex Labs. Div., Aeroflex Corp., k, q, q-1, v-1.
Aeronautical Electronics, Inc., k-1, l-1.
Aeronca Mfg. Corp.-Aerospace Div., f, g, h, o, q, j-1, n-1, o-1, q-1, v-1.
Aeroscience, Inc., p, t-1.
Aetna Electronics Corp., q-1, w-1.
Airborne Accessories Corp., g, i, x, l-1, q-1, v-1.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., q, r, f-1, h-1.
Aircom Inc., a, z, h-1.
Aircraft Accessory Turbine Dept.-General Electric Co., g, q-1.
*AIRESEARCH MFG. CO. DIV.-THE GARRETT CORP., x, q-1.
Airpax Electronics Inc., Cambridge Div., f, g, i, l, p, q, x, c-1, l-1, m-1, q-1, t-1.
Airpax Electronics Inc. Seminole Div., f, g, i, l, p, q, x, c-1, l-1, m-1, q-1, t-1.
Airtron, Div.-Litton Industries, n, z, b-1.
Alfred Electronics, p, z.
Allegany Instrument Co., Inc., i, j, l, q, q-1, t-1.
Allied International Corp., a, o.
Allison Div., General Motors Corp., x.
Alto Scientific Co., Inc., r, v-1.
Amerac Inc., z.
American Electronic Labs., Inc., i.
American Electronics, Inc., f, g, x, a-1, l-1, q-1, v-1.
American Electronics Incorporated, p, q-1.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., h, p-1.
American Latex Products Corp., o.
American Machine & Foundry Co., Government Products Group, e-1.
American Measurement & Control, Inc., i, q-1, t-1.
American Missile Products Co., Inc., b, t, n-1, v-1.
American Rectifier Corp., x.
American Research & Mfg. Corp., d, f, i, k, l, o, p, x, s, x, f-1, h-1, i-1, j-1, l-1, n-1, q-1, v-1, x-1.
Ampex Data Products Co., h, p.
Analogue Controls, Inc., q-1.
Andersen Labs., Inc., w-1, y-1, z-1.
Antlab Inc., h, p-1.
Applied Electronics Corp. of N. J., f, g, h, k, p, x, h-1, t-1, v-1.
Applied Research Inc., a, n, r, z, b-1, v-1, z-1.
Arnoux Corp., d, i, o, x, q-1, t-1.
Associated Engineers, Inc., p, r, v, x, a-1, c-1, d-1, k-1, n-1, v-1.
Astra Tech, i.
Raymond Atchley, Inc., q-1.
Atlas Engrg. Co. Inc., g, i, x, l-1, m-1.
Audio Instrument Co., Inc., d, w.
Automatic Timing & Controls, Inc., q-1.
Avien, Inc., i, k, l, p, k-1, q-1, t-1, x-1.
B & F Instruments, Inc., h, p, t-1.
B & K Instruments, Inc., h, j, p, y, t-1, x-1.
Bearing Inspection, Inc., w-1.
Beckman Instruments, Inc., Berkeley Div., f, f-1.
Beckman-Systems Div., i, l.
Beech Aircraft Corp., g, n.
Behlman Engrg. Co., l-1.
Bell & Gossett Co., f, g, i, k, p, f-1.
Belmar Wheel & Machine Co., Inc., l-1, m-1.
Belock Instrument Corp., c, f, i, k, o, q-1, v-1.
Bendix Aviation Corp., f, g, i, k, p, q, w, x, z, b-1, c-1, d-1, f-1, h-1, n-1, o-1, q-1, v-1, w-1, y-1, z-1.
Bendix Aviation Corp., Cincinnati Div., b, c, f thru n, p, q, r, t, x, a-1 thru e-1, g-1, i-1, k-1, l-1, m-1, o-1, q-1, s-1, v-1, w-1, x-1.
Bendix Corp., The, Eclipse-Pioneer Div., f, g, x, q-1.
Bendix-Pacific Div., Bendix Aviation Corp., q-1.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., g, t.
Bergen Labs., Inc., x, q-1, v-1.
Beva Lab., Inc., i, o-1.
A. Biederman, Inc., p.
Blackstone Corp., w-1.
Blonder-Tongue Labs., Inc., a, c, n, u, b-1, z-1.
Blonder-Tongue Labs. Inc., Special Products Div., a thru e, k, m, n, t, v, w, y, a-1, b-1, c-1, h-1, n-1, o-1, r-1, u-1, v-1, z-1.
Bogue Electric Mfg. Co., i, x, l-1, q-1, v-1.
Bo Myte Co., Inc., The, n-1.
Boonton Electronics Corp., i, l.
Bowser, Inc., k.
Brach Mfg. Corp., a, g, i, p, t, x, i-1, j-1, l-1, m-1, q-1, s-1, v-1.
*BRISTOL CO., THE, p.
Bruno-New York Industries Corp., b, f, i, l, o, p, q, n-1, q-1, v-1.
Brush Instruments, Div.-Clevite Corp., h, i, p, p-1, t-1.
Budd Lewyt Electronics, Inc., a, b, d, f, g, h, n, h-1, v-1, y-1, z-1.
Budelman Electronics Corp., z, l-1, z-1.
Bulova Research & Development Labs., Inc., g, k, w, h-1, q-1, v-1.
Bulova Watch Co., Electronics Div., q-1.
Burr-Brown Research Corp., f, g, i, j, l, p, q, s, f-1, k-1, n-1, q-1, t-1, v-1, w-1, y-1.
Burton-Rodgers, Inc., f, g, i, k, a-1, k-1, n-1, z-1.
Bytrex Corp., p, p-1, q-1, t-1.
CBS Laboratories, Div.-Columbia Broadcasting System, a, b, d, h, j, k, o, x, y, z, b-1 thru e-1, p-1, r-1, t-1, v-1, y-1.
CG Electronics Corp., a, h, n-1, o-1.
CGS Labs., Inc., a, n, x.
Calcor Corp., a.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., p.
Cedar Engrg. Div.-Control Data Corp., x, q-1.
Central Safety Equip. Co., a.
Centralab, Div.-Globe-Union, Inc., b, n-1, v-1.
Century Electronics & Instruments, Inc., h, p, p-1, t-1.
Chalco Engrg. Corp., b, d, e, g, h, i, k thru n, p, q, t, u, v, c-1, e-1, f-1, i-1, k-1 thru n-1, q-1, r-1, v-1.
Chance Vought Aircraft, Inc., a, f, q, y, e-1, h-1, l-1, n-1, q-1, s-1.
Chicago Electronic Engrg. Co., Inc., x.
Circo Equipment Co., w-1.
Circo Ultrasonic Corp., w-1.
Cleveland Instrument Co., l.
Cleveland Metal Specialties Co., Electronics Div., b, n-1.
Clevite Ordnance, Div.-Clevite Corp., b, d, g, h, i, k, l, o, p, q, t, w, x, y, a-1, c-1, g-1, i-1, k-1, l-1, n-1, o-1, q-1, v-1, w-1, y-1.
Coil Co. of America, x.
Colorado Research Corp., f-1, q-1.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., x.
Communication Accessories Co., i, x.
Communication Measurements Lab., Inc., l-1, y-1.
Community Engrg. Corp., a, n, r, n-1, o-1, z-1.
Computer Engrg. Associates, Inc., f thru i, l, p, q, s, t-1, x-1.
Computer Systems, Inc., h, i, p, o-1, p-1, q-1.
Consolidated Airborne Systems, Inc., k, l, q-1.
Consolidated Controls Corp., g, i, k, q-1.
*CONSOLIDATED ELECTRODYNAMICS CORP., h, p, n-1, p-1, t-1, v-1, x-1.
Continental Electronics Mfg. Co., Sub.-Ling-Altec Electronics Inc., l-1, m-1, o-1, r-1, z-1.
Control Circuits Inc., f, g, i, k, o, p, k-1 thru n-1.
Control Data Corp., x, q-1.
Control Electronics Co., Inc., k, n, r, z, o-1, v-1.
Control Technology Co., d, f, g, k, l, o, p, r, s, t, x, l-1, q-1, s-1, v-1.
Courter Products, Div.-Model Engrg. & Mfg., Inc., b.
Crescent Engrg. & Research Co., g, k, o, p, s, y, k-1, n-1, q-1, t-1, v-1.
Crosby-Teletronics Corp., k, r-1.
Cycle Transformer Corp., x.
DBM Research Corp., p, h-1.
Dage Television Div., Thompson Ramo Wooldridge, Inc., o-1.
Dale Products, Inc., k, o, n-1.
Dalmo Victor Co., Div.-Textron, Inc., a, b, i, k, o, p, w, z, b-1, h-1, j-1 thru r-1, v-1, z-1.
Data-Control Systems, Inc., h, t-1.
Daven Co., The, b, c, d, g, i thru p, r, t, thru w, a-1 thru d-1, f-1, g-1, i-1, k-1, l-1, o-1, u-1, v-1, w-1, y-1, z-1.
Joe Davidson & Associates, g-1, l-1.
Daystrom, Inc., Control Systems Div., f, i, x.
Daystrom, Inc., Military Electronics Div.
Daystrom Inc., Pacific Div., k, q-1.
Daystrom Inc., Weston Instruments Div., g, l, q, l-1.
Dayton Aircraft Products, Inc., g, k, l, q-1.
Daytronic Corp., h, p, p-1, t-1.
Decker Corp., The, d, k, l, o, p, r, t, x, q-1, v-1.
De Havilland Aircraft of Canada, Ltd., Special Products Div., x, v-1.
Dejur-Amsco Corp., Electronic Sales Div., j-1.
Delco Radio Div.-General Motors Corp., g, l-1, m-1, n-1, q-1, v-1.
Deltron Inc., g, i, w, l-1, m-1, q-1, v-1, y-1.
Designers for Industry, Inc., k, p, z, d-1, r-1, v-1, w-1.
Detecto Scales, Inc., f.
Diehl Mfg. Co., q-1.
Djeco, Div.-Djordjevic Engrg. Co., f, g, i, l, q, w, x, l-1, m-1, o-1, v-1.
Don-Lan Electronics Inc., a, k.
Donner Scientific Co., i.
Dorne & Margolin, Inc., a, z.
Dorsett Electronic Labs., Inc., i, b-1, v-1.
Dudwallen Mfg. Co., Inc., The, e-1.
Du Kane Corp., b, f, g, i, k, m, o, r, v, y, a-1, c-1, k-1, n-1, u-1, v-1, y-1.
Dynametrics Corp., p, t-1.
Dynamic Controls Corp., g, o, v-1.
Dynamics Instrumentation Co., f thru i, l, p, q, s, u, f-1, p-1, t-1, v-1, x-1.
Dynatronics, Inc., h, k, l, p, r, s, z, k-1, o-1, q-1, v-1.
Dytronics Co., j.
Eclipse-Pioneer Div., Bendix Aviation Corp., p, l-1, q-1.
Eitel-McCullough, Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., p, z, q-1.
Elcor, Inc., d, i, k, l, q.
Eldorado Electronics, f-1.
Electro Instruments, Inc., f thru l, p, q, s, t, f-1, g-1, i-1 thru q-1, s-1, t-1, v-1 thru y-1.
Electro Precision Corp., f, i, l, p, q, t, f-1, k-1, l-1, q-1, s-1.
Electromation Co., Div.-Del Mar Engrg. Labs., a thru z, a-1 thru z-1.
Electronic Applications, Inc., m, t, u, v, y, a-1, v-1.
Electronic Computer Co., Inc., f, i, l, q, t, f-1, i-1, t-1.
Electronic Control Corp., j-1.
Electronic Engrg. Co. of California, p.
Electronic Measurements Corp., y-1.
Electronic Mechanics, Inc., n-1.
Electronic Tube Corp., k, l, p, g-1, k-1, l-1, o-1.
Electro-Pulse, Inc., o-1.
Elin Div., International Electronic Research Corp., l-1, m-1.
Emertron, Sub.-Emerson Radio & Phonograph Corp., a, h, k, p, t thru x, z, a-1 thru e-1, h-1, n-1, p-1, q-1, r-1, w-1, y-1, z-1.
Emhart Mfg. Co., Maxim Div., e-1.
Empire Products Sales Corp., k, p, z, b-1 thru e-1, z-1.
Endevco Corp., d, p, x-1.
Engrg. Specialties, i, w, x.
Ensco, Inc., f, i, w, f-1.
*EQUIPMENT DIV., RAYTHEON CO., o, x, z, h-1, l-1, m-1, v-1, w-1.
Erdco Engrg. Corp., p, q-1, v-1.

Erie Instrumation, Div.-Erie Resistor Corp., p, c-1.
FXR, Inc., z.
Fairchild Astronics Div., Fairchild Engine & Airplane Corp., f, g, j, k.
Fairfield Engrg. Corp., a, g, i, k, x, l-1, m-1, q-1.
Farmer Electric Products Co., Inc., j-1.
Farwest Mfg. Div., Inc., o, p, y, g-1, j-1, l-1, n-1, t-1.
Feedback Controls, Inc., f, g, x, k-1, l-1, q-1, v-1.
Ferrotran Electronics Co., Inc., b, k, o, p, r, s, u, v, y, a-1, k-1, l-1, q-1, v-1, y-1.
Ferroxcube Corp. of America, h, x, z.
Fidelity Instrument Corp., x.
Fisher Engrg., Inc., x.
Fla. Aircraft Radio & Marine, a, s.
Flight Support, Inc., f thru i, k, w, x, c-1, f-1, v-1.
Flite-Tronics, Inc., m, v.
Ford Instrument Co., Div.-Sperry Rand Corp., f, g, i, k, o, p, u, x, f-1, j-1, l-1, n-1, q-1, s-1, v-1.
Foto-Video Labs., Inc., c, d, k, t, g-1, i-1, v-1.
Freed Transformer Co., Inc., x.
Friez Instrument Div., Bendix Aviation Corp., p-1, q-1.
Fugle-Miller Labs. Inc., n, x.
GPL Div.-General Precision, Inc., n.
Gates Radio Co., e, k, s thru v, a-1, c-1, i-1, l-1 thru o-1, r-1, v-1, w-1, y-1, z-1.
General Aniline & Film Corp., Ansco Div., z.
General Communication Co., z.
General Devices, Inc., f, h, i, k, l, o thru r, l-1, o-1, r-1, s-1, t-1, v-1.
General Electric Co., Apparatus Sales Div.
General Electric Co., Heavy Military Electronics Dept., o, z, z-1.
General Electric Co., Instrument Dept., p.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense & Engrg. Products Group, g, k, r, z, d-1, f-1, h-1, l-1, m-1, o-1, r-1, w-1.
General Magnetics, Inc., x, q-1.
General Plastics Corp., n-1.
General Radio Co., i, k, p, r, w, y, b-1, l-1, o-1, p-1, y-1.
Genisco, Inc., l-1, m-1, x-1.
Paul E. Gerst & Co., g, i, x.
Gilfillan Bros. Inc., d, f, g, k, l, p thru s, w, z, f-1, h-1, n-1, o-1, v-1.
Gonset Div.-Young Spring & Wire Corp., r-1, u-1.
Good Electronic Corp., d, i, o, p, k-1, n-1, s-1, t-1.
Gordon Enterprises, h, p.
Gorham Electronics-Div.-Gorham Mfg. Co., z.
Gray Mfg. Co., The, b, l-1, n-1, y-1.
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., g, v-1.
Guided Missile Div., The Firestone Tire & Rubber Co., a, g, a-1, b-1, d-1, n-1, q-1, s-1, v-1, y-1, z-1.
Gulton Industries, Inc., d, f, h, k, o, p, q, x, p-1, q-1, t-1, v-1, x-1.
Gyrex Corp., The, k, o, k-1.
HRB-Singer, Inc., Sub.-Singer Mfg. Co., a, b, k, n, r, w, b-1, n-1, o-1, v-1, z-1.
B. H. Hadley, Inc., c, g, k, q-1.
Hagan Chemicals & Controls Inc., g, h, p, x.
Hallamore Electronics Co., Div.-Siegler Corp., g, i, k, l, p.
Hallicrafters Co., The, h, r, z.
Hamilton Standard, Div.-United Aircraft Corp., n-1, q-1.
Hammarlund Mfg. Co., The, g, h, r, u, v, c-1, n-1, p-1, r-1, v-1.
Hammett-Mercury-Rex Div., p, z, g-1, l-1, q-1.
Donald C. Harder Co., x.
George E. Harris & Co., Inc., a, h, p, x, a-1, k-1, l-1, q-1, v-1.
Hathaway Instruments, Inc., l, o, p, u, k-1, m-1, t-1, v-1.
Hays Corp., The, q-1.
Hazeltine Electronics Div.-Hazeltine Corp., a, b, d, f, i, q thru t, x, f-1, k-1, n-1, o-1, v-1.
Hewlett-Packard Co., i, z, g-1, o-1, v-1, z-1.
Hickok Electrical Instrument Co., The, g-1.
Hoffman Electronics Co., o, v-1.
Hoover Electric Co., l-1, m-1, q-1, v-1.
Hoover Electronics Co., g, i, thru m, o thru v, x, a-1, e-1, f-1, h-1, n-1, o-1, t-1, v-1, y-1.
Houston Fearless Corp., a.
Houston Instrument Corp., i.
Hughes Semiconductor Div.-Hughes Aircraft Co., h-1.
Huyck Systems Co., f, g, h, k, p, q, l-1, m-1, q-1.
Hydraulic Research & Mfg. Co., b, n, p, g-1, q-1.
ITI Electronics, Inc.
ITT Federal Div., International Telephone & Telegraph Corp., r, x, z, h-1, n-1, o-1, q-1, v-1, z-1.
Iconix Inc., f, f-1, n-1.
Illinois Testing Laboratories, Inc., p.
Image Instruments, Inc., o-1.
Indiana Gear Works, Inc., a.
Industrial Control Co., f, g, i, l, o, p, q, s, x, l-1, n-1, q-1, s-1, t-1, v-1.
Industrial Test Equipment Co., p, s, l-1, m-1, q-1, y-1.
Industron Corp., m-1.
Instrument Div., The W. L. Maxson Corp., r.
Instrument Labs., v-1.
Instruments for Jnaustry, Inc., n, r, b-1, z-1.
Intercontinental Electronics Corp., u, x, o-1, v-1.
*INTERELECTRONICS CORP., b thru e, g thru k, m, o thru x, a-1, e-1, f-1, i-1 thru n-1, p-1, u-1, v-1, w-1.
Interstate Electronics Corp., b, c, i, l, p, u, v, w, a-1, o-1, v-1.
JEM Electronics Corp., j-1.
J-V-M Microwave Co., n, z, b-1, d-1, z-1.
E. F. Johnson Co., r-1.
Jordan Controls Inc., k-1, l-1, n-1, q-1, v-1.
Jordan Electronics, Div.-Victoreen Instrument Co., i, v-1.
Kay Electric Co., b, j, o, k-1, v-1, y-1.
*KEARFOTT DIV., GENERAL PRECISION, INC., f, g, o, p, q, x, z, h-1, k-1, q-1, v-1.
Keithley Instruments, Inc., d, i, j, l, p, s, u, w, j-1, p-1, t-1, w-1, x-1, y-1.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., b, d, g, k, m, s thru v, y, a-1, c-1, f-1, i-1, k-1 thru n-1, u-1.
Kelsey-Hayes Co., q-1.
Ketay Dept., Norden Div., United Aircraft Corp., x, q-1, v-1.
Kin Tel Div.-Cohu Electronics, Inc., f, h, i, l, f-1, p-1, t-1.
Kistler Instrument Corp., w-1, x-1.
Kollmorgen Optical Corp., q-1.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., f, g, h, k, o, p, x, j-1, k-1, n-1, q-1, v-1.
L & R Mfg. Co., w-1.
Lab. for Electronics, Inc., g, u, x, z, h-1, q-1.
Lane Electronics Mfg. Corp., b, m, r, y, j-1 thru n-1, p-1, v-1.
Langevin Div., The W. L. Maxson Corp., b, m, v, a-1, c-1, l-1, y-1.
La Pointe Industries Inc., c, d, f, r, n-1, o-1.
Leach Corp., b, x, p-1, v-1.
Leak Div.-British Industries Corp., l-1.
Lear, Inc., a thru z, a-1 thru f-1, h-1 thru q-1, s-1 thru z-1.
Lee Electric & Mfg. Co., x.
Leeds & Northrup Co., i, p-1, t-1.
Lel, Inc., a, d, k, n, r, t, u, w, z, b-1, h-1, r-1, v-1, z-1.
Leland Airborne Products, Div.-American Machine & Foundry Co., l-1, m-1.
Levinthal Electronic Products, Inc., z, l-1.
Librascope Div., General Precision, Inc., f, g, l, q, t, u, x, f-1, l-1 thru o-1, q-1.
Ling Electronics Div.-Ling-Altec Electronics, Inc., x-1.
Liquidometer Corp., The, g, p, q-1.
Lockheed Aircraft Corp., Missiles & Space Div., z, h-1, z-1.
J. M. Loge, Sound Engineers
Lumen, Inc., f, g, i, l, o, p, q, x, j-1, l-1, p-1, q-1.
Lytle Corp., n-1.
MB Electronics, d, e, j, k, q, i-1, l-1, m-1, q-1, v-1, x-1.
MEG Products, Div.-Mandrel Industries, Inc., i.
Madigan Corp., a, f, g, h, k, p thru s, w, a-1, b-1, c-1, f-1, j-1, n-1, p-1, q-1, r-1, v-1, y-1.
Magnasync Corp., f, h, v, a-1, c-1, l-1, v-1.
*MAGNAVOX CO., THE, b.
Magnetic Circuit Elements, Inc., i, l, x, l-1.
Magnetic Controls Co., g, o, x, v-1.
Magnetic Instrument Co., Inc., h, i, l, p, x, p-1, q-1.
Magnetic Research Corp., i, l, x, n-1, o-1, q-1, t-1.
Magnetico, Inc., f, g, x, q-1, v-1.
Maico Electronics, Inc., f-1.
P. R. Mallory & Co., Inc., b, o, k-1, n-1, r-1, v-1, y-1.
*MARTIN CO., THE, DENVER DIV., a thru e, g thru m, p thru s, x, a-1, c-1, g-1, j-1, k-1, l-1, n-1 thru q-1, t-1, x-1, y-1.
Mason Electric Corp., a thru d, m, n, o, x, y, z, a-1 thru f-1, i-1 thru p-1, r-1, s-1, u-1 thru z-1.
Massa Div.-Cohu Electronics, Inc., i, l, p, k-1, p-1, t-1, v-1, w-1.
Master Mobile Mounts, Inc., a.
W. L. Maxson Corp., The, a, f, g, l, m, p, s, t, u, z, a-1, c-1, e-1, p-1, q-1, v-1, w-1, z-1.
McDonnell Aircraft Corp., b, d, o, p, a-1, f-1, k-1, q-1, v-1.
McKenna Labs., w-1.
Metaplast Co., Inc., n-1.
Micro Gee Products, Inc., d, f, g, h, k, l, p, q, t, x, f-1, k-1, l-1, m-1, q-1.
Microwave Associates, Inc., z, h-1.
Mid-West Coil & Transformer Co., b, o, x, k-1.
Midwestern Instruments, Inc., h, i, n, p, v, b-1, c-1, d-1, q-1.
Milgo Electronic Corp., f, h.
James Millen Mfg. Co. Inc., o, r, g-1, l-1, m-1.
Milro Controls Co., Inc., i, x.
Minneapolis-Honeywell, Heiland Div., h, t-1, x-1.
Minneapolis-Honeywell Regulator Co., Boston Div., h, i, l, p, x, g-1, p-1, v-1.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., h, p-1.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., f, g, h, p, p-1, t-1.
Mira Corp., The, h, i, l, p, t-1, v-1, x-1.
Mitchell Camera Corp.
Modern Design Div.-H. C. Schloer, Inc., b, d, f, h, i, a-1, c-1, m-1, n-1, v-1.
Moran Instrument Corp., h, q-1, t-1.
Motoresearch Co., x.
Motorola, Inc., b, f thru k, m thru u, w thru z, a-1 thru n-1, q-1 thru w-1, y-1, z-1.
Muirhead Instruments Inc., q-1, x-1.
Narda Microwave Corp., The, z.
National Co., Inc., a thru z, a-1 thru r-1, u-1, v-1, w-1, y-1, z-1.
National Scientific Labs., Inc., k, h-1, n-1, v-1.
National Ultrasonic Corp., w-1.
Navigation Computer Corp., f, g, h, n-1, o-1, p-1, v-1.
Neff Instrument Corp., h, i, l, p, s, p-1, t-1, v-1.
Networks Electronic Corp., i, k, l, o, p, x, j-1, n-1, q-1, t-1, v-1, y-1.
New London Instrument Co. Inc., v, g-1, l-1, z-1.
Newton Co., The, i.
Northeast Electronics Corp., j, v, i-1.
Northeast Metals Industries, Inc., a.
Northern Plastics Corp., n-1.
Northrop Corp.
Nuclear-Chicago Corp., o-1.
Offner Electronics Inc., i, l, p, s, k-1, m-1, t-1, v-1, x-1.
Ortho Filter Corp., x.
Otis Elevator Co., Defense & Industrial Div., f, k, p, v, w, q-1.
Overhaul & Aerosystems, Div.-Temco Aircraft, a, n, x, p-1, y-1, z-1.
Pace Engrg. Co., t-1.
Pacific Automation Products, Inc., n-1, v-1.
Pacific Magnetic Corp., o, p, x.
Packard Bell Computer Corp., h, i, k, l, p, q, s, f-1, n-1, t-1, v-1.
Paco Electronics Co., Inc., j.
M. V. Palmer, Inc., t, u, r-1.
Paraplegics Mfg. Co., Inc., m-1, n-1, q-1, v-1.
Pegasus Labs., Inc., i, q-1, v-1,
Penn Keystone Corp., v-1.
Penn-East Engrg. Corp., x, k-1.
Performance Measurements Co., f, g, h, l, p, q, w, j-1, l-1, o-1, q-1, t-1, v-1.
Permoflux Products Co., b, m, s, v, a-1, c-1, v-1.
Philco Corp.-Govt. & Industrial Group, c, d, f thru k, m thru p, r, u, v, x, y, z, a-1 thru d-1, h-1, k-1, l-1, n-1, o-1, q-1, v-1, y-1, z-1.
Photobell Co., Inc., j-1, k-1.
Photocon Research Products, i, p.
Photron Instrument Co., f, h, i, p, f-1, k-1, p-1, s-1, t-1, x-1.
Piasecki Aircraft Corp., a, c, d, i thru m, r, v, y, z, k-1, l-1, n-1, t-1, v-1, w-1, y-1, z-1.
Piqua Engrg. Inc., q-1.
Pitometer Log Corp., g, z, v-1.
Plastic Age Sales, Inc., a.
Polarad Electronics Corp., y, z.
Polyphase Instrument Co., x.
Potter Instrument Co., Inc., f, h, p-1.
Power Supplies Inc., i, l-1, m-1, n-1, q-1, v-1, w-1.
Precise Development Corp., j, r, b-1.
Pressman Associates Inc., l-1.
Process & Instruments, i, p.
Projects Unlimited, Inc., b, d, g, j, v-1.
Quan-Tech Labs., Inc., i, j, l, s, g-1, t-1, v-1, y-1.
RS Electronics Corp., k, n, p, r, w, z, b-1, d-1, l-1, n-1, o-1, v-1, z-1.
Radalab Inc., y, g-1.
Radiaphone Co. Inc., d, p, v-1, z-1.
Radiation, Inc., a, i, r, b-1, d-1, t-1.
Radiation Instrument Development Lab., Inc., i, o-1.
Radio City Products Co. Inc., k, n, r, b-1, o-1, z-1.
Radio Condenser Co., k, n, r, b-1, d-1, o-1, v-1, z-1.
*RADIO CORP. OF AMERICA, a thru z, a-1 thru s-1, u-1 thru z-1.
*RADIO CORPORATION OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a, b, c, f, g, h, k, m, t, x, y, z, a-1, b-1, c-1, g-1, l-1, n-1 thru r-1, v-1, y-1, z-1.
*RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY, d, p, k-1, n-1, v-1.
Radio Development & Research Corp., g, i, x, l-1, m-1, v-1.
Radio Frequency Co., Inc., l-1, w-1.
Radio Receptor Co., Inc., Sub.-General Instrument Corp., g, k, r, z, f-1, h-1, l-1, m-1, o-1, r-1, w-1.
Railway Communications, Inc., g-1, r-1.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., f thru i, k, o, z, n-1, v-1.
Rangertone Inc., j, m, v, x.
Rantec Corp., z, b-1, d-1, h-1, r-1, z-1.
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., o.
Reed Instrument Co., k, px-1.
Reed Research Inc., k, p, x-1.
Reeves Instrument Corp., c, d, f, g, i, l, o, q, t, f-1, n-1, q-1, v-1.
Remler Co., m, u, v, y, v-1.
Resdel Engrg. Corp., a, k, r, b-1, l-1, z-1.
Rese Engrg., Inc., k-1, n-1, o-1, v-1.

Robertshaw-Fulton Controls Co., A & I Div., s-1.
Ryan Aeronautical Co., n-1.
Rytron Co., Inc., x.
Sage Labs., Inc., z, b-1, h-1.
Sage-Craft, Inc., n, z-1.
Sanders Associates, Inc., g, p.
Sangamo Electric Co., x.
Santa Barbara Research Center, k, j-1, v-1.
Schaevitz Engrg., q-1.
Scientific-Atlanta, Inc., a, h, p, w, z, b-1, p-1, q-1.
H. H. Scott, Inc., b, m, n, p, s, u, v, w, y, c-1, e-1, g-1, l-1, m-1, w-1, x-1, y-1.
Secode Corp., u, v, k-1, v-1.
Seeburg Corp., The, a-1, b-1, d-1, l-1, n-1, o-1, q-1.
*SEMICONDUCTOR DIV., RAYTHEON CO., o, v-1.
Servomechanisms, Inc., f, g, i, k, l, p, q, x, k-1, n-1, q-1, v-1.
Servo-Tek Products Co., i, x, q-1, v-1.
Sierra Electronic Corp., Div.-Philco Corp., z, l-1, z-1.
Sigma Instruments, Inc., x.
Signal Equipment Co., Inc., l-1, m-1.
Singer Military Products Div.-The Singer Mfg. Co., a, k, z, q-1, v-1, y-1, k, g-1, k-1, n-1, v-1.
Skiatron Electronics & Television Corp., i, v-1.
Solar Aircraft Co., k, m, o, l-1, m-1, n-1, v-1.
Sonex, Inc.
Sonotone Corp., b, v-1.
Southwest Research Institute, b, h, i, l, o, p, x, k-1 thru n-1, q-1, t-1, v-1, x-1.
Southwestern Industrial Electronics Co.
Special Products Dept., Melpar, Inc., q-1, v-1.
Specialties, Inc., x.
Specialty Electronics Development Corp., a, b, g, j, m, r, v, z, a-1, b-1, l-1, b, d, i, k, l, p, q, r, t, a-1 thru d-1, f-1, i-1, j-1, o-1, v-1, y-1, z-1.
Spectra Electronics Corp.
Spectralab Instruments, h-1, z-1.
Spectrol Electronics Corp., i, o, n-1, q-1, v-1.
Spencer-Kennedy Labs., Inc., n, p, d-1, o-1, z-1.
Sperry Electronic Tube Div., Sperry Rand Corp., z, z-1.
Sperry Gyroscope Co., Div.-Sperry Rand Corp., q-1.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., h-1.
a, c, j, m, n, r thru v, x, y, a-1 thru e-1, i-1, l-1, m-1, o-1, r-1, s-1, u-1, v-1, w-1, y-1, z-1.
Standard Electronics Div.-Reeves Instrument Corp.
State Testing Laboratory Inc., u.
Statham Development Corp., f, g, i, k, o, p, q, k-1, o-1, p-1, q-1, t-1, v-1.
Statham Instruments, Inc., f, p, t-1, v-1.
Stewart-Warner Electronics Div., f, r, t, z, b-1, e-1, o-1.
Stromberg-Carlson Div.-General Dynamics Corp., m, r, u, v, z, a-1, c-1, h-1, l-1, n-1, r-1, v-1, y-1.
Summers Gyroscope Co., q-1.
Sun Electric Corp., Aeronautical Div., a, b, c, f thru i, l, n, p, r, s, t, w, x, g-1, j-1, l-1, n-1, o-1, q-1, v-1, x-1, z-1.
Sunair Electronics, Inc., l-1, n-1, v-1.
Superior Electric Co., The, o-1, w-1, z-1.
B. K. Sweeney Mfg. Co., i, p, v-1, x-1.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., k, r, z, b-1, i-1, o-1, z-1.
Sylvania Semiconductor Div., Sylvania Electric Products Inc., v-1.
TRG, Inc., a, f, r, x, z, b-1, n-1, q-1.
*TABER INSTRUMENT CORP., b, d, f thru m, o, p, q, s, t, v, y, a-1, c-1, f-1, g-1, j-1 thru n-1, p-1, q-1, t-1, v-1, x-1, y-1.
Taffet Electronics, Inc., d, g, i, k, r, s, t, l-1, m-1.
Tamar Electronics, Inc., a, c, n, o, p, r, s, z, b-1, c-1, d-1, l-1, o-1, v-1, y-1, z-1.
Tapco Group, Thompson Ramo Wooldridge Inc., g, i, k, l, o, x, f-1, q-1, t-1, x-1.
Technical Products Co., h, p, y, p-1, x-1.
Technology Instrument Corp., e, j, p, l-1, y-1.
Tektronix, Inc., i, l, p, g-1.
Telechrome Mfg. Corp., b, d, f, h, k, o, p, r, u, v, a-1, c-1, f-1, k-1 thru n-1, t-1, u-1, v-1, z-1.
Telectro Industries Corp., a, f, h, o-1, p-1.
Telerad Mfg. Corp., z.
Television Utilities Corp., j-1.
Telex, Inc., i, m, o, v, x, n-1, v-1.
Tel-Instrument Electronics Corp., n.
Telkor, Inc., b, c, i, m, p, x, l-1, m-1, v-1.
Texas Instruments Inc., h-1, q-1, t-1, v-1.
Thermador Electrical Mfg. Co., x.
Thermo Electric Co., Inc., g, i, p, p-1, q-1.
Thompson Ramo Wooldridge Inc., g, i, k, l, o, x, f-1, q-1, t-1, x-1.
Topper Mfg. Co., Inc., o, q-1, v-1.
Torwico Electronics, Inc., i, x, l-1, m-1, q-1.
Tracerlab Inc., h.
Transformers, Inc., x.
Transicoil Div.-Daystrom Inc., q-1, v-1.
Transistor Electronics Corp., v-1.
Trepac Corp. of America, g, h, i, l, k-1, t-1, v-1.
Tresco, Inc., o, x.
Trio Laboratories, Inc., f, g, i, o, p, c-1, k-1, n-1, q-1, v-1, y-1.
United Control Corp., x, q-1, v-1.
U. S. Industries, Inc., a.
U. S. Science Corp., Div.-Topp Industries, Inc., c, f, k, l, o, x, f-1, h-1, q-1, r-1, v-1.
United States Plywood Corp., k.
Universal Toroid Coil Winding, Inc., x.
Universal Transistor Products Corp., x.
Universal Unlimited, Inc., a.
Vap-Air Aeronautical Products Div., Vapor Heating Corp., i.
Vari-L Co., Inc., x.
Varo Mfg. Co., Inc., b, c, d, f thru j, l thru x, z, a-1 thru d-1, f-1, h-1, i-1, k-1 thru q-1, s-1 thru v-1, y-1, z-1.
Vickers Inc., Electric Products Div., g, p, q, s, x, f-1, j-1, l-1, q-1, s-1, t-1.
Victoreen Instrument Co., a-1.
Video Instruments Co., Inc., b, d, h, i, l, o, p, q, s, k-1 thru n-1, p-1, q-1, t-1, v-1, x-1.
Viking Industries Inc., x, n-1, q-1, v-1.
Virginia Electronics Co., Inc., b, d, g, k, m, o, r thru v, y, a-1, b-1, c-1, k-1, l-1, n-1, o-1, v-1, y-1, z-1.
Voi-Shan Electronics, a, g, l, q, x, l-1, q-1, v-1.
Wahlgren Magnetics, Div.-Marshall Industries, x.
Walkirt Co., b, f, l, o, k-1, n-1, o-1, v-1.
Waltham Electronics Corp., d-1, z-1.
Wasley Products, Inc., k.
Waters Mfg., Inc., g.
Waugh Engrg. Co., q-1.
A. W. Welch Mfg. Co., Inc., x.
Wells Industries Corp., g, i, k, p, j-1, k-1, t-1.
Wesrep Corp., i, l-1.
Westgate Lab., Inc., g, p-1, q-1.
Westinghouse Electric Corp., a, b, k, m, n, r, v, x, z, a-1, d-1, h-1, j-1, l-1, m-1, n-1, q-1, r-1, u-1, w-1, x-1.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., q-1.
Westronics Inc., q-1.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., b, k, m, o, u, v, x, l-1, n-1, o-1, p-1, v-1.
White Instrument Labs., p, k-1.
Wickes Engrg. & Construction Co., i, m, t, u, v, x, k-1, l-1, y-1.
Winder Aircraft Corp. of Florida, a.
Zacharias Electronics Corp., b, d, f, h thru l, p, q, s, y, c-1, f-1, g-1, k-1, l-1, m-1, p-1, q-1, v-1 thru y-1.

ANALYSIS EQUIPMENT, ELECTRO-CHEMICAL

American Instrument Co., Inc.
Armament Div.-Universal Match Corp.
Baird-Atomic, Inc.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bjorksten Research Labs. for Industry, Inc.
Computer Systems, Inc.
*CONSOLIDATED ELECTRODYNAMICS CORP.
*ENGIS EQUIPMENT CO.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Furane Plastics, Inc.
Gardner Laboratory, Inc.
Hanson-Van Winkle-Munning Co.
Industrial Instruments Inc.
Jarrell-Ash Co.
Wayne Kerr Corp.
Lear, Inc.
Leeds & Northrup Co.
New England Scientific Instruments Co.
Perkin-Elmer Corp.
Philips Electronic Instruments
Southwest Research Institute
State Testing Laboratory Inc.
TRG, Inc.

ANALYZERS

a. Antenna Pattern
b. Audio Amplifier
c. Cable
d. Capacitor
e. Circuit
f. Coincidence
g. Crystal
h. Differential
i. Differential Computer
j. Digital
k. Dimensional
l. Distortion
m. Electrochemical
n. Engine
o. Flight
p. Frequency
q. Gas
r. Ignition
s. Infrared
t. Intermodulation
u. Internal Combustion
v. Magnetic
w. Microwave
x. Neutron Absorption
y. Noise
z. Phase
a-1. Radar
b-1. Servo
c-1. Spectrum
d-1. Spectrum, Nuclear
e-1. Stress Surface
f-1. Transducer
g-1. Transistor
h-1. Ultrasonic
i-1. Vibration
j-1. Wave
k-1. Waveform

ASCOP Div., Electro-Mechanical Research, Inc., p, y, c-1.
Acton Laboratories Inc., z.
Advance Industries, Inc., f, h, i, j, a-1 thru d-1.
Advanced Electronics, Inc., i-1.
Aero Instrument Co., p.
*AEROJET-GENERAL CORP., s.
Aeronca Mfg. Corp.-Aerospace Div., j.
Aerovox Corp., d.
Aetna Electronics Corp., b-1.
Air Logistics Corp., z, b-1.
Air Products, Inc., q.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., a, e, g, y.
Aircom Inc., w.
Aircraft Armaments, Inc., a-1.
Airtron, Div.-Litton Industries, w.
All Star Products Inc., d.
Allen Electric & Equipment Co., n, r, u.
Allied International Corp., h, n, o.
Allison Labs., Inc., y.
American Agile Corp., x.
American Instrument Co., Inc., j, m, q, s, c-1.
American Machine & Foundry Co., Government Products Group, n, p.
American Machine & Foundry Co., Greenwich Engrg. Div., b-1.
American Research & Mfg. Corp., i-1.
American Tradair Corp., a.
Antlab Inc., a.
Applied Dynamics Corp., w, c-1.
Applied Electronics Corp. of N. J., j.
Applied Research Inc., c-1.
Applied Research Labs., Inc., c-1.
Armament Div.-Universal Match Corp., m.
Arnoux Corp., f-1, g-1.
Associated Engineers, Inc., s.
Associated Research, Inc., d.
Atlantic Research Corp., f-1.
Atlas Precision Products, Co., h.
Audio Instrument Co., Inc., t.
B & F. Instruments, Inc., f-1.
B & K Instruments, Inc., b, l, p, y, c-1, i-1.
Bausch & Lomb Optical Co., c-1.
Bearing Inspection, Inc., y.
Bendix Aviation Corp., a, n, o, q, r, z, a-1 thru d-1.
Bendix Aviation Corp., Cincinnati Div., b, d, e, j, q, t, x, d-1.
Bendix Computer Div.-Bendix Aviation Corp., i.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., n.
Bendix Radio Div., Bendix Aviation Corp., a-1.
Benson-Lehner Corp., j.
Bergen Labs., Inc., m.
Beva Lab., Inc., f, d-1.
Bogue Electric Mfg. Co., e, n.
Bowmar Instrument Corp., i.
Briggs Associates, Inc., e, p, y, c-1, j-1.
Bruno-New York Industries Corp., w.
Brunswick Instruments, z.
Brush Instruments, Div.-Clevite Corp., b-1.
Budd Lewyt Electronics, Inc., i, j, z, a-1.
Bulova Watch Co., Electronics Div., g.
CBS Laboratories, Div.-Columbia Broadcasting System, b, g, m, v, f-1, g-1.
CG Electronics Corp., a, j.
CGS Labs., Inc., p.
Chadwick-Helmuth Co., l, k-1.
Chance Vought Aircraft, Inc., a.
Chemalloy Electronics Corp., w.
Cincinnati Cleaning & Finishing Machinery, h-1.
Circo Equipment Co., h-1.
Circo Ultrasonic Corp., h-1.
G. L. Collins Corp., f-1.
Collins Radio Co., c-1.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., c-1.
Computer Control Co., Inc., j.
Consolidated Airborne Systems, Inc., n, o.
*CONSOLIDATED ELECTRODYNAMICS CORP., m, q, f-1, i-1.
Control Electronics Co., Inc., z.
Convair Instruments, Convair Div.-General Dynamics Corp., n, i-1, j-1, k-1.
Control Technology Co., b-1.
Cornell-Dubilier Electric Corp., d.
Cosa Corp., i-1.

Curtiss-Wright Corp., Electronics Div., **g-1.**
Dale Products, Inc., **c, e.**
Daven Co., The, **l.**
Davis Instruments, **q.**
Daystrom Inc., Weston Instruments Div., **j, p.**
Decker Corp., The, **d, h, k, m, c-1, f-1, g-1, i-1, k-1.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **s.**
Delsen Corp., **m.**
Designers for Industry, Inc., **p, g-1, i-1.**
Dit-Mco, Inc., **c, e.**
Allen B. Du Mont Labs., Inc., **a-1.**
Dytronics Co., **z.**
Eldorado Electronics, **d-1.**
Electro Instruments, Inc., **d, e, f, j, p, z, b-1, g-1.**
Electro Scientific Industries, **d, b-1, f-1, g-1.**
Electronic Applications, Inc., **b, d, p, t, w, y, c-1, d-1, k-1.**
Electronic Mechanics, Inc.
Ellison Draft Gage Co., Inc., **a.**
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Products Sales Corp., **a, l, w, y, a-1, k-1.**
Engelhard Industries, Inc., **p, q.**
***ENGIS EQUIPMENT CO., j, s, c-1, d-1.**
FAE Instrument Corp., **h.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **g-1.**
Federal Products Corp., **k.**
Federal Scientific Corp., **c-1.**
Ferrotran Electronics Co., Inc., **y, g-1.**
Ferroxcube Corp. of America, **v, w, f-1.**
Film Capacitors, Inc., **d.**
Fisher Scientific Co., **m.**
Flow Corp., **j-1.**
Food Machinery & Chemical Corp., Ordnance Div., **c, e.**
Ford Instrument Co., Div.-Sperry Rand Corp., **j.**
Foto-Video Labs., Inc., **a-1, g-1, k-1.**
Franklin Electronics Inc., **j.**
Freed Transformer Co., Inc., **l.**
Furane Plastics, Inc., **m.**
General Communication Co., **w, a-1.**
General Electric Co., Apparatus Sales Div., **h.**
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Radio Co., **b, d, e, l, p, y, z, c-1, i-1, j-1, k-1.**
Gow-Mac Instrument Co., **q.**
Guided Missile Div., The Firestone Tire & Rubber Co., **b-1.**
Gulton Industries, Inc., **j, m, p, c-1, f-1, h-1, i-1.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hallamore Electronics Co., Div.-Siegler Corp., **c, o.**
Hammett-Mercury-Rex Div., **c, e, g thru j, n, p, r, v, w, a-1, b-1, g-1, j-1, k-1.**
George E. Harris & Co., Inc., **d, b-1, f-1.**
Hays Corp., The, **q.**
Herlo Corp., **f-1.**
Hewlett-Packard Co., **l, p, g-1, j-1, k-1.**
Hickok Electrical Instrument Co., The, **p, q, y, g-1, i-1, j-1, k-1.**
ITT Federal Div., International Telephone & Telegraph Corp., **c-1.**
Illinois Testing Laboratories, Inc., **f-1.**
Industrial Acoustics Co., Inc., **p, y.**
Industrial Control Co., **b-1, c-1.**
Industrial Instruments Inc., **q.**
Industrial Test Equipment Co., **z.**
Infrared Industries, Inc., **s.**
Instrument Labs., **e.**
Instrumentation Associates, Inc., **s.**
Instrument Div., The Budd Co., **h-1.**
Integrated Dynamics Div., Globe Industries, Inc., **o.**
***INTERELECTRONICS CORP., q.**
Interstate Electronics Corp., **f, h.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **d-1.**
Johnson-Williams, Inc., **q.**
Kahn & Co., Inc., **i-1.**
Kay Electric Co., **a, b, c, e, g, l, p, y, a-1, c-1, g-1 thru k-1.**
***KEARFOTT DIV., GENERAL PRECISION, INC., d, i, j, w, a-1, b-1.**
***KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS, c-1.**
Wayne Kerr Corp., **d, y, g-1, i-1, j-1, k-1.**
Kingston Electronics-Div.-Kingston Industries Inc., **e, r.**
Kistler Instrument Corp., **n, u, f-1, h-1, i-1.**
Lab. for Electronics, Inc., **p, w.**
Lavoie Labs., Inc., **c-1.**
Lear, Inc., **b, d, e, h thru o, q, y, b-1, f-1, g-1, i-1, j-1.**
Leeds & Northrup Co., **q, s.**
Librascope Div., General Precision, Inc., **h, i, j, m, o, s, v, b-1.**
Ling Electronics Div.-Ling-Altec Electronics, Inc., **i-1.**
Lockheed Aircraft Corp., Missiles & Space Div., **j.**
Thomas J. Long, Inc., **m.**
Loral Electronics Corp., **p,** w. **a-1, c-1.**
MB Electronics, **p, y, c-1, i-1.**
Madigan Corp., **b, c, e, i, j, o,** b-1, **g-1.**
Magnaflux Corp., Sub.-General Mills, Inc., **v, e-1, h-1.**
Marconi Instruments, **t, c-1, j-1.**
***MARTIN CO., THE, DENVER DIV., c, d, e, j, k, l, n, o, s, v, y, z, b-1, f-1, i-1, j-1.**
Mechanics Research Div., American Machine & Foundry Co., **k-1.**
Micro Gee Products, Inc., **m, p, b-1.**
Microwave Associates, Inc., **w.**
Milgo Electronic Corp., **h, i, j.**
Mine Safety Appliances Co., **q, s, y.**
Minneapolis-Honeywell Regulator Co., Boston Div., **b-1.**
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., **p, y, c-1, i-1, j-1, k-1.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **c, j.**
Modern Design Div.-H. C. Schloer, Inc., **b.**
Motorola, Inc., **g thru j, p, t, w, y, z, a-1, b-1, g-1, h-1.**
Muirhead Instruments Inc., **b, l, p, y, z, b-1, h-1 thru k-1.**
National Instrument Laboratories, inc., **q.**
National Ultrasonic Corp., **h-1.**
Networks Electronic Corp., **s.**
Northeastern Engrg. Inc., **c-1.**
Northrop Corp., **e, h, i, j, i-1.**
Nuclear-Chicago Corp., **d-1.**
Paul Nurches Co., **b-1, g-1.**
Overhaul & Aerosystems, Div.-Temco Aircraft, **c-1.**
Owen Labs., Inc., **e-1, g-1.**
Packard Bell Computer Corp., **h, i, j.**
Paco Electronics Co., Inc., **b, d.**
Panoramic Radio Products, Inc., **c-1, h-1, i-1, j-1.**
Parabam, Inc., **b-1.**
Patterson Moos Research, Div.-Leesona Corp., **q, s.**
Performance Measurements Co., **n.**
Perkin-Elmer Corp., **m, q, s.**
Permoflux Products Co., **b.**
Peschel Electronics, Inc., **c, e.**
Photobell Co., Inc., **k, l.**
Piasecki Aircraft Corp., **a, b, d, e.**
Pioneer Industries Div., Almar-York Co. Inc., **q, s, h-1.**
Piqua Engrg. Inc., **b-1.**
Pitometer Log Corp., **p, w.**
Polarad Electronics Corp., **a, w, a-1, b-1, c-1, k-1.**
Polyphase Instrument Co., **f-1.**
Polytechnic Research & Development Co., Inc., **w.**
Potter Aeronautical Corp., **f-1.**
Potter Instrument Co., Inc., **j.**
Precision Apparatus Co., Inc., **b, d, k-1.**
Probescope Co., Inc., **g, l, n, p, t, y, c-1, h-1 thru k-1.**
Process & Instruments, **q.**
Production Research Corp., Sub.-Radio Condenser Co., **a, j, s, c-1.**
Quan-Tech Labs., Inc., **b, l, p, t, y, c-1, g-1, h-1, j-1, k-1.**
Radiation, Inc., **j, l, b-1.**
Radiation Instrument Development Lab., Inc., **f, d-1.**
Radio Condenser Co., **d, e, p, s, g-1, h-1.**
Railway Communications, Inc., **j-1.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **i, x, g-1.**
Rantec Corp., **w.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., c-1.**
Rimak, Inc.
Scientific & Process Instruments Div.-Beckman Instruments, Inc., **q, s.**
Scientific-Atlanta, Inc., **a, w.**
Scintilla Div., Bendix Aviation Corp., **r, i-1.**
H. H. Scott, Inc., **b, y, i-1.**
Servo Consultants Ltd., **d, z, b-1.**
Servomechanisms, Inc., **b-1.**
Sharples Corp., The, **g.**
Shaw Process Development Corp., Div.-British Industries Corp., **j.**
Sheffield Corp., The, Sub.-Bendix Aviation Corp., **k.**
Sierra Electronic Corp., Div.-Philco Corp., **c, j, p, t, a-1, c-1, j-1.**
Skiatron Electronics & Television Corp., **n.**
Solar Aircraft Co., **h-1, i-1.**
Southwest Research Institute
Special Products Dept., Melpar, Inc., **c, s, c-1.**
Spectra Electronics Corp., **p, y, c-1, h-1, i-1, j-1.**
Spectrum Instruments, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **w, c-1.**
Sprague Electric Co., **d.**
Stromberg-Carlson Div.-General Dynamics Corp., **c-1.**
H. W. Sullivan Ltd., **d.**
Sun Electric Corp., Aeronautical Div., **e, j, n thru r, u, e-1, i-1.**
TRG, Inc., **a, s, w, z.**
Tamar Electronics, Inc., **w, z, a-1.**
Technical Electronics Co. Div.-Consolidated Electronic Industries, **e.**
Technical Materiel Corp., The, **l.**
Technical Products Co., **i-1.**
Telechrome Mfg. Corp., **j, f-1.**
Telex, Inc., **j.**
Tel-Instrument Electronics Corp., **i-1.**
Theta Instrument Corp., **z, b-1.**
Towaco Electronics, **l.**
Tracerlab Inc., **f, h, j.**
Transistor Electronics Corp., **g-1.**
Trans-Western Electronics, **g-1.**
Triplett Electrical Instrument Co., **e, r, g-1.**
U. S. Industries, Inc., **a, y, c-1, k-1.**
U. S. Science Corp., Div.-Topp Industries, Inc., **e, h, v, b-1, f-1.**
Varo Mfg. Co., Inc., **f.**
Victor R. F. & Microwave Co., **w.**
Victoreen Instrument Co., **d-1.**
Victory Engrg. Corp., **q.**
Virginia Electronics Co., Inc., **e.**
Vitramon, Inc., **d.**
Waltson Associates, Inc., **g-1.**
Waltham Electronics Corp., **e, p.**
Wang Labs., Inc., **f, j.**
Westberg Mfg. Co., **n.**
Westinghouse Electric Corp., **e, s, w.**
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., **b-1.**
Winkler Labs., **i-1.**

ANEMOMETERS

Advance Instrument Corp.
Aero Research Instrument Co. Inc.
Beckman & Whitley, Inc., Instrument Div.
Bendix Aviation Corp.
Decker Corp., The
Dynamic Controls Corp.
Ellison Draft Gage Co., Inc.
Epic, Inc.
Flow Corp.
W. & L. E. Gurley
Hickok Electrical Instrument Co., The
E. Vernon Hill & Co.
Illinois Testing Laboratories, Inc.
A. Lietz Co., The
Mine Safety Appliances Co.
M. C. Stewart
Westberg Mfg. Co.

ANGLE DRIVES

Breeze Corporations, Inc.
Dana Corp.
FAE Instrument Corp.
Hoover Electric Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Indiana Gear Works, Inc.
Kelsey-Hayes Co.
Lear, Inc.
Link-Belt Co.
***MARTIN CO., THE, DENVER DIV.**
Metron Instrument Co.
Micro Gee Products, Inc.
Sargent Engrg. Corp.
Spiroid Div., Illinois Tool Works
Talley Corp., The
Teleflex Inc.
Theta Instrument Corp.
Waste King Corp., Technical Products Div.
Western Gear Corp.-Precision Products Div.

ANNUNCIATORS

American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
Eagle Electric Mfg. Co. Inc.
Hammarlund Mfg. Co., The
H. R. Kirkland Co., The
Lear, Inc.
Marco Industries Co.
Radar Relay, Inc.
Scam Instrument Corp., The
Sun Electric Corp., Aeronautical Div.
United Control Corp.
Wheelock Signals Inc.

ANODES, GRAPHITE

Division Lead Co.
Great Lakes Carbon Corp.-Electrode Div.
Hammett-Mercury-Rex Div.
National Carbon Co., Div.-Union Carbide Corp.
Norrich Screw Machine Products
Ohio Carbon Co., The
Stackpole Carbon Co.
United Carbon Products Co.
Wallace & Tiernan Inc.

ANODES, METAL

Allied Research Products, Inc.
Alpha Metals, Inc.
Aluminum Co. Of America
American Brass Co., The
American Smelting & Refining Co.
Belmont Smelting & Refining Works, Inc.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
Chase Brass & Copper Co., Inc.
Division Lead Co.
Dow Chemical Co., The
Electronic Parts Mfg. Co., Inc.

Fansteel Metallurgical Corp.
Hammett–Mercury–Rex Div.
Handy & Harman
Hanson–Van Winkle–Munning Co.
Heil Process Equipment Corp.
W. L. Maxson Corp., The
Metal & Thermit Corp.
***RADIO CORP. OF AMERICA**
Rembar Co., Inc., The
Research Development Mfg. Inc.
Revere Copper & Brass Inc.
Texas Instruments Inc.
Wallace & Tiernan Inc.

ANTENNA FEED SYSTEMS

Ainslie Corp.
Aircom Inc.
All Products Co.
American Machine & Foundry Co., Government Products Group
American Tube Bending Co., Inc.
Bendix Aviation Corp.
Bogue Electric Mfg. Co.
CG Electronics Corp.
CGS Labs., Inc.
Chance Vought Aircraft, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Diamond Antenna & Microwave Corp.
Dorne & Margolin, Inc.
Douglas Microwave Co., Inc.
Dynatronics, Inc.
Electronic Specialty Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Gabriel Co., The, Gabriel Electronics Div.
General Bronze Electronics Corp.
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Ordnance Dept.
Gilfillan Bros. Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Intercontinental Electronics Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
D. S. Kennedy & Co.
Lieco, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lockheed Electronics Co., Stavid Div.
Mark Products Co.
***MARTIN CO., THE, DENVER DIV.**
Meridian Metalcraft, Inc.
Motorola, Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
Radiation, Inc.
***RADIO CORP. OF AMERICA**
Rantec Corp.
Sanders Associates, Inc.
Scientific-Atlanta, Inc.
Special Products Dept., Melpar, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
TRG, Inc.
Tamar Electronics, Inc.
Technical Appliance Corp.
Tower Construction Co.
Transco Products, Inc.
Wind Turbine Co.

ANTENNA FITTINGS & ACCESSORIES

ACF Industries Inc.
Ainslie Corp.
Aircom Inc.
All Products Co.
Amerac Inc.
American Latex Products Corp.
American Machine & Foundry Co., Greenwich Engrg. Div.
Bendix Aviation Corp.
CG Electronics Corp.
Calcor Corp.
Chance Vought Aircraft, Inc.
Copperweld Steel Co., Wire & Cable Div.
Corning Glass Works
Dalmo Victor Co., Div.-Textron, Inc.
Dayton Aircraft Products, Inc.
Diamond Antenna & Microwave Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Products Sales Corp.
Gabriel Co., The, Gabriel Electronics Div.
General Bronze Electronics Corp.
General Radio Co.
Gorham Electronics-Div.-Gorham Mfg. Co.
Isolantite Mfg. Corp.
Javex Electronics
Kelsey-Hayes Co.
Kings Electronics Co., Inc.
Lieco, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Mark Products Co.
Marman Div., Aeroquip Corp.
Master Mobile Mounts, Inc.
McMillan Companies, The
Meridian Metalcraft, Inc.
Motorola, Inc.
National Moldite Co.
Norrich Plastics Corp.
North & Judd Mfg. Co.
Northeast Metals Industries, Inc.
Pegasus Labs., Inc.
Penn Metal Co., Inc.
Portland Copper & Tank Works Inc.
Prestole Corp.
***RADIO CORP. OF AMERICA**
Rantec Corp.
Sanders Associates, Inc.
Scientific-Atlanta, Inc.
South River Metal Products Co., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stainless Inc.
Stanley-Judd Div.-The Stanley Works
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
TRG, Inc.
Tamar Electronics, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Technical Materiel Corp., The
Thompson Ramo Wooldridge Inc.
Thor Ceramics, Inc.
Tower Construction Co.
Transco Products, Inc.
Tri-Ex Tower Corp.
Vickers Inc.
Western Coil & Electrical Co.
Western Design, Div.-U. S. Industries, Inc.
Wind Turbine Co.

ANTENNA TOWER LIGHTING

Allied International Corp.
Bethlehem Steel Co.
E-Z Way Towers, Inc.
General Bronze Electronics Corp.
Hughey & Phillips, Inc.
E. F. Johnson Co.
Rohn Mfg. Co.
Specialty Electronics Development Corp.
Stainless Inc.
Tabet Mfg. Co., Inc.
Tower Construction Co.
Tri-Ex Tower Corp.
Westinghouse Electric Corp.
Wind Turbine Co.

ANTENNA TOWERS

a. Inflatable
b. Rigid, Fixed
c. Rigid, Portable

ACF Industries Inc.
Advanced Engineering Div., D. S. Kennedy & Co., **b.**
All Products Co., **b, c.**
Allied International Corp., **b, c.**
Allison Steel Mfg. Co., **b.**
Alpar Mfg. Corp., **b, c.**
American Car & Foundry Div., ACF Industries, inc., **b, c.**
American Conveyor Co.
American Electronic Labs., Inc., **a, b, c.**
American Machine & Foundry Co., Government Products Group, **b.**
American Machine & Foundry Co., Government Products, N. Y., **a, b, c.**
American Machine & Foundry Co., Greenwich Engrg. Div., **b, c.**
Antlab Inc.
Barker Sales Co.
Beacon Steel Corp., **b, c.**
Belmar Wheel & Machine Co., Inc., **c.**
Bethlehem Steel Co., **b.**
Birdair Structures, Inc., **a.**
Blaw-Knox Equipment, Div.-Blaw-Knox Co., **b.**
Calcor Corp., **b, c.**
Chance Vought Aircraft, Inc., **b, c.**
Colonial Aircraft Corp., **b, c.**
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co., **b, c.**
Dresser-Ideco Co., Div.-Dresser Industries, Inc., **b.**
E-Z Way Towers, Inc., **b, c.**
Eastern Rotorcraft Corp., **a, c.**
Eclipse-Pioneer Div., Bendix Aviation Corp.
Eubanks Industries, Inc., **b, c.**
General Bronze Electronics Corp., **b, c.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co., **b, c.**
Houston Fearless Corp., **c.**
ITE Circuit Breaker Co., Special Products Div., **a, b, c.**
D. S. Kennedy & Co., **b.**
Lofstrand Co., The, **b, c.**
MEG Products, Div.-Mandrel Industries, Inc., **b, c.**
Mark Products Co., **b, c.**
Northeast Metals Industries, Inc., **b, c.**
Opelika Welding, Machine & Supply Inc., **b.**
Philco Corp.-Govt. & Industrial Group, **b.**
Pimex, Inc.
Portland Copper & Tank Works Inc., **b, c.**
***RADIO CORP. OF AMERICA, b, c.**
Reynolds Metals Co., Sheffield Missile Plant, **c.**
Rimak, Inc., **b, c.**
Rohn Mfg. Co., **b.**
Sancor Corp., **b, c.**
Scientific-Atlanta, Inc., **c.**
Stainless Inc., **a, b, c.**
Tabet Mfg. Co., Inc.
Technical Appliance Corp., **b, c.**
Tower Construction Co.
Tri-Ex Tower Corp., **b, c.**
Twin Coach Co., Aircraft-Missiles, **b, c.**
United States Steel Corp., **c.**
Waco Aircraft Co., **b, c.**
Western Coil & Electrical Co.
Western Iron & Foundry Co., Inc.
Westinghouse Electric Corp., **a.**
Wind Turbine Co.
Winder Aircraft Corp. of Florida, **b, c.**
Young Development Div., Hercules Powder Co., **c.**

ANTENNAS

a. Direction Finding
b. Fixed Station
c. High Frequency
d. Loop-Direction Finder
e. Low Frequency
f. Microwave
g. Mobile Commercial
h. Mobile Communication
i. Radar
j. Radiation Test
k. Rotary Beam
l. Slotted Line
m. Ultra High Frequency
n. Very High Frequency

ACF Industries Inc., **e, i, m, n.**
Adler Electronics, Inc., **f, h, m, n.**
Admiral Corp., **m, n.**
Advanced Engineering Div., D. S. Kennedy & Co., **f, i.**
Aeronautical Electronics, Inc., **b, g, h, m, n.**
Aeronca Mfg. Corp., **i.**
Ainslie Corp., **f, i, m.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **i.**
Aircom Inc., **a, f, i, l, m, n.**
Aircraft Armaments, Inc., **f, l.**
Airtron, Div.-Litton Industries, **f, l.**
All Products Co., **a, b, c, e thru i, k, m, n.**
Allied International Corp., **a thru i, m, n.**
Allied Research & Engrg., Div.-Allied Record Mfg. Co., **f, i.**
Alpar Mfg. Corp., **b, c, e, f, i.**
Amerac Inc., **f, i.**
American Electronic Labs., Inc., **f, m, n.**
American Machine & Foundry Co., Government Products Group, **a, b, i.**
American Machine & Foundry Co., Government Products, N. Y., **a thru e, i, j, m, n.**
American Machine & Foundry Co., Greenwich Engrg. Div., **i.**
***ANDREW CORP., b, c, e, f, h, m, n.**
Antenna Specialists Co., The, **a, b, c, e, g, h, m, n.**
Barker Sales Co., **c, f, n.**
Rex Bassett, Inc., **h.**
Belmar Wheel & Machine Co., Inc., **a, d.**
Bendix Aviation Corp., **a thru n.**
Bendix Corp., The, Eclipse-Pioneer Div., **i.**
Bendix Radio Div., Bendix Aviation Corp., **i.**
Bethlehem Steel Co., **f, i.**
Birdair Structures, Inc., **h, i.**
Blaw-Knox Equipment, Div.-Blaw-Knox Co., **i.**
Blonder-Tongue Labs. Inc., Special Products Div., **m.**
Bogart Mfg. Corp., **c, f, m, n.**
Bowser, Inc., **a, b.**
Bowser Inc., Defense Div., **i.**
Brach Mfg. Corp., **n.**
Brooks & Perkins, Inc., **a, c, e, f, h, i, m, n.**
Brunswick Balke Collender Co., The, Defense Proucts Div., **e, f, i.**
H. H. Buggie Div., Burndy Corp., **g, h.**
CG Electronics Corp., **a, c, e, g, h, j, m, n.**
Calcor Corp.
Central Safety Equip. Co., **g, h.**
Chance Vought Aircraft, Inc., **a, b, c, e, f, h, i, j, l, m, n.**
Collins Radio Co., **b, c, d, f, i, k thru n.**
Columbia Products Co., **b, e, g, h, m, n.**
Communications Research Co., **b, h, n.**
Conrad & Moser, **a, d, i.**
Control Electronics Co., Inc., **d, f.**

Cordo Chemical Corp., **i.**
Dalmo Victor Co., Div.-Textron, Inc., **b, c, f, i, l, m.**
Joe Davidson & Associates, **f, i.**
Daystrom, Inc., Military Electronics Div., **i.**
Dayton Aircraft Products, Inc., **c.**
Diamond Antenna & Microwave Corp., **a, b, c, e, f, i, l, m.**
Don-Lan Electronics Inc., **c, f, i, m, n.**
Dorne & Margolin, Inc., **a thru f, i, j, m, n.**
Douglas Microwave Co., Inc., **f, i.**
Dresser-Ideco Co., Div.-Dresser Industries, Inc., **b.**
Dynatronics, Inc., **a, c, f, i, k, m, n.**
E-Z Way Towers, Inc., **f.**
Eclipse-Pioneer Div., Bendix Aviation Corp., **a.**
Electronic Specialty Co., **c, f, l, m, n.**
Electron-Radar Products, **f, i, m.**
Eljay Corp., **i.**
Emerson & Cuming, Inc., **f, i.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **c, f, i, k thru n.**
Empire Products Sales Corp.,
***EQUIPMENT DIV., RAYTHEON CO., f, i, k, l, m.**
FXR, Inc., **f.**
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp., **i.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **a thru f, i, m, n.**
Ferroxcube Corp. of America, **f.**
Finney Co., The, **m. n.**
Fla. Aircraft Radio & Marine
Freeman Co., The, **c, k, n.**
Gabriel Co., The, Gabriel Electronics Div., **a thru d, f thru n.**
General Bronze Electronics Corp., **a thru n.**
General Communication Co., **f.**
General Controls Co.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Electric Co., Ordnance Dept., **i.**
General Instrument Corp., Defense & Engrg. Products Group, **f, i.**
Gilfillan Bros. Inc., **f, i.**
John Gombos Co., Inc., **f.**
Goodyear Aircraft Corp., **f, i.**
Gorham Electronics Div.-Gorham Mfg. Co., **e, f, i.**
Gulton Industries, Inc., **b, c, f, k, l.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co., **a, c, f, i, j, l, m, n.**
Hallamore Electronics Co., Div.-Siegler Corp.
Hallicrafters Co., The, **f, l, m, n.**
Hammett-Mercury-Rex Div., **f, i.**
Hazeltine Electronics Div.-Hazeltine Corp., **a, b, f, h, i, j, m, n.**
Hauston Fearless Corp., **c, f.**
Hughes Tool Co., Aircraft Div., **i.**
ITE Circuit Breaker Co., Special Products Div., **a thru n.**
ITT Federal Div., International Telephone & Telegraph Corp., **c, h, m, n.**
Indiana Gear Works, Inc., **m, n.**
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp., **g.**
Interstate Electronics Corp., **a.**
J-V-M Microwove Co., **f, i.**
E. F. Johnson Co., **b, g, h.**
K-W Engrg. Works, **h.**
***KEARFOTT DIV., GENERAL PRECISION, INC., a, f, i.**
***KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS, f, i, m, n.**
Kelsey-Hayes Co., **c, i.**
D. S. Kennedy & Co., **f, i.**
Kentucky Metal Products Co., **f, i.**
Kings Electronics Co., Inc., **f.**
Herb Kreckman Co., **b, g, h, n.**
Lear, Inc., **a, d, i.**
Lieco, Inc., **f, i.**
Litton Industries, Inc.
Litton Industries, Maryland Div., **a thru f, i, k thru n.**
Lockheed Aircraft Corp., Missiles & Space Div., **i, l.**
Lockheed Electronics Co., Stavid Div., **f, i, m, n.**
Lunn Laminates, Inc., **f, g, h.**
Lycoming Div., Avco Corp., **n.**
MEG Products, Div.-Mandrel Industries, Inc., **i.**
***MAGNAVOX CO., THE, d, i.**
Mark Products Co., **b, c, e thru i, k, m, n.**
***MARTIN CO., THE, DENVER DIV., b, f, m.**
Martin Machine Works, Inc.
Master Mobile Mounts, Inc., **g, h, n.**
W. L. Maxson Corp., The, **a, c, f, i, l, m, n.**
Mc Donnell Aircraft Corp., **f, l, m, n.**
Mc Millan Companies, The, **f, m, n.**
Meridian Metalcraft, Inc., **f, i, j, l, m.**
Microwave Associates, Inc., **f.**
***MINNESOTA MINING & MFG. CO., i.**
Mosley Electronics, Inc., **b, c,** h, k, m, n.
Motorola, Inc., **a thru i, k thru** n.
Munston Electronic Mfg. Corp., a, d.
Narda Microwave Corp., The, **f.**
Narmco Mfg. Co., **f, i.**
Norden Div., United Aircraft Corp., **i.**
Northeast Metals Industries, Inc., **a thru f, i, l, m, n.**
Northrop Corp.
Overhaul & Aerosystems, Div.-Temco Aircraft, **a, c, e, m, n.**
Pacific Automation Products, Inc., **m, n.**
M. V. Palmer, Inc., **b, f, m, n.**
Ralph M. Parsons Co., The, Electronics Div., **m, n.**
Permax Products Div., Chisholm-Ryder Co., Inc., **b, c, g, h, m, n.**
Philco Corp.-Govt. & Industrial Group, **a, b, c, e, f, h, i, m, n.**
Phoenix Products Co., **i.**
Plastic Age Sales, Inc., **i.**
Polarad Electronics Corp., **f.**
Portland Copper & Tank Works Inc., **a, b, c, f thru i, m, n.**
Prodelin Inc., **f, g, h, m, n.**
Production Research Corp., Sub.-Radio Condenser Co.
Radalab Inc.
Radiation, Inc., **d, f, i.**
Radio City Products Co. Inc., **a.**
Radio Condenser Co., **c, m, n.**
***RADIO CORP. OF AMERICA, a thru n.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **c, f, l, m, n.**
Rantec Corp., **f, i.**
Reeves Instrument Corp., **i.**
Republic Aviation Corp., Missile Systems Div., **a, b, c, e, f, h, i, m, n.**
Robot Industries Inc., **a, i.**
Sage Labs., Inc., **f.**
Sanders Associates, Inc., **a, f, i, k.**
Scala Radio Co., **a, b, c, e, g, h, m, n.**
Scientific-Atlanta, Inc., **c, f, i, j, m, n.**
Singer Military Products Div.-The Singer Mfg. Co., **a, c, f, i, m.**
Skyline Electric & Mfg. Co., **f.**
Southwest Research Institute, **a.**
Special Products Dept., Melpar, Inc., **a, c, f, m, n.**
Specialty Electronics Development Corp., **a, f.**
Spectra Electronics Corp., **c, e, f, m, n.**
Sperry Gyroscope Co., Div.-Sperry Rand Corp., **f, i.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **f, i, j, l.**
Sperry Piedmont Co., Div.-Sperry Rand Corp., **i.**
Stainless Inc., **f, i, l.**
Standard Electronics Div.-Reeves Instrument Corp., **c, n.**
State Testing Laboratory Inc., **b, c, g, h.**
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co. **i.**
Stewart-Warner Electronics Div., **a, d, e, f, i, m.**
Strand Engrg. Co., **f, i, m.**
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., **a, f, i, l, m.**
Systems Incorporated, **d.**
TRG, Inc., **a thru f, i thru n.**
Tamar Electronics, Inc., **a, f thru i, m, n.**
Tapco Group, Thompson Ramo Wooldridge Inc., **f.**
Technical Appliance Corp., **b, c, f thru i, m, n.**
Technical Materiel Corp., The, **c.**
Technicraft, Div.-Electronic Specialty Co., **f, l.**
Telectro Industries Corp., **a, c, d.**
Telerad Mfg. Corp., **f, i.**
Telkor, Inc., **b, c, n.**
Temco Aircraft Corp., **f, m, n.**
A. S. Thomas, Inc., **a thru n.**
Thompson Ramo Wooldridge Inc., **a, f, i.**
Tober Electronic Corp., **a, f, i, l.**
C. W. Torngren Co., Inc., **f.**
Tower Construction Co., **f.**
Transco Products, Inc., **a, c thru f, h, i, j, m, n.**
Tri-Ex Tower Corp., **f, g, h.**
United Shoe Machinery Corp., **f, i.**
U. S. Science Corp., Div.-Topp Industries, Inc., **b, j, n.**
United States Testing Co., Inc., **c, e, f, l.**
Universal Moulded Products Corp., **a thru m.**
Universal Unlimited, Inc.
Victor R. F. & Microwave Co., **f.**
Virginia Electronics Co., Inc., **h.**
Washington Aluminum Co., Inc., **a thru n.**
Waveline, Inc., **f, i, l.**
Western Gear Corp.-Precision Products Div., **a, b, c, f, i, l, m, n.**
Westinghouse Electric Corp., **c, f, i, m, n.**
Wheeler Laboratories, Inc., **b, e thru i, m, n.**
Wind Turbine Co., **k.**
Winder Aircraft Corp. of Florida, **c, i.**

ANTIMONY

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Alpha Metals, Inc.
American Smelting & Refining Co.
Barium & Chemicals, Inc.
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bow Solder Products Co., Inc.
Bram Metallurgical Chemical Co.
City Chemical Corp.
Delta Chemical Works, Inc.
Division Lead Co.
Harmon, Lichtenstein & Co.
Semi-Elements, Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

ANTI-VIBRATION EQUIPMENT

American Felt Co.
American Latex Products Corp.
Anaconda Metal Hose Div., The American Brass Co.
Armstrong Cork Co.
Bushings, Inc.
Chance Vought Aircraft, Inc.
Convair Instruments, Convair Div.-General Dynamics Corp.
Dow-Elco, Inc.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Industrial Acoustics Co., Inc.
K. W. Johnson & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lord Mfg. Co.
MB Electronics
Mechanics Research Div., American Machine & Foundry Co.
Northrop Corp.
Owens-Corning Fiberglas Corp.
Propulsion Test Facilities Div.-MB Electronics
Seaman Products, Div.-Seaman Paper Co.
Southwest Research Institute
A. T. Stevens Co.
Uniform Hood Lace Co.
United States Rubber Co.
Vibration Isolation Products
Westinghouse Electric Corp.

ASBESTOS

Abesto Corp.
American Smelting & Refining Co.
Anchor Packing Co., The
Auburn Mfg. Co., The
General Gasket Inc.
Greene, Tweed & Co.
Insulation Mfrs. Corp.
Johns-Manville Sales Corp.
Raybestos-Manhattan, Inc.
Thermoid Div.-H. K. Porter Co., Inc.
United States Rubber Co.
Zippertubing Co., The

ASPHALT

Biwax Corp.
Borden Chemical Co.
Mitchell Rand Mfg. Corp.
Southwest Research Institute
Standard Oil Co. of Indiana
Thermon Mfg. Co.
Zophar Mills Inc.

ASSEMBLY EQUIPMENT, AUTOMATIC

American Machine & Foundry Co., Greenwich Engrg. Div.
Anchor Specialty Mfg. Co. Inc.
Barnes Development Co.
Bendix Aviation Corp.
E. W. Bliss Co.
Bulova Research & Development Labs., Inc.
Burklyn Co.
Eyelet Tool Co. Inc.
Hydroforming Co. of America Inc.
Lear, Inc.
Lennox Tool & Machine Builders
Lepel High Frequency Labs. Inc.
Link-Belt Co.
***MARTIN CO., THE, DENVER DIV.**
Modern Design Div.-H. C. Schloer, Inc.
George L. Nankervis Co.
Pyles Industries, Inc.
***RADIO CORP. OF AMERICA**
Sheffield Corp., The, Sub.-Bendix Aviation Corp.
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Squiers Gage Co.
Taft-Peirce Mfg. Co., The
Thomson, Judson L.
Zippertubing Co., The

ASSEMBLY SHIELD, NUCLEAR

Armament Div.-Universal Match Corp.
Bar-Ray Products, Inc.
Bendix Aviation Corp.
E. W. Bliss Co.
Brooks & Perkins, Inc.
A. M. Byers Co.
Fansteel Metallurgical Corp.
Flight Refueling, Inc.
General Electric Co., Missile & Space Vehicle Dept.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
International Steel Co.

Jan Hardware Mfg. Co., Inc.
Portland Copper & Tank Works Inc.
Westinghouse Electric Corp.
Zippertubing Co., The

ATTENUATORS

a. Audio
b. Logarithmic
c. Microwave
d. Precision
e. RF & IF

ACDC Electronics, Inc., **e.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **d, e.**
Aircom Inc., **c, d, e.**
Airtron, Div.-Litton Industries, **c.**
Allegany Instrument Co., Inc.
Allison Labs. Inc., **a.**
Antlab Inc., **b.**
Applied Research Inc., **c, e.**
Blonder-Tongue Labs., Inc., **e.**
Blonder-Tongue Labs. Inc., Special Products Div., **e.**
Bogart Mfg. Corp., **c.**
Bruno-New York Industries Corp., **c.**
CG Electronics Corp., **c.**
Carborundum Co., Refractories Div., **c.**
Chance Vought Aircraft, Inc., **c.**
Chemalloy Electronics Corp., **c.**
Clevite Ordnance, Div.-Clevite Corp., **a, b.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., c.**
Control Electronics Co., Inc., **c.**
Dalmo Victor Co., Div.-Textron, Inc., **c.**
Daven Co., The, **a, e.**
Joe Davidson & Associates, **c.**
Dell Optics Co., Ltd., **c.**
Demornay-Bonardi, **c.**
Diamond Antenna & Microwave Corp., **c, d, e.**
Dan-Lan Electronics Inc., **c, d, e.**
Dorne & Margolin, Inc., **c, e.**
Double E Products Co., **a thru e.**
Douglas Microwave Co., Inc., **c.**
Du Kane Corp., **a.**
Electrical & Physical Instrument Corp., **e.**
Electro Scientific Industries, **d.**
Electromation Co., Div.-Del Mar Engrg. Labs, **a thru e.**
Electronic Applications, Inc., **a, c, e.**
Electron-Radar Products, **c.**
Elektro-Serv Co., **c.**
Empire Products Sales Corp., **c, d, e.**
***EQUIPMENT DIV., RAYTHEON CO., c.**
FXR, Inc., **c.**
General Aniline & Film Corp., Ansco Div., **c.**
General Communication Co., **c.**
General Instrument Corp., Defense & Engrg. Products Group, **c.**
General Radio Co., **a, c, d.**
Gilfillan Bros. Inc., **c.**
John Gombos Co., Inc., **c.**
Hammett-Mercury-Rex Div., **c, d.**
Hewlett-Packard Co., **a, c, d, e.**
***INTERELECTRONICS CORP., a.**
Interstate Electronics Corp., **a.**
J-V-M Microwave Co., **c, e.**
Javex Electronics, **a.**
Kay Electric Co., **a, b, d, e.**
***KEARFOTT DIV., GENERAL PRECISION, INC., c.**
***KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS, c, d, e.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **a.**
Kentucky Metal Products Co., **c, e.**
Wayne Kerr Corp., **a, c, e.**
Kings Electronics Co., Inc., **e.**
Lab. for Electronics, Inc., **c.**
Lavoie Labs., Inc., **c.**
Lear, Inc., **a, e.**
Lieco, Inc., **c.**
Lockheed Aircraft Corp., Missiles & Space Div., **c.**
Marconi Instruments, **e.**
***MARTIN CO., THE, DENVER DIV., e.**
W. L. Maxson Corp., The, **a, c, e.**
McMillan Companies, The, **c.**
Meridian Metalcraft, Inc., **c, d.**
Microlab, **c, e.**
Microphase Corp., **c.**
Microwave Associates, Inc., **c.**
Motorola, Inc., **a, c.**
Muirhead Instruments Inc., **a, d, e.**
Narda Microwave Corp., The, **c, d.**
National Co., Inc., **a thru e.**
New London Instrument Co. Inc., **e.**
Northrop Corp.
Omega Labs., Inc., **c.**
Overhaul & Aerosystems, Div.-Temco Aircraft, **e.**
Piasecki Aircraft Corp., **a.**
Pitometer Log Corp., **c.**
Polarad Electronics Corp., **c.**
Polytechnic Research & Development Co., Inc., **c.**
Projects Unlimited, Inc., **a, e.**
Pyroferric Co. Inc., **c.**
Radar Design Corp., **c.**
***RADIO CORP. OF AMERICA, a thru e.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **c.**
Rantec Corp., **c.**
Ray-O-Vac Co., Div.-Electric Storage Battery Co.
Republic Aviation Corp., Missile Systems Div.
Sage Labs., Inc., **c.**
Sanders Associates, Inc., **c.**
Servo Consultants Ltd., **a, d.**
Shallcross Mfg. Co., **a, d.**
Sierra Electronic Corp., Div.-Philco Corp., **c, e.**
Specialty Electronics Development Corp., **a, c, d, e.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **c.**
Stoddart Aircraft Radio Co., Inc., **c, d, e, a.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, e.**
Sun Electric Corp., Aeronautical Div.
Superior Electric Co., The, **e.**
Sylvania Electric Products Inc., Special Tube Operations, **c.**
Tamar Electronics, Inc., **c, e.**
Technicraft, Div.-Electronic Specialty Co., **c.**
Telechrome Mfg. Corp., **a.**
Telerad Mfg. Corp., **c.**
Telex, Inc., **d.**
Telonic Industries, Inc., **a, c, d, e.**
Tober Electronic Corp., **c.**
Transco Products, Inc., **c, e.**
Vernistat Div., The Perkin-Elmer Corp., **d.**
Victor R. F. & Microwave Co., **c.**
Virginia Electronics Co., Inc., **a.**
Waltham Electronics Corp., **e.**
Waveline, Inc., **c.**

AUTOMATIC CHECKOUT SYSTEMS

ACF Electronics Div., ACF Industries Inc.
Adage, Inc.
Adler Electronics, Inc.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Air Logistics Corp.
Aircraft Armaments, Inc.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alto Scientific Co., Inc.
Alwac Computer, Div.-El-Tronics Inc.
American Machine & Foundry Co., Government Products Group
American Missile Products Co., Inc.
Anaheim Electronics Div.-Electronic Engrg. Co. of Calif.
Anchor Specialty Mfg. Co. Inc.
Auto-Control Labs. Inc.
Autonetics, Div.-North American Aviation, Inc.
Avien, Inc.
Avtron Mfg., Inc.
Beckman-Systems Div.
Beech Aircraft Corp.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Aviation Corp., York Div.
Bendix Corp., The, Eclipse-Pioneer Div.
Bendix-Pacific Div., Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Radio Div., Bendix Aviation Corp.
Bogue Electric Mfg. Co.
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
Burton-Rodgers, Inc.
CBS Laboratories, Div.-Columbia Broadcasting System
California Plasteck Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chance Vought Aircraft, Inc.
Compudyne Corp.
Computer Systems, Inc.
Consolidated Diesel Electric Corp.
James Cunningham Son & Co., Inc.
Curtiss-Wright Corp., Santa Barbara Div.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Control Systems Div.
Daystrom Inc., Pacific Div.
Designers for Industry, Inc.
Dit-Mco, Inc.
Douglas Aircraft Co., Inc.
Du Kane Corp.
Allen B. Du Mont Labs., Inc.
Dynatronics, Inc.
Electro Instruments, Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
Electronics Div.-The National Cash Register Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Ensco, Inc.
Epsco Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
Erdco Engrg. Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
J. W. Fecker Div., American Optical Co.
Food Machinery & Chemical Corp., Ordnance Div.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Genisco, Inc.
Gilfillan Bros. Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hallamore Electronics Co., Div.-Siegler Corp.
A. W. Haydon Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
Hoover Electronics Co.
Hughes Tool Co., Aircraft Div.
Iconix Inc.
Industrial Control Co.
Intercontinental Dynamics Corp.
Lab. for Electronics, Inc.
Lavoie Labs., Inc.
Leach Corp.
Lear, Inc.
***WALLACE O. LEONARD, INC.**
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lockheed Electronics Co., Stavid Div.
Lundy Mfg. Corp.
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Corp.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Mc Donnell Aircraft Corp.
Micro Gee Products, Inc.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Missile Div., North American Aviation, Inc.
Modern Design Div.-H. C. Schloer, Inc.
Motorola, Inc.
George L. Nankervis Co.
National Co., Inc.
Navigation Computer Corp.
Norden Div., United Aircraft Corp.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Optimized Devices, Inc.
Otis Elevator Co., Defense & Industrial Div.
Pacific Automation Products, Inc.
Packard Bell Computer Corp.
Packard-Bell Electronics Corp.
Performance Measurements Co.
Philco Corp.-Govt. & Industrial Group
Polarad Electronics Corp.
Potter Instrument Co., Inc.
REF Mfg. Corp.
Radiaphone Co. Inc.
Radiation, Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORPORATION OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGR. FACILITY
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Republic Aviation Corp., Missile Systems Div.
Sanders Associates, Inc.
Secode Corp.
Servomechanisms, Inc.
Sierra Electronic Corp., Div.-Philco Corp.
Singer Military Products Div.-The Singer Mfg. Co.
Skydyne, Inc.
Slaughter Co., Inc.
Soroban Engrg., Inc.
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Statham Development Corp.
Strand Engrg. Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Sundstrand Turbo
Systron Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Theta Instrument Corp.
Thompson Ramo Wooldridge Inc.
Transco Products, Inc.
Trio Laboratories, Inc.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Video Instruments Co., Inc.
Wang Labs., Inc.
Wells Industries Corp.

Westinghouse Electric Corp.
Wiancko Engrg. Co.

AUTOMATIC PILOT CONTROL VALVES

***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Instrument Co., Inc.
Arkwin Industries, Inc.
Automatic Switch Co.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Captive Seal Corp.
Chance Vought Aircraft, Inc.
Consolidated Controls Corp.
Custom Component Switches Inc.
George W. Dahl Co., Inc.
FAE Instrument Corp.
Fisher Governor Co.
Garwin, Inc.
General Controls Co.
B. H. Hadley, Inc.
Hoefner Corp.
Hydra-Power Corp.
Hydraulic Research & Mfg. Co.
Integral Corp.
Interstate Engrg. Corp.
Kemp Aero Products
Kieley & Mueller, Inc.
Lear, Inc.
***MARTIN CO., THE, DENVER DIV.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
OPW-Jordan
Pneu-Hydro Valve Corp.
Research Controls
Sargent Engrg. Corp.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Tactair Valve Div.-Aircraft Products Co.
Talley Corp., The
United Aircraft Products, Inc.
Weatherhead Co., The
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.
Whittaker Controls, Div.-Telecomputing Corp.

AUTOMATIC PILOTS, ELECTRONIC

***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Autonetics, Div.-North American Aviation, Inc.
Beech Aircraft Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Chance Vought Aircraft, Inc.
Collins Radio Co.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Daystrom Inc., Pacific Div.
Daystrom Inc., Transicoil Div.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
Guided Missile Div., The Firestone Tire & Rubber Co.
Integrated Dynamics Div., Globe Industries, Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Lear, Inc.
Mc Donnell Aircraft Corp.
Micro Gee Products, Inc.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Northrop Corp.
Pacific Automation Products, Inc.
Paraplegics Mfg. Co., Inc.
Philco Corp.-Govt. & Industrial Group
Sanders Associates, Inc.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
TRG, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Texas Instruments Inc.
Thompson-Ramo Wooldridge Inc.
Westinghouse Electric Corp.
Whittaker Gyro. Div.-Telecomputing Corp.

AUTOMATIC PILOTS, HYDRAULIC

Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Consolidated Controls Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Garwin, Inc.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
Hoefner Corp.
Hydra-Power Corp.
Interstate Engrg. Corp.
Kemp Aero Products
Kieley & Mueller, Inc.
Lear, Inc.
***MARTIN CO., THE, DENVER DIV.**
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Northrop Corp.
Radio Development & Research Corp.
SKF Industries, Inc.
Sanders Associates, Inc.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Whittaker Controls, Div.-Telecomputing Corp.

AUXILIARY POWER SOURCES

Adel Precision Products of Calif., Div.-General Metals Corp.
Aircraft Accessory Turbine Dept.-General Electric Co.
***AiRESEARCH MFG. OF ARIZONA**
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix-Pacific Div., Bendix Aviation Corp.
Bjorksten Research Labs. for Industry, Inc.
Carson Mach & Supply Co.
Clevite Ordnance, Div.-Clevite Corp.
Consolidated Diesel Electric Corp.
Cook Batteries, Sub.-Telecomputing Corp.
Datascan Inc.
Joe Davidson & Associates
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Eagle-Picher Co., The
John Fluke Mfg. Co., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Georator Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard, Div.-United Aircraft Corp.
Hammett-Mercury-Rex Div.
ITI Electronics, Inc.
***INTERELECTRONICS CORP.**
Jack & Heintz, Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Magnetic Research Corp.
***MARTIN CO., THE, DENVER DIV.**
Sanford Miller Co.
***MINNESOTA MINING & MFG. CO.**
Olin Mathieson Chemical Corp., N. Y.
Patterson Moos Research, Div.-Leesona Corp.
Pesco Products Div., Borg-Warner Corp., Calif.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Radio Development & Research Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Solar Aircraft Co.
Stewart & Stevenson Services, Inc.
Sun Electric Corp., Aeronautical Div.
Varo Mfg. Co., Inc.
Vickers Inc., Electric Products Div.
Wincharger Corp., Sub.-Zenith Radio Corp.

BADGES, RADIATION

Acromark Co., The
Adept Industries Inc.
American Electronics, Inc.
Bausch & Lomb Optical Co.
Corning Glass Works
Isotopes Specialties Co., Div.-Nuclear Corp. of America
Nuclear-Chicago Corp.
St. John X-Ray Laboratory
Sillcocks-Miller Co.
Tracerlab Inc.

BAFFLES, AIR

Allied Witan Co. Inc.
Anchor Metal Spinning Co., The
B. H. Aircraft Co., Inc.
Carborundum Co., The
Colonial Aircraft Corp.
Hanlon & Wilson Co., The
Ludwig Honold Mfg. Co.
Industrial Acoustics Co., Inc.
Kling Metal Spinning & Stamping Co.
***LAVELLE AIRCRAFT CORP.**
***MARTIN CO., THE, DENVER DIV.**
Northeast Metals Industries, Inc.
Portland Copper & Tank Works Inc.
Rimak, Inc.
T. O. D. Mfg. Co. Inc.
Winder Aircraft Corp. of Florida
Woolf Aircraft Products, Inc.

BALANCING EQUIPMENT

R. B. Annis Co.
Bendix Aviation Corp.
Cosa Corp.
Decker Corp., The
Dynametrics Corp.
Integrated Dynamics Div., Globe Industries, Inc.
Micro Balancing, Inc.
Performance Measurements Co.
Stewart-Warner Corp., Alemite Div.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.
Westinghouse Electric Corp.

BALL JOINTS

Aero Mfg. & Mach. Co., Inc.
Allegany Instrument Co., Inc.
Arkwin Industries, Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Barco Mfg. Co., Inc.
Bendix Aviation Corp.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Dana Corp.
Flight Refueling, Inc.
B. H. Hadley, Inc.
Hanlon & Wilson Co., The
Walter K. Jaros Aircrafters
Langley Corp.
Lear, Inc.
Marman Div., Aeroquip Corp.
Ohlson Empire Inc.
Solar Aircraft Co.
Southwest Products Co.
Weatherhead Co., The

BALL LATCHES

Aeroquip Corp., Jackson Div.
Capital City Mfg. Co., Inc.
George E. Harris & Co., Inc.
***MARTIN CO., THE, DENVER DIV.**
Western Div., Aeroquip Corp.

BALLISTOCARDIOGRAPHS

Decker Corp., The
Gulton Industries, Inc.
Statham Instruments, Inc.

BARIUM

Barium & Chemicals, Inc.
Bram Metallurgical Chemical Co.
Hammett-Mercury-Rex Div.
King Labs., Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

BAROGRAPHS

American Paulin System
Pimex, Inc.
Southwest Research Institute

BAROMETERS

American Paulin System
Bendix Aviation Corp.
A. Biederman, Inc.
***BRISTOL CO., THE**
Bulova Research & Development Labs., Inc.
Decker Corp., The
Dynametrics Corp.
***ENGIS EQUIPMENT CO.**
Hass Instrument Corp., The
E. Vernon Hill & Co.
Ideal-Aerosmith, Div.-Royal Industries, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
Narda Microwave Corp., The
Pimex, Inc.
Southwest Research Institute
Uehling Instrument Co.
Wallace & Tiernan Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

BASES

a. Antenna
b. Diode
c. Relay
d. Transistor

ACF Industries Inc., **a.**
Alpar Mfg. Corp., **a.**
American Car & Foundry Div., ACF Industries, Inc., **a.**
American Machine & Foundry Co., Greenwich Engrg. Div., **a.**
Antlab Inc., **a.**
Armel Electronics, Inc., **c.**
Associated Engrg. & Mfg. Corp., **d.**
Belmar Wheel & Machine Co., Inc., **a, b, d.**
Bendix Aviation Corp., **a, b, d.**
Bendix Corp., The, Eclipse-Pioneer Div., **a.**
Blaw-Knox Equipment, Div.-Blaw-Knox Co., **a.**
E. W. Bliss Co., **a.**
Bowser Inc., Defense Div., **a.**

Brooks & Perkins, Inc., **a.**
Burndy Corp., Omaton Div., **c.**
CG Electronics Corp., **a.**
Conrad & Moser, **a.**
Corning Glass Works, **b, d.**
Dalmo Victor Co., Div.-Textron, Inc., **a.**
Dayton Aircraft Products, Inc., **a.**
Diamond Antenna & Microwave Corp., **a.**
Don-Lan Electronics Inc., **a.**
***EQUIPMENT DIV., RAYTHEON CO., a.**
Falstrom Co., **a.**
Hahn & Clay
Hermetic Seal Corp., **b, c, d.**
ITE Circuit Breaker Co., Special Products Div., **a.**
Industrial Equipment Div., Baldwin Lima Hamilton **a.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **c.**
Litton Industries, Maryland Div., **a.**
Motorola, Inc., **a, b, d.**
Nippert Electric Products Co., The
Northeast Metals Industries, Inc., **a.**
Portland Copper & Tank Works Inc., **a.**
***RADIO CORP. OF AMERICA, a thru d.**
Reeves Instrument Corp., **a.**
Rimak, Inc., **a thru d.**
Robot Industries Inc., **a.**
Milton Ross Metals Co., The, **b, c, d.**
Scientific-Atlanta, Inc., **a, b, d.**
Sinclair Mfg. Co., **a.**
South River Metal Products Co., Inc.
Specialty Electronics Development Corp., **a.**
Stackpole Carbon Co., **b.**
TRG, Inc., **a.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a.**
Thermon Mfg. Co., **b, d.**
Thompson Ramo Wooldridge Inc., **a.**
Tower Construction Co.
Twin Coach Co., Aircraft-Missiles, **a.**
U. S. Pipe & Foundry Co., Steel & Tubes Div., **a.**
Warren Components, Div.-El-Tronics, Inc., **d.**
Washington Aluminum Co., Inc., **a.**
Westinghouse Electric Corp., **a.**

BATTERIES

a. Atomic
b. Cadmium
c. Dry Cell
d. Lead-Acid
e. Mercury
f. Nickel Alkaline
g. Nickel-Cadmium
h. Nuclear
i. Silver
j. Silver Zinc
k. Transistor

Aircraft Accessory Turbine Dept.-General Electric Co.
Allied International Corp., **c, d, g.**
American Electronics, Inc., Nuclear Div., **a.**
Beech Aircraft Corp.
Bjorksten Research Labs. for Industry, Inc.
Bowers Battery & Spark Plug Co., **d.**
Bright Star Industries, **c, k.**
Burgess Battery Co., Div.-Servel, Inc., **c, e, g, k.**
Carbone Corp., The, **c.**
Cook Batteries, Sub.-Telecomputing Corp., **i, j.**
Eagle-Picher Co., The, **b, f, g, i, j.**
Eastman Kodak Co.
Electric Autolite Co., The, **d.**
Electroid Corp., **j.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **a, h.**
Esso Standard, Div.-Humble Oil & Refining Co., **d.**
Eureka Williams Corp.
Exide Industrial Div.-The Electric Storage Battery Co., **j.**
General Electric Co., Ordnance Dept.
Gordon Enterprises, **b, f, g.**
Gulton Industries, Inc., **g.**
Hammett-Mercury-Rex Div., **b, d thru g.**
***INTERELECTRONICS CORP., f, g, i, j.**
Lockheed Aircraft Corp., Missiles & Space Div.
Madigan Corp., **k.**
***MAGNAVOX CO., THE, j.**
P. R. Mallory & Co. Inc., **c, e, i, k.**
Marathon Battery Co., **c, k.**
D. B. Milliken Co., **g.**
NUMEC-Nuclear Materials & Equipment Corp., **a.**
Nicad Div., Gould-National Batteries, Inc., **b, f, g.**
Nutron Mfg. Co. Inc., **k.**
Ohmart Corp., The, **a.**
Olin Mathieson Chemical Corp., N. Y., **a, b.**
Pass & Seymour, Inc., Defense Div.
Patterson Moos Research, Div.-Leesona Corp., **a, h, k.**
Radiation Research Corp., **a, h.**
***RADIO CORP. OF AMERICA, a, b, c, e, f, g, k.**
Ray-O-Vac Co., Div.-Electric Storage Battery Co., **c.**
Sonotone Corp., **g.**
Southwest Research Institute
Standard Electric Co., Inc., **d.**
Tracerlab Inc., **h.**
U. S. Industries, Inc., **b, c.**
Willard Storage Battery Div., **d.**
Yardney Electric Corp., **b, i, j, k.**

BATTERY BOXES, CRADLES, ,ETC.

Aeroil Products Co., Inc.
American Latex Products Corp.
Associated Co., Inc.
Atkins & Merrill, Inc.
Augat Brothers, Inc.
Belmar Wheel & Machine Co., Inc.
S. Blickman, Inc.
Colonial Aircraft Corp.
Cramer Mfg. & Engrg., Inc.
Cutler Metal Products Co.
Doak Aircraft Co. Inc.
Elzee Metal Products Co., Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Jeta, Inc.
Kellett Aircraft Corp.
Keystone Electronics Corp.
Kirk & Blum Mfg. Co., The
***MARTIN CO., THE, DENVER DIV.**
***MINNESOTA MINING & MFG. CO.**
Piasecki Aircraft Corp.
Pneumafil Corp.
Prewitt Aircraft Co.
Rimak, Inc.
Scientific-Atlanta, Inc.
Structural Fibers, Inc.
Telkor, Inc.
Twin Coach Co., Aircraft-Missiles
Waco Aircraft Co.
Westholt Mfg. Inc.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.

BATTERY CHARGING & SERVICING EQUIPMENT

Acme Electric Corp.
Allen Electric & Equipment Co.
American Rectifier Corp.
Automatic Switch Co.
Bogue Electric Mfg. Co.
Chatham Electronics Div.-Tung-Sol Electric Inc.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Joe Davidson & Associates
Djeco, Div.-Djordjevic Engrg. Co.
Dresser Electric Co.
Electric Autolite Co., The
Electronic Measurements Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Esso Standard, Div.-Humble Oil & Refining Co.
John Fluke Mfg. Co., Inc.
Gates Electronic Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Gulton Industries, Inc.
Hammett-Mercury-Rex Div.
Hertner Electric Co., The
Hobart Brothers Co.
Hughes Electronics Co.
Indiana Gear Works; Inc.
***INTERELECTRONICS CORP.**
Jeta, Inc.
Lee Electric & Mfg. Co.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Lincoln Electric Co., The
Macarr, Inc.
Madigan Corp.
P. R. Mallory & Co. Inc.
***MARTIN CO., THE, DENVER DIV.**
Sanford Miller Co.
Model Rectifier Corp.
Motor Appliance Corp.
Motor Generator Corp.
George L. Nankervis Co.
D. W. Onan & Sons Inc.
Opad Electric Co.
M. V. Palmer, Inc.
Sonotone Corp.
Stewart & Stevenson Services, Inc.
A. U. Stone & Co., Inc.
Sun Electric Corp., Aeronautical Div.
Technical Apparatus Builders
Telkor, Inc.
Terado Co.
Westinghouse Electric Corp.
Wickes Engrg. & Construction Co.
Willard Storage Battery Div.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.
Yardney Electric Corp.

BATTERY SERVICING EQUIPMENT

Electronic Applications, Inc.
Gates Electronic Co.
General Scientific Equipment Co.
***MARTIN CO., THE, DENVER DIV.**
Motor Generator Corp.
George L. Nankervis Co.
Opad Electric Co.
Penn Keystone Corp.
Q. V. S. Inc.
Sonotone Corp.
Winder Aircraft Corp. of Florida

BEACONS, RADIO

Advance Industries, Inc.
Bendix Aviation Corp.
Collins Radio Co.
Dalmo Victor Co., Div.-Textron, Inc.
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
Dorsett Electronic Labs., Inc.
Du Kane Corp.
Dynatronics, Inc.
Eastman Kodak Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Fla. Aircraft Radio & Marine
Gates Radio Co.
General Communication Co.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Interstate Electronics Corp.
Lear, Inc.
Lel, Inc.
Litton Industries, Maryland Div.
Lockheed Electronics Co., Stavid Div.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
National Co., Inc.
Packard-Bell Electronics Corp.
Production Research Corp., Sub.-Radio Condenser Co.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Raven Industries Inc.
Simmonds Aerocessories, Inc.
Special Products Dept., Melpar, Inc.
Tamar Electronics, Inc.
Telectro Industries Corp.
Telerad Mfg. Corp.
Texas Instruments Inc.
Virginia Electronics Co., Inc.

BEARINGS

a. Ball
b. Ball Miniature
c. Jewel
d. Needle
e. Oiless
f. Rod End
g. Roller
h. Roller Taper
i. Self Aligning
j. Special Purpose

Acme Industrial Co., **j.**
Acorn Bearing Co., **g, i, j.**
Aetna Ball & Roller Bearing Co., Div.-Parkersburg-Aetna Corp., **a, g, j.**
Allison Div., General Motors Corp., **j.**
American Latex Products Corp., **j.**
American Standard Products, Inc., **j.**
Amplex Div.-Chrysler Corp., **e, i.**
Analogue Controls, Inc., **e, j.**
Associated Engineers, Inc., **j.**
Atlas Brass Foundry, **e, i.**
Atlas Precision Products, Co., **b.**
Barden Corp., The, **a, b.**
Bearing Inspection, Inc., **a, b, d, f thru j.**
Bearium Metals Corp., **e.**
Beemer Engrg. Co., **e, i, j.**
Bendix Filter Div., Bendix Aviation Corp., **j.**
Richard H. Bird & Co., Inc., **c.**
Bonny Mfg. Corp., **j.**
Booker-Cooper, Inc., **j.**
Bound Brook Oil-Less Bearing Co., **e, i, j.**
Bulova Watch Co., Inc., Turtle Mountain Div., **c, j.**
Bunting Brass & Bronze Co., The, **e, j.**
Bushings, Inc., **e, i, j.**
A. M. Byers Co., **a, g.**
CBS Laboratories, Div.-Columbia Broadcasting System, **b, j.**
Capital City Mfg. Co., Inc., **j.**
Carbone Corp., The, **e, j.**

Corning Glass Works, **j.**
Custom Products Corp., **f.**
Derby Castings Co., The, **j.**
Dixon Corp., **e.**
Dodge Mfg. Corp., **a, g thru j.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **c.**
Ex-Cell-O Corp., **g, i, j.**
Fafnir Bearing Co., The, **a, b, f, g, i, j.**
Federal Bearings Co. Inc., The, **a, i, j.**
Ford Instrument Co., Div.-Sperry Rand Corp., **j.**
Freeman Co., The, **f.**
Garlock Packing Co., **e.**
General Electric Co., Apparatus Sales Div., **c.**
General Plastics Corp., **j.**
Gladding, McBean & Co., **j.**
Graphite Metallizing Corp., **e, i, j.**
Gries Reproducer Corp., **j.**
Gwilliam Co., The, **a, g, i, j.**
Hamilton Watch Co., Military Products Div., **c.**
Hammett-Mercury-Rex Div., **a, g, h.**
Hyatt Bearings Div., General Motors Corp., **g, h, i.**
Walter K. Jaros Aircrafters, **a thru g, i.**
Joclin Mfg. Co., The, **j.**
Kaydon Engrg. Corp., The, **a, d, g, h, j.**
***KEARFOTT DIV., GENERAL PRECISION, INC., a, b, j.**
Hugo P. Keller, Jr., **c.**
Kennametal Inc., **e.**
Keystone Carbon Co., **e, i.**
Kwikset Powdered Metal Products, **e, j.**
Landis & Gyr, Inc., **a, b, g, i, j.**
Lear, Inc., **j.**
Link-Belt Co., **a, g, i, j.**
Marlin-Rockwell Corp., **a, b, f, g, i, j.**
Mc Gill Mfg., Co. Inc., Bearing Div., **a, d, g.**
Microtech Div., Federal-Mogul-Bower Bearings, Inc., **b.**
Miniature Precision Bearings, Inc., **a, b, i, j.**
Morganite, Inc., **e, j.**
National Beryllia Corp., **j.**
***NEW DEPARTURE DIV., GENERAL MOTORS CORP. a, b, i, j.**
New Hampshire Ball Bearings, Inc., **b.**
Nice Ball Bearing Co., **a, j.**
Norrich Plastics Corp., **j.**
Norrich Screw Machine Products, **j.**
Ohio Carbon Co., The, **j.**
Polymer Corp., The, **e, j.**
Radial Bearing Corp., **e, i, j.**
Randall Graphite Bearings, Inc., **i, j.**
Raway Bearing Co., Inc., **a, b, d, f, g, i, j.**
Research Development Mfg. Inc., **j.**
J. R. Robbins Co., **i.**
Rogers Corp., **j.**
Roller Bearing Co. of America, **d, g, i.**
Rollway Bearing Co., Inc., **g, j.**
SKF Industries, Inc., **a, b, g thru j.**
St. Marys Carbon Co., **e, i, j.**
St. Regis Paper Co., Panelyte Div., **e, i.**
Shafer Bearings, Chain Belt Co., **f, g, i, j.**
Southwest Products Co., **a, j.**
Split Ballbearing, Div.-MPB, **j.**
Springfield Brass Co., Inc.
Squiers Gage Co. **j.**
Stackpole Carbon Co., **j.**
***STEPHENS ADAMSON MFG. CO., SEAL MASTER BEARING DIV., a, f, i.**
Swiss Jewel Co., **c.**
Synthane Corp., **a, j.**
Timken Roller Bearing Co., The, **h.**
Torrington Co., The, **a, d, g thru j.**
United Supply Co., **a, b, d, f, g, h.**
Westinghouse Electric Corp., **j.**

BELLOWS

Aero Leather Products Co.
Allied Plastics Supply Corp.
Alloy Bellows Inc
American Potash & Chemical Corp., National Northern Div.
American Tubing Co., Inc.
Anaconda Metal Hose Div., The American Brass Co.
Avica Corp.
Belfab Corp., The
Bendix Aviation Corp.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Breeze Corporations, Inc
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co.
Bulova Research & Development Labs , Inc
California Aircraft Products
Cartriseal Corp.
Chicago Gasket Co.
Chicago Rawhide Mfg. Co.
Components Corp.
Emerson Plastics Corp.
FAE Instrument Corp.
Falcon Machine & Tool Co.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
Flexible Metal Hose Mfg. Co.
Flexible Tubing Corp.
Flexonics Corp.
Flight Refueling, Inc.
Gits Brothers Mfg. Co.
Glassco Instrument Co.
B. F. Goodrich Aviation Products
Hallett Mfg. Co.
Hanlon & Wilson Co., The
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
Leemath Inc.
Marman Div., Aeroquip Corp.
Minnesota Rubber Co.
J. J. Monaghan Co., Inc.
Parts Engrg. Co., Inc.
Resistoflex Corp.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Rubbercraft Corp. of California
Seaman Products, Div.-Seaman Paper Co.
Solar Aircraft Co
Southwest Products Co.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Tetrafluor, Inc.
Trans-Sonics, Inc.
Uni-Flex Mfg. & Engrg. Inc.
United States Chemical Milling Corp.
United States Rubber Co.
Westport Development & Mfg. Co., Inc.

BELLS & BUZZERS

Cable Electric Products Inc.
Eagle Electric Mfg. Co. Inc.
***MARTIN CO., THE, DENVER DIV.**
Telkor, Inc.
Wheelock Signals Inc

BELTS, DIAL DRIVE

American Felt Co.
Lear, Inc.
A. T. Stevens Co.
United States Rubber Co.

BERYLLIUM

Belmont Smelting & Refining Works, Inc.
Belock Instrument Corp.
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Brush Beryllium Co., The
Budd Co., The
City Chemical Corp.
Custom Tool & Mfg. Co.
Delta Chemical Works, Inc.
Hammett-Mercury-Rex Div.
Hughes Tool Co., Aircraft Div.
Kerns Mfg. Corp.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div , Avco Corp.
P. R. Mallory & Co. Inc.
NUMEC-Nuclear Materials & Equipment Corp.
Rodney Metals Inc.
Standard Pressed Steel Co.
Stauffer Chemical Co.
Sylvania-Corning Nuclear Corp.
Tapco Group, Thompson Ramo Wooldridge Inc
Thompson Ramo Wooldridge Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Wyman-Gordon Co.

BEZELS

Adept Industries Inc.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
Anchor Metal Spinning Co., The
Apahouser Corp. of N. E.
Baird-Atomic, Inc.
L. J. Barwood Mfg. Co. Inc.
A. Biederman, Inc.
Croname Inc.
Jan Hardware Mfg. Co., Inc.
Kling Metal Spinning & Stamping Co.
Libroscope Div., General Precision, Inc.
James Millen Mfg. Co. Inc.
Penn Keystone Corp.
Milton Ross Metals Co., The
Sillcocks-Miller Co.

BIMETALS, THERMOSTATIC

American Instrument Co., Inc.
Bendix Aviation Corp.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Carpenter Steel Co., The
Chicago Development Corp.
Engelhard Industries, Inc.
Fansteel Metallurgical Corp.
Fasco Industries Inc.
Texas Instruments Inc.

BINDERS, LIQUID

Food Machinery & Chemical Corp.-Epoxy Dept.
B. F. Goodrich Chemical Co.
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Monsanto Chemical Co.
Philadelphia Quartz Co.

BINDING POSTS

Accurate Electronics Corp.
Amatom Electronic Hardware Co. Inc.
Bead Chain Mfg. Co., The
Birnbach Radio Co., Inc.
Federal Screw Products Inc.
G-C Electronics Co.
General Radio Co.
Graphite Metallizing Corp.
Grayhill, Inc.
Hermetic Seal Corp.
E. F. Johnson Co.
Kings Electronics Co., Inc.
Malco Mfg. Co.
James Millen Mfg. Co. Inc.
Molded Insulation Co.
Norrich Screw Machine Products
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Milton Ross Metals Co., The
Standard Electric Time Co., The
Superior Electric Co., The
Whitso, Inc.

BINS

Aerocal Div., Aeronca Mfg. Corp.
American Conveyor Co.
Anchor Metal Spinning Co., The
Bethlehem Steel Co.
S. Blickman, Inc.
Corrugated Paper Products, Inc.
Deluxe Metal Products Co.
General American Transportation Corp.
International Steel Co.
Kirk & Blum Mfg. Co., The
***MARTIN CO., THE, DENVER DIV.**
Nooter Corp.
Republic Steel Corp.
Stackbin Corp.
Standard Pressed Steel Co.
Unified Industries, Inc.
United States Steel Corp.

BLADDERS, FUEL

Dilectrix Corp.
General Plastics Corp.
B. F. Goodrich Aviation Products
Guided Missile Div., The Firestone Tire & Rubber Co.
Joclin Mfg. Co., The
McGregor Mfg. Corp.
***MINNESOTA MINING & MFG. CO.**
United States Rubber Co.

BLADES

a. Compressor
b. Stator
c. Turbine

ABA Tool & Die Co., **a, b, c.**
All American Engrg. Co., **c.**
Allison Div., General Motors Corp., **a, b, c.**
Austenal Co., Div.-Howe Sound Co.-Microcast Products, **a, b, c.**
Belmar Wheel & Machine Co., Inc., **b.**
A. M. Byers Co., **c.**
Calcor Corp.
Christie Machine Works, **c.**
Curtiss-Wright Corp., Metals Processing Div., **a, b, c.**
Custom Tool & Mfg. Co., **a, b, c.**
***DEL MAR ENGRG. LABS., c.**
Ex-Cell-O Corp., **a, b, c.**
George Gorton Machine Co., **a, b, c.**
Haynes Stellite Co., Div.-Union Carbide Corp., **a, b, c.**
ITE Circuit Breaker Co., Special Products Div., **a, b, c.**
Jarvis Corp., **a, b, c.**
Kerns Mfg. Corp., **a, b, c.**
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., **a, b, c.**
Kwikset Powdered Metal Products, **b.**
Ladish Co., **a, b, c.**
Lapointe Machine Tool Co., The, **a, b, c.**
Lycoming Div., Avco Corp., **a, b.**
Napier Engines Inc., **a, b, c.**
New England Aircraft Products Co., **a, b, c.**
Portland Copper & Tank Works Inc., **a, b, c.**
Prewitt Aircraft Co., **a, b, c.**
Schellens-True Corp., **a, b, c.**
Solar Aircraft Co., **a, b, c.**

Stalker Corp., The, **a, b, c.**
Steel Improvement & Forge., The
Structural Fibers, Inc., **a, b, c.**
T. O. D. Mfg. Co. Inc., **c.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, c.**
Thompson Ramo Wooldridge Inc., **a, b, c.**
Veet Industries, **a, b, c.**
Walbar Machine Products, Inc., **a, c.**
Westinghouse Electric Corp., **a, b, c.**
Whiton Machine Co., The, **c.**

BLAST DEFLECTOR, PADS & TUBES

***AEROJET-GENERAL CORP.**
American Latex Products Corp.
American Machine & Foundry Co., Greenwich Engrg. Div.
Anchor Metal Spinning Co., The
Beacon Steel Corp.
Bethlehem Steel Co.
A. M. Byers Co.
Calcor Corp.
Carborundum Co., The
Chicago Bridge & Iron Co.
Continental Diamond Fibre Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Daystrom, Inc., Military Electronics Div.
Food Machinery & Chemical Corp., Ordnance Div.
Guided Missile Div., The Firestone Tire & Rubber Co.
Kentucky Metal Products Co.
Lukens Steel Co.
Lycoming Div., Avco Corp.
Marquardt Corp., The
***MINNESOTA MINING & MFG. CO.**
National Forge Co.
Opelika Welding, Machine & Supply Inc.
Pittsburgh Corning Corp.
Portland Copper & Tank Works Inc.
Prewitt Aircraft Co.
Swedlow Inc.
Thermon Mfg. Co.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Steel Corp.
Waco Aircraft Co.
Wells Industries Corp.

BLISTERS

Anchor Metal Spinning Co., The
Emeloid Co., Inc., The
***MARTIN CO., THE, DENVER DIV.**
REF Mfg. Corp.
Sillcocks-Miller Co.
Texstar Plastics, Div.-The Texstar Corp.

BLOWERS

Accessory Controls & Equipment Corp.
Aero Supply Mfg. Inc.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Air-Marine Motors, Inc.
Amco Engrg. Co.
American Electronics, Inc.
American Standard Industrial Div.
Beacon Steel Corp.
Benson Mfg. Co.
Blowers Inc.
Bogue Electric Mfg. Co.
Breeze Corporations, Inc.
Bud Radio, Inc.
Budd Lewyt Electronics, Inc.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Coppus Engrg. Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Joe Davidson & Associates
Dean & Benson Research, Div.-Benson Mfg. Co.
Detroit Stamping Co.
Diehl Mfg. Co.
Dynamic Air Engrg., Inc.
Eclipse Fuel Engrg. Co.
Eicor Div.-Scranton
Fuller Co.
Garden City Fan & Blower Co.
General American Transportation Corp.
Hammett-Mercury-Rex Div.
Heil Process Equipment Corp.
Highland Engrg. Co.
Holub Industries, Inc.
Hoover Electric Co.
ILG Electric Ventilating Co.
IMC Magnetics Corp.
Invincible Vacuum Cleaner Mfg. Co.
Joy Mfg. Co.
Lamson Corp., The
Leiman Brothers, Inc.
M-D Blowers, Inc.
***MARTIN CO., THE, DENVER DIV.**
Martindale Electric Co.
McLean Engrg. Laboratories
Heinz Mueller Eng. Co. Inc.
Nevada Air Products Co.
John Oster Mfg. Co., Avionic Div.
Peerless Electric Div.-H. K. Porter Co., Inc.
Radex Corp.
Ripley Co., Inc.
Rotron Mfg. Co.
Schutte & Koerting Co.
Small Motors Inc.
Solar Aircraft Co.
Spencer Turbine Co.
Task Corp.
Torit Mfg. Co.
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
U. S. Industries, Inc.

BOARDS, CAPACITOR OR RESISTOR

Accurate Electronics Corp.
Belock Instrument Corp.
Chalco Engrg. Corp.
Consolidated Airborne Systems, Inc.
Corning Glass Works
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Daystrom, Inc., Military Electronics Div.
Double E Products Co.
Excellex Electronics Inc.
Film Capacitors, Inc.
Graflex Inc.
Graphik Circuits, Div.-Cinch Mfg. Co.
George E. Harris & Co., Inc.
Keystone Electronics Corp.
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
J. W. Miller Co.
***MINNESOTA MINING & MFG. CO.**
Piasecki Aircraft Corp.
Precision Metal Products Co. Inc.
Projects Unlimited, Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Sealectro Corp.
Statham Development Corp.
Telkor, Inc.
Westinghouse Electric Corp.

BOARDS, PLOTTING

Accurate Electronics Corp.
Aeronca Mfg. Corp.-Aerospace Div.
Belock Instrument Corp.
Bendix Aviation Corp.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Brooks & Perkins, Inc.
Budd Lewyt Electronics, Inc.
California Plasteck Inc.
Daystrom, Inc., Military Electronics Div.
Allen B. Du Mont Labs., Inc.
Dura Plastics of N. Y., Inc.
Electro Instruments, Inc.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Ludwig Honold Mfg. Co.
Libroscope Div., General Precision, Inc.
A. Lietz Co., The
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
Norrich Screw Machine Products
***RADIO CORP. OF AMERICA**
Sealectro Corp.
Servo Consultants Ltd.
Sillcocks-Miller Co.
Special Products Dept., Melpar, Inc.
Sunshine Scientific Instrument
Universal Unlimited, Inc.
Virginia Plak Co.

BOARDS, PLUG

Accurate Electronics Corp.
Brook Molding Corp.
Burndy Corp., Omaton Div.
Comco Plastics Inc.
Daystrom, Inc., Military Electronics Div.
Emerson Plastics Corp.
General Products Corp.
Graphik Circuits, Div.-Cinch Mfg. Co.
Hammett-Mercury-Rex Div.
Thomas J. Long, Inc.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
Norrich Plastics Corp.
Norrich Screw Machine Products
***RADIO CORP. OF AMERICA**
Sealectro Corp.
Special Products Dept., Melpar, Inc.
Standard Electric Time Co., The
Vector Electronic Co., Inc.

BOBBINS, COIL WINDING

A. P. W. Co.
Bonny Mfg. Corp.
Christie Machine Works
Comco Plastics Inc.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Du-Co Ceramics Co.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Form-It Products, Inc.
Franklin Fibre-Lamitex Corp.
Garde Mfg. Co.
Gries Reproducer Corp.
Walter J. Hyatt Co., The
Hydro Molding Co. Inc.
Insulation Mfrs. Corp.
James Electronics, Inc.
Lamtex Industries Inc.
Lear, Inc.
Leetronics, Inc.
Thomas J. Long, Inc.
***MARTIN CO., THE, DENVER DIV.**
James Millen Mfg. Co. Inc.
Molding Corp. of America
Mycalex Corp. of America
Norrich Plastics Corp.
Norrich Screw Machine Products
Plastic Age Sales, Inc.
Milton Ross Metals Co., The
Ray A. Scharer & Co.
Spaulding Fibre Co., Inc.
Stevens Products, Inc.
Stratfield Co., The
Tetrafluor, Inc.
Thor Ceramics, Inc.
Topper Mfg. Co., Inc.
U. E. Electronics Corp.
U. S. Plastic Molding Corp.
Waterbury Companies, Inc.
Westinghouse Electric Corp., Micarta Div.

BOBBINS, TRANSFORMER WINDING

Bonny Mfg. Corp.
Christie Machine Works
Emerson Plastics Corp.
Franklin Fibre-Lamitex Corp.
Garde Mfg. Co.
Hydro Molding Co. Inc.
Isolantite Mfg. Corp.
Lamtex Industries Inc.
***MARTIN CO., THE, DENVER DIV.**
Norrich Plastics Corp.
Norrich Screw Machine Products
Milton Ross Metals Co., The
Stevens Products, Inc.
Stratfield Co., The
Thor Ceramics, Inc.
Topper Mfg. Co., Inc.
U. S. Plastic Molding Corp.
Waterbury Companies, Inc.
Westinghouse Electric Corp., Micarta Div.

BOLT CARTRIDGES, EXPLOSIVE

***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
American Potash & Chemical Corp., National Northern Div.
Armament Div.-Universal Match Corp.
Bermite Powder Co.
Joe Davidson & Associates
Gabriel Co., Rocket Power-Talco
Hercules Powder Co., Chemical Propulsion Div.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Lithium Corp. of America Inc., The Fulton-Irgon Div.
***MARTIN CO., THE, DENVER DIV.**
Mc Cormick Selph Associates
Olin Mathieson Chemical Corp., N. Y.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Ray A. Scharer & Co.
Thiokol Chemical Corp.
Tober Electronic Corp.

BOLTS, LOCK

Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Airhardware, Inc.
All Specs Corp.
American Standard Products, Inc.
Bland Burner Co., The
Capital City Mfg. Co., Inc.
Chandler Products Corp.
Cherry Rivet Div.-Townsend Co.
Continental Screw Co.
Eaton Mfg. Co., Reliance Div.
George E. Harris & Co., Inc.
Hi-Shear Rivet Tool Co.
Huck Mfg. Co.

Keystone Bolt & Nut Corp.
Mercury Air Parts Co., Inc
National Screw & Mfg. Co., The
Nylok Corp., The
Ohlson Empire Inc.
Republic Steel Corp.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Thompson-Brewer & Co. Div.-American Machine & Foundry Co.
Tober Electronic Corp.
Townsend Co., Cherry Rivet Div.
Voi-Shan Mfg. Co., Div.-Voi-Shan Industries, Inc.

BOLTS, SPADE

All Specs Corp.
Allmetal Screw Products Co., Inc.
Amatom Electronic Hardware Co. Inc.
Birnbach Radio Co., Inc.
R. C. Dudek & Co
Federal Screw Products Inc
G-C Electronics Co.
H. M. Harper Co.
National Screw & Mfg. Co., The
Ohlson Empire Inc.
Tober Electronic Corp.

BOLTS, TOGGLE OR EXPANSION

Ackerman-Johnson Co
Aero Spares, Inc.
All Specs Corp.
Alvo Nut & Bolt Co., Inc.
Arro Expansion Bolt Co.
Atlas Screw & Specialty Co.
Aviation Textile Associates
Capital City Mfg. Co., Inc.
Chase Brass & Copper Co., Inc.
Chicago Expansion Bolt Co.
Commercial Shearing & Stamping Co.
Continental Screw Co.
Federal Screw Products Inc.
Hammett-Mercury-Rex Div.
Hi-Shear Rivet Tool Co.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Keystone Bolt & Nut Corp.
Manhattan Lighting Equipment Co., Inc.
Norrich Plastics Corp.
Ohlson Empire Inc.
Ravenna Metal Products, Div.-Standard Screw Co.
Republic Steel Corp.

BONDING MATERIALS

Adhesive Engrg. Div.-Hiller Aircraft Corp.
American Latex Products Corp.
Armstrong Cork Co.
Carl H. Biggs Co.
Bjorksten Research Labs. for Industry, Inc.
Borden Chemical Co.
Connecticut Hard Rubber Co., The
Corning Glass Works
Daystrom, Inc., Military Electronics Div.
Emerson & Cuming, Inc.
Farwest Mfg. Div., Inc.
Furane Plastics, Inc
B. F. Goodrich Industrial Products Co.
Hastings Plastics, Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Lamtex Industries Inc.
Lebec Chemical Corp
*MARTIN CO., THE, DENVER DIV.
*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
Mitchell Rand Mfg. Corp
Norrich Plastics Corp.
Pioneer Industries Div., Almar-York Co. Inc.
Silicone Products Dept., General Electric Co., Dept. C.
Silicones Div.-Union Carbide Corp.
Synthane Corp.
Topper Mfg. Co., Inc.
Wasley Products, Inc.
Wesrep Corp.

BOOSTERS, GAS PRESSURE

Accessory Controls & Equipment Corp
American Instrument Co., Inc.
Bell Aircraft Corp., Niagara Frontier Div
Clark Bros. Co., Div.-Dresser Operations, Inc
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Eclipse Fuel Engrg. Co
Gabriel Co., Rocket Power-Talco
Haskel Engrg. & Supply Co.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Joy Mfg. Co.
Kaiser Fleetwings, Inc.
Leiman Brothers, Inc.
Lycoming Div., Avco Corp.
*MARTIN CO., THE, DENVER DIV.
Pressed Steel Tank Co.
Propellex Chemical Div., Chromalloy Corp.
S-P Mfg. Corp., The
Schutte & Koerting Co.
Southwest Research Institute
Weatherhead Co., The
Worthington Corp.

BOOSTERS, MISSILE, LIQUID FUELED

*AEROJET-GENERAL CORP.
Allison Div., General Motors Corp.
American Potash & Chemical Corp., National Northern Div.
Bell Aircraft Corp., Niagara Frontier Div.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bermite Powder Co
A. M. Byers Co.
Douglas Aircraft Co., Inc.
General Electric Co., Rocket Engine Section
Guided Missile Div., The Firestone Tire & Rubber Co.
Haskel Engrg. & Supply Co.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Hydro-Aire Co., Div.-Crane Co.
Kaiser Fleetwings, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Marquardt Corp., The
Missile Div., North American Aviation, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Pressed Steel Tank Co.
Reynolds Metals Co., Sheffield Missile Plant
Southwest Research Institute
Spaceatomics Div., The Budd Co.

BOOSTERS, MISSILE, SOLID FUELED

*AEROJET-GENERAL CORP.
Allison Div., General Motors Corp.
Amcel Propulsion Inc.
American Car & Foundry Div., ACF Industries, Inc.
American Potash & Chemical Corp., National Northern Div.
Arde-Portland, Inc.
Bell Aircraft Corp., Niagara Frontier Div.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bermite Powder Co.
Brunswick Balke Collender Co., The, Defense Products Div.
A. M. Byers Co.
Cosmic Instruments Inc.
Daystrom, Inc., Military Electronics Div.
Douglas Aircraft Co., Inc.
*EXCELCO DEVELOPMENTS INC.
Gabriel Co., Rocket Power-Talco
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Grand Central Rocket Co.
Hercules Powder Co., Chemical Propulsion Div.
Hicks Corp., The
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kaiser Fleetwings, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Marquardt Corp., The
Norris-Thermador Corp.
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Pressed Steel Tank Co.
Propellex Chemical Div., Chromalloy Corp.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation
Southwest Research Institute
Spaceatomics Div., The Budd Co.
Thiokol Chemical Corp., Hunter-Bristol Div.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Steel Corp.
United Technology Corp.
Universal Moulded Products Corp.
Waste King Corp., Technical Products Div.
Young Development Div., Hercules Powder Co.

BORON

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Potash & Chemical Corp.
American Potash & Chemical Corp., National Northern Div.
Bell Aircraft Corp., Niagara Frontier Div.
Brom Metallurgical Chemical Co.
Callery Chemical Co.
Delta Chemical Works, Inc.
General Electric Co., Rocket Engine Section
Olin Mathieson Chemical Corp., N. Y.
Semi-Elements, Inc.
Southwest Research Institute
Stauffer Chemical Co.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

BOXES

A&P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Alpitec, Inc.
Althor Products
Arch Gear Works Inc.
Benson Mfg. Co.
Brooks & Perkins, Inc.
Bud Radio, Inc.
Calcor Corp.
California Stamping & Mfg. Co.
Clover Industries, Inc.
Commercial Services Co., Inc.
Corrugated Paper Products, Inc.
Cutler Metal Products Co.
Doak Aircraft Co. Inc.
Dura Plastics of N. Y., Inc.
George D. Ellis & Sons, Inc.
Elzee Metal Products Co., Inc.
Eubanks Industries, Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Folstrom Co.
Farwell Metal Fabricating
General Box Co.
Goldsman
Henry & Miller Industries, Inc.
Hinde & Dauch Div.-West Virginia Pulp & Paper
International Steel Co.
Kirk & Blum Mfg. Co., The
Lyon Aircraft Services
J. E. Menaugh Co.
Metal Edge Industries
Muckle Mfg. Co.
Northeast Metals Industries, Inc.
Piasecki Aircraft Corp.
Pneumafil Corp.
Ravenna Metal Products, Div.-Standard Screw Co.
Rimak, Inc.
Roberts Industries Inc.
Sillcocks-Miller Co.
Skydyne, Inc.
Stackbin Corp.
Standard Molding Corp.
Telkor, Inc.
Twin-Coach Co., Aircraft-Missiles
Twix Mfg. Co., Inc.
Unified Industries, Inc.
United States Chemical Milling Corp.
United States Steel Corp.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Wesrep Corp.
Westholt Mfg. Inc.
Winder Aircraft Corp. of Florida

BOXES, JUNCTION

A&P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Accurate Electronics Corp.
Aerotest Laboratories, Inc.
Artisan Metal Works Co.
Associated Co., Inc.
Bendix Aviation Corp.
Bernco Engrg. Corp.
Brooks & Perkins, Inc.
Bud Radio, Inc.
Cable Electric Products Inc.
Chance Vought Aircraft, Inc.
Daven Co., The
Elzee Metal Products Co., Inc.
Engrg. Specialties
Folstrom Co.
Farwest Mfg. Div., Inc.
Flight Refueling, Inc.
Grimes Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Heldor Mfg. Co., Inc.
Henry & Miller Industries, Inc
Hoffman Engrg. Corp.
Hoover Electronics Co.
Indiana Gear Works, Inc.
International Electric Industries, Inc.
Janco Corp.
Javex Electronics
Kirk & Blum Mfg. Co., The
Kolton Electric Mfg. Co.
*LAVELLE AIRCRAFT CORP.
Lear, Inc.
Lycoming Div., Avco Corp.
Manhattan Lighting Equipment Co., Inc.
*MARTIN CO., THE, DENVER DIV.

Motorola, Inc.
Nelson Electric Mfg. Co.
Olympic Plastics Co., Inc.
Piasecki Aircraft Corp.
Pneumafil Corp.
REF Mfg. Corp.
Radio City Products Co. Inc.
Radio Condenser Co.
Skyline Electric & Mfg. Co.
Specialty Electronics Development Corp.
Telkor, Inc.
Tober Electronic Corp.
Twin Coach Co., Aircraft-Missiles
Waco Aircraft Co.
Westholt Mfg. Inc.
Winder Aircraft Corp. of Florida
Woolf Aircraft Products, Inc.

BOXES, STORAGE

A&P Metal Products Mfg. Corp.
American Car & Foundry Div., ACF Industries, Inc.
American Conveyor Co.
Benson Mfg. Co.
Brooks & Perkins, Inc.
California Stamping & Mfg. Co.
Clover Industries, Inc.
Commercial Services Co., Inc.
Cutler Metal Products Co.
Deluxe Metal Products Co.
Dempster Brothers, Inc.
Doak Aircraft Co. Inc.
Dudwallen Mfg. Co., Inc., The
Eubanks Industries, Inc.
Falstrom Co.
Farwell Metal Fabricating
Gatewood Products, Inc.
Goldsman
Hammett-Mercury-Rex Div.
Hardman Tool & Engrg. Co.
Henry & Miller Industries, Inc.
International Steel Co.
Jeta, Inc.
Kellett Aircraft Corp.
Kirk & Blum Mfg. Co., The
*MARTIN CO., THE, DENVER DIV.
Metal Edge Industries
Northrop Corp.
Piasecki Aircraft Corp.
Pneumafil Corp.
Prewitt Aircraft Co.
Pry Welding & Mfg., Inc.
REF Mfg. Corp.
Royal Jet, Div.-Royal Industries, Inc.
Skydyne, Inc.
Stackbin Corp.
Tober Electronic Corp.
Twin Coach Co., Aircraft-Missiles
Twix Mfg. Co., Inc.
Waco Aircraft Co.
Westholt Mfg. Inc.
Young & Rioux Woodworking Co., Inc.

BRACKETS, HARDWARE

ABA Tool & Die Co.
A&P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Adel Precision Products, Div.-General Metals Corp
Alden Products Co.
Allied Plastics Supply Corp.
Alpitec, Inc.
Amatom Electronic Hardware Co. Inc.
Anchor Metal Spinning Co., The
Artisan Metal Works Co.
Augat Brothers, Inc.
Wallace Barnes Div. Associated Spring Corp.
Belmar Wheel & Machine Co., Inc.
Benson Mfg. Co.
Bernco Engrg. Corp.
Brooks & Perkins, Inc.
Bruce Engrg. Co.
Bud Radio, Inc.
Burklyn Co.
California Stamping & Mfg. Co.
Dana Corp.
Doak Aircraft Co. Inc.
*EXCELCO DEVELOPMENTS INC.
Flight Refueling, Inc.
General Logistics Div., Aeroquip Corp.
Hardman Tool & Engrg., Co.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Keystone Electronics Corp.
Leece-Neville Co., The
Malco Mfg. Co.
Marman Div., Aeroquip Corp.
*MARTIN CO., THE, DENVER DIV.
Paul & Beekman, Inc.
Richard Philip Co.
Piasecki Aircraft Corp.
Precision Metal Products Co. Inc.
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.
J. H. Sessions & Son
South River Metal Products Co., Inc.
Stanley-Judd Div.-The Stanley Works
TA Mfg. Corp.
T. O. D. Mfg. Co. Inc.
Tober Electronic Corp.
Vector Electronic Co., Inc.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Winder Aircraft Corp. of Florida

BRACKETS, MOUNTING

ABA Tool & Die Co.
A & E Metal Specialties Inc.
A & P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Adel Precision Products, Div.-General Metals Corp.
Allied Plastics Supply Corp.
Alpitec, Inc.
Amatom Electronic Hardware Co. Inc.
Amco Engrg. Co.
American Conveyor Co.
Anchor Metal Spinning Co., The
Artisan Metal Works Co.
Augat Brothers, Inc.
B. H. Aircraft Co., Inc.
Wallace Barnes Div. Associated Spring Corp.
Belmar Wheel & Machine Co., Inc.
Benson Mfg. Co.
Bernco Engrg. Corp.
Brooks & Perkins, Inc.
Bruce Engrg. Co.
Bud Radio, Inc.
Burklyn Co.
California Stamping & Mfg. Co.
Commercial Shearing & Stamping Co.
Cutler Metal Products Co.
Dana Corp.
Doak Aircraft Co. Inc.
*ENGIS EQUIPMENT CO.
*EXCELCO DEVELOPMENTS INC.
Flight Refueling, Inc.
General Logistics Div., Aeroquip Corp.
Hobson Brothers, Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kellett Aircraft Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kirk & Blum Mfg. Co., The
Lear, Inc.
Leece-Neville Co., The
Link-Belt Co.
Lycoming Div., Avco Corp.
Malco Mfg. Co.
Marman Div., Aeroquip Corp.
*MARTIN CO., THE, DENVER DIV.
Ohlson Empire Inc.
Paul & Beekman, Inc.
Richard Philip Co.
Piasecki Aircraft Corp.
Premier Metal Products Co.
Prewitt Aircraft Co.
REF Mfg. Corp.
Radio City Products Co. Inc.
Raybestos-Manhattan, Inc.
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.
Regent Jack Mfg. Co., Inc.
Rimak, Inc.
South River Metal Products Co., Inc.
Stanley-Judd Div.-The Stanley Works
Stone City Products Co.
TA Mfg. Corp.
T. O. D. Mfg. Co. Inc.
Thomas & Betts Co., Inc., The
Tober Electronic Corp.
Twix Mfg. Co., Inc.
United Mfg. Co., The
Vector Electronic Co., Inc.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Warren Components, Div.-El-Tronics, Inc.
Weba, Inc.
Winder Aircraft Corp. of Florida
Woolf Aircraft Products, Inc.

BRAKE CONTROL UNITS

Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Budd Co., The
General Electro-Mechanical Corp.
B. F. Goodrich Aviation Products
Guidance Controls Corp.
Hydro-Power Corp.
Hydraulic Research & Mfg. Co.
Hydro-Aire Co., Div.-Crane Co.
*MARTIN CO., THE, DENVER DIV.
J. R. Robbins Co.
Ronson Hydraulic Units Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
United Mfg. Co., The
Western Design, Div.-U. S. Industries, Inc.
Westinghouse Air Brake Co., Industrtrial Products Div.
Westinghouse Electric Corp.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

*AMERICAN STEEL FOUNDRIES, HAMMOND DIV., a thru d.
Auto Specialties Mfg. Co., Inc., **a thru d.**
Autotronics Inc., **b.**
Bendix Aviation Corp., **c, d.**
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., **c, d.**
Budd Co., The
Clark Controller Co., The, **a, b, c.**
Joe Davidson & Associates, **a, b.**
Dial Products Co., **a, b.**
Dynamic Instrument Corp., **b.**
Eaton Mfg. Co., **a, b.**
Eicor Div.-Scranton, **a, c.**
FAE Instrument Corp., **a, b, c.**
Ford Instrument Co., Div.-Sperry Rand Corp., **b.**
General Electric Co., Apparatus Sales Div., **a, b.**
General Electro-Mechanical Corp., **a, b.**
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div., **c, d.**
Guidance Controls Corp., **a, b, c.**
Hammett-Mercury-Rex Div., **a, b.**
George E. Harris & Co., Inc., **c.**
Hobbs Mfg. Co., **a, b.**
Hoover Electric Co., **a, b.**
Hydra-Power Corp., **d.**
ITE Circuit Breaker Co., Special Products Div., **b.**
*KEARFOTT DIV., GENERAL PRECISION, INC., **a, b.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **d.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **a, b.**
Lear, Inc., **a, b.**
Link-Belt Co., **c.**
Magtrol, Inc., **a, b.**
Radio Condenser Co., **b.**
Reeves Instrument Corp., **b.**
Robot Industries Inc., **a, b, c.**
Rockwell-Standard Corp., Brake Div., **c, d.**
Safety Electrical Equipment Corp., **a, b, c.**
Southwest Research Institute, **c.**
Technology Instrument Corp., **b.**
Trombetta Solenoid Corp., **a, b, d.**
United Mfg. Co., The, **a, c.**
U. S. Science Corp., Div.-Topp Industries, Inc., **b.**
Van Zelm Associates, Inc., **c, d.**
Vickers Inc., Electric Products Div., **b.**
Western Design, Div.-U. S. Industries, Inc., **c.**
Westinghouse Electric Corp., **a, b.**
Zurn Industries, Inc., **a thru d.**

BRAKESHOES

ACF Industries Inc.
American Brake Shoe Co.
American Felt Co.
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Auto Specialties Mfg. Co., Inc.
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.

BRAKE DRUM

Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
B. F. Goodrich Aviation Products
Robot Industries Inc.
Southwest Research Institute
United Mfg. Co., The

BRAKE LININGS

American Brake Shoe Co.
American Felt Co.
Anchor Packing Co., The
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Raybestos-Manhattan, Inc.
Russell Mfg. Co.
Southwest Research Institute
Thermoid Div.-H. K. Porter Co., Inc.
S. K. Wellman Co., The

BRAKES

a. Electrical
b. Magnetic
c. Mechanical
d. Pneumatic

Airborne Accessories Corp.
American Felt Co., **c.**
American Rectifier Corp., **a.**

B. F. Goodrich Aviation Products
Raybestos-Manhattan, Inc.
Southwest Research Institute

BRASS

American Brass Co., The
American Brazing Alloys Corp.
Ampco Metal, Inc.
Bohn Aluminum & Brass Corp.
Bond Metal Surplus Co.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Bristol Brass Corp., The
Custom Tool & Mfg. Co.
Electronic Parts Mfg. Co., Inc.
C. G. Hussey & Co., Div.-Copper Range Co.
Kwikset Powdered Metal Products
Laminated Shim Co., Inc.
National Copper & Smelting Co.
Olin Mathieson Chemical Corp., Metals Div.
Olin Mathieson Chemical Corp., N. Y.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass Inc.
Roovers-Lotsch Corp.
Scovill Mfg. Co.
Seymour Mfg. Co., The
Springfield Brass Co., Inc.
Titan Metal Mfg. Co., Div.-Cerro de Pasco Corp.
United Wire & Supply Corp.
Utility Brass & Copper Corp.

BRAZING ALLOYS

Alloys Unlimited Inc.
American Brass Co., The
American Brazing Alloys Corp.
Ampco Metal, Inc.
Engelhard Industries, Inc.
Eutectic Welding Alloys Corp.
Fusion Engrg.
General Electric Co., Metallurgical Products Dept.
Goldsmith Bros. Div., National Lead Co.
Handy & Harman
Hughes Tool Co., Aircraft Div.
Huntington Alloy Products Div.-The International Nickel Co., Inc.
Kerns Mfg. Corp.
Leach & Gardner Co., Indsl. Div.
NUMEC-Nuclear Materials & Equipment Corp.
Rimak, Inc.
Solar Aircraft Co.
Texas Instruments Inc.
United Wire & Supply Corp.
Vac-Hyd Processing Corp.
Wall Colmonoy Corp., Stainless Processing Div.
Western Gold & Platinum Co.

BREADBOARD KITS, ELECTRONIC

Alden Products Co.
Associated Engineers, Inc.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
FAE Instrument Corp.
General Instrument Corp., Defense & Engrg. Products Group
Litton Industries, Maryland Div.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
National Co., Inc.
Rimak, Inc.
Sonex, Inc.
Specific Products
Transistor Electronics Corp.
Unified Industries, Inc.
Vector Electronic Co., Inc.

BREAK-AWAY MECHANISMS

Aerojet-General Corp., Downey Plant
Aeroquip Corp., Jackson Div.
American Latex Products Corp.
Bermite Powder Co.
Conax Corp.
Joe Davidson & Associates
Dayton Aircraft Products, Inc.
Gabriel Co., Rocket Power-Talco
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Lockheed Aircraft Corp., Missiles & Space Div.
Marman Div., Aeroquip Corp.
***MARTIN CO., THE, DENVER DIV.**
Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
United Mfg. Co., The
Weatherhead Co., The
Weber Aircraft Corp.
Western Div., Aeroquip Corp.

BREAKERS, CIRCUIT

Aero Spares, Inc.
Airpax Electronics Inc., Cambridge Div.
Airpax Electronics Inc., Seminole Div.
Allis-Chalmers
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
George E. Harris & Co., Inc.
Heinemann Electric Co.
Leach Corp.
Lear, Inc.
***MARTIN CO., THE, DENVER DIV.**
Mechanical Products, Inc.
Resitron Labs., Inc.
Sangamo Electric Co.
Shallcross Mfg. Co.
Texas Instruments Inc.
Westinghouse Electric Corp.

BREATHERS, ENGINE

Bendix Filter Div., Bendix Aviation Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Southwest Research Institute

BRIDGES

a. Capacitance
b. Cathode Interface Impedance
c. Impedance
d. Inductance
e. Resistance
f. RF
g. Self-Balancing
h. Standing Wave
i. Synchro
j. VHF
k. Wheatstone

Aerovox Corp., **a.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **f.**
All Products Co., **h.**
Allegany Instrument Co., Inc., **k.**
Arnoux Corp., **e, k.**
Associated Engineers, Inc., **c, d.**
Astra Tech, **e, k.**
Avien, Inc., **a, g.**
B & F Instruments, Inc., **g.**
Barnes Development Co., **e, k.**
James G. Biddle Co., **e.**
Boonton Electronics Corp., **a, d.**
Briggs Associates, Inc., **b.**
***BRISTOL CO., THE**
Bruno-New York Industries Corp., **f.**
Brunswick Instruments, **e, g.**
Bytrex Corp., **g.**
Clegg Labs., Div.-Clegg, Inc., **a thru e.**
Consolidated Airborne Systems, Inc., **a, c, d, e, g, i.**
Datascan Inc., **a.**
Daven Co., The, **e.**
Daystrom Inc., Weston Instruments Div., **g.**
Decker Corp., The, **a, f.**
Dytronics Co., **a, c, d, e.**
Electro Instruments, Inc., **a, c, d, e.**
Electro Scientific Industries, **a, c, d, e, i, k.**
Electronic Applications, Inc., **a, c, d, e, h, k.**
Epic, Inc., **a, d, e, k.**
Erdco Engrg. Corp., **a.**
Freed Transformer Co., Inc., **a, d.**
General Communication Co., **f, g.**
General Electric Co., Apparatus Sales Div., **k.**
General Radio Co., **a, c thru h, j, k.**
Gray Instrument Co., **e, i, k.**
Gulton Industries, Inc., **a.**
Hammett-Mercury-Rex Div., **d, e, f, i, j, k.**
Hewlett-Packard Co., **c, j.**
Hickok Electrical Instrument Co., The, **a, d.**
Industrial Control Co., **a, g.**
Industrial Instruments Inc., **a, c, e, k.**
Instrument Div., The Budd Co., **e.**
International Steel Co
E. F. Johnson Co., **h.**
Kahn & Co., Inc., **a, e, k.**
Kanarr Corp., **k.**
***KEARFOTT DIV., GENERAL PRECISION, INC., c, e, i, k.**
Keithley Instruments, Inc., **e.**
Wayne Kerr Corp., **a, c thru f, j.**
Leeds & Northrup Co., **a, d, e, g, k.**
Liquidometer Corp., The, **g.**
Mac Lead & Hanopol, Inc., **a.**
Marconi Instruments, **a, c thru f, j.**
***MARTIN CO., THE, DENVER DIV., a thru k.**
James Millen Mfg. Co. Inc., **c, f, h.**
Millitest Corp., **e.**
Muirhead Instruments Inc., **a, c, d, e, i, k.**
Narda Microwave Corp., The, **c.**
New England Scientific Instruments Co., **a, c, e, k.**
Northrop Corp.
Paco Electronics Co., Inc., **a, e.**
Performance Measurements Co., **e, i.**
Pimex, Inc., **k.**
Precision Apparatus Co., Inc., **a, b, e.**
Radalab Inc., **f, h, j, k.**
Radio City Products Co. Inc., **e.**
***RADIO CORP. OF AMERICA, a thru k.**
Rinco, Inc., **a, c, d, e, k.**
Shallcross Mfg. Co., **e, k.**
Sierra Electronic Corp., Div.-Philco Corp., **f.**
Southwestern Industrial Electronics Co., **a, c, d, e.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **h.**
Standard Electronics Div.-Reeves Instrument Corp., **f, j.**
Herman H. Sticht Co., Inc., **e, k.**
H. W. Sullivan Ltd., **a, c, d, e, k.**
B. K. Sweeney Mfg. Co., **a.**
Taffet Electronics, Inc., **a, c, d, e.**
Tamar Electronics, Inc., **f.**
Technology Instrument Corp., **a, c, d, e.**
Telechrome Mfg. Corp., **e, g.**
Telectro Industries Corp., **a, c, d.**
Theta Instrument Corp., **i.**
Transformers, Inc., **c, d.**
Trans-Sonics, Inc., **e.**
Varo Mfg. Co., Inc., **i.**
Virginia Electronics Co., Inc., **a, c, d, e.**
Waters Mfg., Inc., **b, c, d.**
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., **k.**
Winder Aircraft Corp. of Florida, **c, d, e.**

BRONZE

American Brake Shoe Co.
American Brass Co., The
American Brazing Alloys Corp.
American Smelting & Refining Co.
Ampco Metal, Inc.
Amplex Div.-Chrysler Corp.
Atlas Brass Foundry
Bearium Metals Corp.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Bristol Brass Corp., The
Bunting Brass & Bronze Co., The
Chase Brass & Copper Co., Inc.
Custom Tool & Mfg. Co.
Derby Castings Co., The
Kwikset Powdered Metal Products
Olin Mathieson Chemical Corp., N. Y.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass Inc.
Saginaw Bearing Co.
Scovill Mfg. Co.
Seymour Mfg. Co., The
Shenango Furnace Co., The, Centrifugally Cast Products Div.
Springfield Brass Co., Inc.
Titan Metal Mfg. Co., Div.-Cerro de Pasco Corp.
Utility Brass & Copper Corp.
Var-Lac-Oid Chemical Co.

BRONZE, PHOSPHOR

American Brake Shoe Co.
American Brass Co., The
American Brazing Alloys Corp.
American Smelting & Refining Co.
Ampco Metal, Inc.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Bristol Brass Corp., The
Bunting Brass & Bronze Co., The
Chase Brass & Copper Co., Inc.
Derby Castings Co., The
Olin Mathieson Chemical Corp.-Metals Div.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass Inc.
Rodney Metals Inc.
Scovill Mfg. Co.
Seymour Mfg. Co., The
Shenango Furnace Co., The, Centrifugally Cast Products Div.
Utility Brass & Copper Corp.

BRUSHES, MOTOR

Carbone Corp., The
Joe Davidson & Associates
Eagle Electric Mfg. Co. Inc.
Gibson Electric Co.
Graphite Metallizing Corp.
Hammett-Mercury-Rex Div.
Hanson-Van Winkle-Munning Co.
Helwig Carbon Products, Inc.
Keystone Carbon Co.
Lear, Inc.
Heinz Mueller Eng. Co. Inc.
National Carbon Co., Div.-Union Carbide Corp.
J. M. Ney Co., The
Ohio Carbon Co., The
Pacific Scientific Co.

St. Marys Carbon Co.
Stackpole Carbon Co.
Superior Carbon Products Inc.
United States Graphite Co., The, Div.-The Wickes Corp.
Westinghouse Electric Corp.

BRUSHES, SOUND REPRODUCTION EQUIPMENT

Airflyte Electronics Co.
Carbone Corp., The
***MARTIN CO., THE, DENVER DIV.**

BUFFERS & GRINDERS

Fisher Scientific Co.
Hanson-Van Winkle-Munning Co.
Merit Products Inc.
***MINNESOTA MINING & MFG. CO.**
Schlegel Mfg. Co.
U. S. Electrical Tool Co.
Wyzenbeek & Staff, Inc.

BULBS, TEMPERATURE RESISTANT

Barber-Colman Co.
***BRISTOL CO., THE**
Corning Glass Works
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
Lear, Inc.
Leeds & Northrup Co.
Rosemount Engrg. Co.
Trans-Sonics, Inc.
Westinghouse Electric Corp.

BUSHINGS

***ACE DRILL BUSHING CO. INC.**
Acme Industrial Co.
Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Alite Div., U. S. Stoneware Co.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Brake Shoe Co.
American Felt Co.
American Standard Products, Inc.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Ampco Metal, Inc.
Amplex Div.-Chrysler Corp.
Atlas Brass Foundry
Bearium Metals Corp.
Beemer Engrg. Co.
Bergen Carbide Co.
Birnbach Radio Co., Inc.
Bonny Mfg. Corp.
Bruce Engrg. Co.
Buchanan Electrical Products Corp.
Bunting Brass & Bronze Co., The
Bushings, Inc.
California Stamping & Mfg. Co.
Derby Castings Co., The
Du-Co Ceramics Co.
Eagle Electric Mfg. Co. Inc.
Emerson Plastics Corp.
Ex-Cell-O Corp.
Federal Screw Products Inc.
Flight Refueling, Inc.
Graphite Metallizing Corp.
Heyman Mfg. Co.
Honti Engrg. & Mfg. Co.
Jan Hardware Mfg. Co., Inc.
Joclin Mfg. Co., The
Kellett Aircraft Corp.
Kennametal Inc.
Keystone Carbon Co.
Keystone Electronics Corp.
Kwikset Powdered Metal Products
Lapp Insulator Co., Inc., Radio Specialties Div.
Lear, Inc.
Link-Belt Co.
***MARTIN CO., THE, DENVER DIV.**
Metal Carbides Corp.
Norrich Plastics Corp.
Norrich Screw Machine Products
Ohio Carbon Co., The
Ohlson Empire Inc.
Richard Philip Co.
Polymer Corp., The
Randall Graphite Bearings, Inc.
Ravenna Metal Products, Div.-Standard Screw Co.
Research Development Mfg. Inc.
Saginaw Bearing Co.
Shenango Furnace Co., The, Centrifugally Cast Products Div.
Sinclair Mfg. Co.
C. M. Smillie & Co.
Southwest Products Co.
Springfield Brass Co., Inc.
Stevens Co. Inc.
Superior Industrial Machine Co.
Thor Ceramics, Inc.
Waterbury Companies, Inc.
Wilmington Fibre Specialty Co.

BUSHINGS, HERMETIC

A. P. M. Corp.
Alite Div., U. S. Stoneware Co.
Arnoux Corp.
Bonny Mfg. Corp.
Carborundum Co., The
Ceramaseal, Inc.
Cosmic Instruments Inc.
Hermetic Seal Corp.
Honti Engrg. & Mfg. Co.
Joclin Mfg. Co., The
Lapp Insulator Co., Inc., Radio Specialties Div.
Mitronics Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Ravenna Metal Products, Div.-Standard Screw Co.
Sphere Co. Inc., The
Thor Ceramics, Inc.
Torwico Electronics, Inc.

BUSHINGS, METALLIC

Acme Industrial Co.
Aero Bolt & Screw Co., Inc.
Aero Mfg. & Mach. Co., Inc.
Aero Spares, Inc.
Aetna Ball & Roller Bearing Co., Div.-Parkersburg-Aetna Corp.
Airhardware, Inc.
Alite Div., U. S. Stoneware Co.
American Brake Shoe Co.
American Standard Products, Inc.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Ampco Metal, Inc.
Amplex Div.-Chrysler Corp.
Atlas Brass Foundry
Bearium Metals Corp.
Beemer Engrg. Co.
Belmont Smelting & Refining Works, Inc.
Bendix Filter Div., Bendix Aviation Corp.
Birnbach Radio Co., Inc.
J. Bishop & Co., Platinum Works
Bohn Aluminum & Brass Corp.
Boston Gear Works
Bunting Brass & Bronze Co., The
California Stamping & Mfg. Co.
Chase Brass & Copper Co., Inc.
Collins Mfg. Corp.
Derby Castings Co., The
Division Lead Co.
R. C. Dudek & Co.
Electric Steel Foundry Co.
Ex-Cell-O Corp.
Federal Screw Products Inc.
Graphite Metallizing Corp.
B. H. Hadley, Inc.
Heli-Coil Corp.
Honti Engrg. & Mfg. Co.
Kellett Aircraft Corp.
Keystone Carbon Co.
Keystone Electronics Corp.
Lear, Inc.
***MARTIN CO., THE, DENVER DIV.**
Morganite, Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Ohlson Empire Inc.
Richard Philip Co.
Precision Metal Products Co. Inc.
Randall Graphite Bearings, Inc.
Rattan Mfg. Co., The
Ravenna Metal Products, Div.-Standard Screw Co.
Research Development Mfg. Inc.
J. R. Robbins Co.
Roller Bearing Co. of America
St. Marys Carbon Co.
Shenango Furnace Co., The, Centrifugally Cast Products Div.
Sinclair Mfg. Co.
C. M. Smillie & Co.
Southwest Products Co.
Springfield Brass Co., Inc.
Stevens Co. Inc.
Superior Industrial Machine Co.
Thomas & Betts Co., Inc., The
Thor Ceramics, Inc.
True Alloys Inc.
United States Graphite Co., The, Div.-The Wickes Corp.
Victor Tool & Mfg., Inc.
Wrought Washer Mfg. Co.

BUSHINGS, NON METALLIC

Ace Plastic Co.
Acme Industrial Co.
Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Alite Div., U. S. Stoneware Co.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Brake Shoe Co.
American Felt Co.
American Latex Products Corp.
American Standard Products, Inc.
Anti-Corrosive Metal Products Co., Inc.
Auburn Mfg. Co., The
Beemer Engrg. Co.
Bergen Carbide Co.
Birnbach Radio Co., Inc.
Bonny Mfg. Corp.
Bushings, Inc.
Calinoy-Div.-Illinois Tool Works
Carbone Corp., The
Carborundum Co., The
Chemplast, Inc.
Comco Plastics Inc.
Continental Rubber Works
Dell Optics Co., Ltd.
Duramic Products, Inc.
Eagle Electric Mfg. Co. Inc.
Emerson Plastics Corp.
Ex-Cell-O Corp.
Franklin Fibre-Lamitex Corp.
Frenchtown Porcelain Co.
General Gasket Inc.
General Plastics Corp.
Gits Brothers Mfg. Co.
Gladding, McBean & Co.
Goshen Rubber Co., Inc.
Graphite Metallizing Corp.
Gries Reproducer Corp.
Heyman Mfg. Co.
Honti Engrg. & Mfg. Co.
Insulation Mfrs. Corp.
Isolantite Mfg. Corp.
Joclin Mfg. Co., The
Keystone Electronics Corp.
M. Kirchberger & Co., Inc.
Lapp Insulator Co., Inc., Radio Specialties Div.
***MARTIN CO., THE, DENVER DIV.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
James Millen Mfg. Co. Inc.
***MINNESOTA MINING & MFG. CO.**
Morganite, Inc.
National Carbon Co., Div.-Union Carbide Corp.
Norrich Plastics Corp.
Norrich Screw Machine Products
Ohio Carbon Co., The
Polymer Corp., The
Raton Mfg. Co., The
Ravenna Metal Products, Div.-Standard Screw Co.
Refractories Div., The, Ferro Corp., Louthan Plant
J. R. Robbins Co.
Roberts Toledo Rubber Co., The
Rogers Corp.
Rubbercraft Corp. of California
St. Marys Carbon Co.
Ray A. Scharer & Co.
Sinclair Mfg. Co.
Southern Plastics Co.
Southwest Products Co.
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co.
Spaulding Fibre Co., Inc.
Sphere Co. Inc., The
Stackpole Carbon Co.
Superior Steatite & Ceramic Corp.
Synthane Corp.
Tetrafluor, Inc.
Thomas & Betts Co., Inc., The
Thor Ceramics, Inc.
Torwico Electronics, Inc.
United States Graphite Co., The, Div.-The Wickes Corp.
Victor Tool & Mfg., Inc.
Wilmington Fibre Specialty Co.
Zirconium Corp. of America

CABINETS

a. Metal
b. Plastic
c. Speaker
d. Temperature Test
e. Wood

A & E Metal Specialties Inc., **a.**
A&P Metal Products Mfg. Corp., **a, c.**
Abalon Precision Mfg. Corp., **a, c.**
Aerocal Div., Aeronca Mfg. Corp., **a.**
Aeroil Products Co., Inc., **a.**
Aircraft Armaments, Inc., **a.**
Albano Co. Inc., **a.**
Alden Products Co., **a.**
Allen Electric & Equipment Co., **a.**
Allied Plastics Supply Corp., **b.**
Alpitec, Inc., **a.**
Althor Products, **b.**
Aluminum Co. of America, **a.**
Amco Engrg. Co., **a.**
American Agile Corp., **b.**
American Aluminum Co., **a.**
American Beryllium Co., **a.**

American Electronics Inc., Taller-Cooper Div. & Data Systems Div., **a.**
American Insulator Corp., **b.**
American Latex Products Corp., **b.**
American Machine & Foundry Co., Government Products Group, **a.**
American Machine & Foundry Co., Government Products, N. Y., **a, b, d.**
American Research Group
Anchor Metal Spinning Co., The, **a.**
Anchor Specialty Mfg. Co. Inc., **a, b, d, e.**
Apex Reinforced Plastics, Div.-White Sewing Machine Corp., **b.**
Applied Design Co., **a.**
Armament Div.-Universal Match Corp., **a.**
Aro Equipment Corp., The, **d.**
Artisan Metal Works Co., **a.**
Associated Engineers, Inc., **a.**
Associated Testing Labs., Inc., **d.**
Atkins & Merrill, Inc., **b.**
Atlas Engrg. Corp., **d.**
Atlas Sound Corp., **c.**
Auto-Control Labs. Inc., **a, d.**
Babco Mfg. Inc., **a, c.**
Basic Tool Industries, Inc., **a.**
Beacon Steel Corp., **a.**
Bell Aircraft Corp., Niagara Frontier Div., **a.**
Belmar Wheel & Machine Co., Inc., **a, c.**
Benson Mfg. Co., **a.**
J. F. Bingham Mfg. Co., **a.**
S. Blickman, Inc., **a.**
Blue M Electric Co., **d.**
Bowser, Inc., **a.**
Brooks & Perkins, Inc., **a.**
Brunswick Balke Collender Co., The, Defense Products Div., **b.**
Bud Radio, Inc., **a, c.**
Budd Lewyt Electronics, Inc., **a.**
Burton-Rodgers, Inc., **a, b, e.**
Calcor Corp., **a.**
California Stamping & Mfg. Co., **a.**
Cincinnati Sub Zero Products, **d.**
Cole Electric Co., **a.**
Colonial Aircraft Corp., **a.**
Comco Plastics Inc., **b.**
Conrad & Moser, **a.**
Craig Systems, Inc., **a.**
Crane Co., Special Products Div., **a.**
Croname Inc., **a, c.**
Cutler Metal Products Co., **a, c.**
Dahlstrom Metallic Door Co., **a.**
Daystrom, Inc., Military Electronics Div., **a.**
Deluxe Metal Products Co., **a.**
Devco Engrg. Inc., **a.**
Development Engrg. Co., Inc., **d.**
Doak Aircraft Co. Inc., **a, b.**
Donnelly Mfg. Co., **a.**
Douglas Aircraft Co., Inc., **a.**
Dudwallen Mfg. Co., Inc., The, **a.**
Dura Plastics of N. Y., Inc., **b.**
Eljay Corp., **b.**
Elzee Metal Products Co., Inc., **a.**
Emeloid Co., Inc., The, **b.**
Erie Resistor Corp., **b.**
Eubanks Industries, Inc., **b.**
***EXCELCO DEVELOPMENTS INC., a.**
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp., **a, b.**
Falstrom Co., **a.**
Farwell Metal Fabricating, **a.**
Flight Refueling, Inc., **a.**
Fouch Electric Mfg. Co., Inc., **a.**
Gardner Laboratory, Inc., **d.**
Gates Radio Co., **a.**
Gatewood Products, Inc., **e.**
General American Transportation Corp., **b.**
General Bronze Electronics Corp., **a.**
General Metal Products Co., **a.**
Goldsman, **e.**
Gremco, Inc., **a.**
Guardite Co., Div.-American-Marietta Co., **d.**
Halliburton, Inc., Mfg. Div., **a.**
Hardman Tool & Engrg., Co., **a, b.**
Harris Refrigeration Co., **d.**
Heldor Mfg. Co., Inc., **a.**
Henry & Miller Industries, Inc., **a.**
Hoffman Engrg. Corp., **a.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., a.**
Ludwig Honold Mfg. Co., **a.**
Houston Fearless Corp., **a.**
Hydroforming Co. of America Inc., **a.**
Industrial Acoustics Co., Inc., **a.**
Industrial Engrg. Corp., **a.**
International Steel Co., **a, d.**
***ITEMCO, INC., d.**
Jeta, Inc., **a.**
Kellett Aircraft Corp., **a, e.**
Kelsey-Hayes Co., **a.**
Kerrco, **b.**
Alfred B. King Co., The, **a.**
Kirk & Blum Mfg. Co., The, **a.**
Lamtex Industries Inc., **b.**
Lancaster Glass Corp., **b.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **a.**
***LAVELLE AIRCRAFT CORP., a.**
Lofstrand Co., The, **a.**
Lone Star Plastics Co. Inc., **b.**
Lunn Laminates, Inc., **b.**
R. H. Lynch Mfg. Co., **a.**
Lyon Metal Products, Inc., **a.**
MEG Products, Div.-Mandrel Industries, Inc., **a.**
Magee-Bralla & Associates, **a, b, d.**
Magnesium Co. of America, **a.**
***MARTIN CO., THE, DENVER DIV., a, d.**
McCathron Boiler Works Co., Inc., **a.**
McGregor Mfg. Corp., **a.**
Meridian Metalcraft, Inc., **a.**
Metal Fabricators Corp., **a.**
Mid-West Metal Products, Inc., **a.**
Molded Insulation Co., **b.**
Monrovia Aviation Corp., **a.**
Muckle Mfg. Co., **a.**
Mullenbach Div.-Electric Machinery Mfg. Co., **a.**
Murphy & Miller Inc., **d.**
George L. Nankervis Co., **a.**
Narmco Mfg. Co., **b.**
National Co., Inc., **a.**
Navigation Computer Corp., **a.**
Nevada Air Products Co., **a.**
Northeast Metals Industries, Inc., **a.**
Northeastern Engrg. Inc., **a.**
Northrop Corp., **a, b.**
Olympic Plastics Co., Inc., **b.**
P. B. R. Mfg. Co., **a.**
Parkway Specialties Co., **c.**
Parsons Corp., Special Products Div., **b.**
Permoflux Products Co., **c.**
Piasecki Aircraft Corp., **a.**
Plastic Age Sales, Inc., **b.**
Pneumafil Corp., **a.**
Portland Copper & Tank Works Inc., **a.**
J. J. Powers Co., **c.**
Premier Metal Products Co., **a, c.**
Prewitt Aircraft Co., **b.**
Projects Unlimited, Inc., **a.**
Protectoseal Co., The, **a.**
Pry Welding & Mfg., Inc., **a.**
REF Mfg. Corp., **a, b.**
Radiaphone Co. Inc., **a.**
Radio City Products Co. Inc., **a.**
Ravenna Metal Products, Div.-Standard Screw Co., **a, d.**
Republic Steel Corp., **a.**
Rimak, Inc., **a, c, d.**
Roberts Industries Inc., **e.**
Milton Ross Metals Co., The, **b.**
Santa Anita Engrg. Co., **a.**
H. M. Scott Co., The, **b.**
Sheltered Workshops, **a, c, e.**
Skydyne, Inc., **a, b, e.**
Skyline Electric & Mfg. Co., **a.**
Skyline Products, Inc., **a.**
L. B. Smith Aircraft Corp., **a, e.**
Southwestern Industrial Electronics Co., **a.**
Standard Cabinet Co., Inc., **d.**
Standard Pressed Steel Co., **a.**
State Testing Laboratory Inc., **d.**
Stromberg-Carlson Div.-General Dynamics Corp., **c.**
Structural Fibers, Inc., **b.**
Sun Electric Corp., Aeronautical Div., **a.**
T. O. D. Mfg. Co. Inc., **a.**
Technical Materiel Corp., The, **a, c.**
Technical Products Co., **a.**
Telkor, Inc., **a.**
Temperature Engrg. Corp., **d.**
Templet Industries Inc., **a.**
Tenney Engrg., Inc., **d.**
Texstar Plastics, Div.-The Texstar Corp., **b.**
Thermon Mfg. Co., **d.**
Twin Coach Co., Aircraft-Missiles, **a, b, e.**
Twix Mfg. Co., Inc., **a.**
Unified Industries, Inc., **a, c.**
United Aircraft Products, Inc., **a, d.**
United Mfg. Co., Div., The W. L. Maxson Corp., **a.**
U. S. Plastic Molding Corp., **b.**
U. S. Science Corp., Div.-Topp Industries, Inc., **a.**
United States Chemical Milling Corp., **a, b.**
United States Testing Co., Inc., **d.**
Universal Unlimited, Inc., **b.**
University Loudspeakers, Inc., **c, e.**
Victor Tool & Mfg., Inc., **a.**
Waco Aircraft Co., **a.**
Washington Aluminum Co., Inc., **a.**
Wasley Products, Inc., **a.**
Waterbury Companies, Inc., **b.**
Webber Engrg. Corp., **d.**
Webber Mfg. Co., Inc., **d.**
Weber Aircraft Corp., **a.**
Welded Construction Inc., **a.**
Wells Industries Corp., **a.**
Wenzlau Engrg. Co., **a.**
Westholt Mfg. Inc., **a.**
Wickes Engrg. & Construction Co., **a.**
Winder Aircraft Corp. of Florida, **a, b.**
Wolverine Diesel Power Co., **a, b.**
Wyco Metal Products, **a.**
Young & Rioux Woodworking Co., Inc., **e.**
Zero Mfg. Co., **a, d.**

CABLE

- **a. Antenna Transmission**
- **b. Clamps & Clips**
- **c. Coaxial Flexible**
- **d. Coaxial Rigid**
- **e. Control**
- **f. Delay**
- **g. Disconnects**
- **h. Flat Woven Ground**
- **i. Guards**
- **j. Guillotines**
- **k. Hangars**
- **l. High Temperature Coaxial**
- **m. Ignition**
- **n. Markers**
- **o. Microphone**
- **p. Shielded**
- **q. Solid Dielectric**
- **r. Splicers**
- **s. Tensioners**
- **t. Transmission Line**

Abalon Precision Mfg. Corp., **b, k.**
Acromark Co., The, **n.**
Actioncraft Products, **n.**
Adept Industries Inc., **n.**
Aero Bolt & Screw Co., Inc., **b.**
Aerolite Electronics Corp., **b.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., c, g, l, m, p.**
Airhardware, Inc., **b.**
Alden Products Co., **g, p.**
All Products Co., **a.**
Allison Steel Mfg. Co., **d.**
Alpha Wire Corp., **o, p.**
Aluminum Co. of America, **p, t.**
Amatom Electronic Hardware Co. Inc., **b.**
American Chain & Cable Co., Inc., **t.**
American Electric Coble Co., **c, m, o, p.**
American Latex Products Corp., **i.**
American Machine & Foundry Co., **j.**
American Potash & Chemical Corp., National Northern Div., **g, m.**
American Steel & Wire Div.-United States Steel Corp., **e.**
American Super-Temperature Wires, Inc., **c, e, l, p, q, t.**
American Tube Bending Co., Inc., **a, c, l.**
Anaconda Wire & Cable Co., **a thru e, l thru q, t.**
***ANDREW CORP., a, c, d, k, q, t.**
Ansonia Wire & Cable Co., The, **a, c, d, e, m, p, q, r.**
Associated Co., Inc., **e, g, p.**
Augat Brothers, Inc., **b.**
Automotive & Aircraft Div.-American Chain & Cable Co., Inc., **e.**
Avco Corp., Crosley Div., **e, g.**
Belden Mfg. Co., **c, e, h, o, p, t.**
Belmar Wheel & Machine Co., Inc., **b, i, k, p.**
Bendix Aviation Corp., **g.**
Bendix Aviation Corp., Cincinnati Div., **e, m, p.**
Bergen Wire Rope Co., **a, b, e.**
Berkshire Electric Cable co., **c, d, o, p, q.**
Bermite Powder Co.. **m.**
Birnbach Radio Co., Inc., **a, b, c, l, m, o, p, t.**
Bjorksten Research Labs. for Industry, Inc.
Boston Insulated Wire & Cable Co., **c.**
W. H. Brady Co., **n.**
William Brand, Rex Div.-American Enka Corp., **a, c thru f, n thru q, t.**
Breeze Corporations, Inc., **h.**
H. H. Buggie Div., Burndy Corp., **b, g.**
Burndy Corp., Omaton Div., **b, g, k, r.**
Butler Mfg. Co., **a thru i.**
Cable Electric Products Inc., **c, e, p.**
Cal Connector Co., **b, g.**
Calcon Mfg. Co., Inc., **a, c, e, l, o, p, q, t.**
Chance Vought Aircraft, Inc., **a.**
Chester Cable Corp., Sub.-Miami Copper Co., **c, d, e, l, m, o, p, q, t.**
Collyer Insulated Wire Co., **e.**
Columbia Technical Corp., **f.**
Continental Wire Sales Corp., **c, d, e.**
Co-Operative Industries, Inc., **m.**
Copperweld Steel Co., Wire & Cable Div., **k.**
Cornish Wire Co. Inc., **o, p.**
Cosmic Instruments Inc., **b, c.**
R. E. Darling Co., Inc., **o, p.**
Dayton Aircraft Products, Inc., **a.**
***DEL MAR ENGRG. LABS., j.**
Deutsch Co., The, Electronic Components Div., **b, g.**
Don-Lan Electronics Inc., **a, c, d, g.**
Douglas Aircraft Co., Inc., **k.**
Duralith Corp., **n.**

Duramark, Inc., a.
Eastern Rotorcraft Corp., s.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., a, d, l.
Elco Corp., g.
Electric Autolite Co., The, c, l, m, p.
Electronic Applications, Inc., o, p.
Emeloid Co., Inc., The, n.
Emertron, Sub.-Emerson Radio & Phonograph Corp., a thru g, l, p, q, t.
Essex Wire Corp., e, t.
FAE Instrument Corp., b.
Farwest Mfg. Div., Inc.
G-C Electronics Co., b.
General Cable Corp., c, d, e, l, m, o, p, q, t.
General Plastics Corp., n.
General Radio Co., c, d, o, p.
Duncan M. Gillies Co. Inc., n.
Gries Reproducer Corp., b.
Guided Missile Div., The Firestone Tire & Rubber Co., a.
Gulton Industries, Inc., p.
Hallett Mfg. Co., b, c, g, h, m, p.
Hammett-Mercury-Rex Div., c, d.
George E. Harris & Co., Inc., g.
Heyman Mfg. Co., b.
Hitemp Wires Inc., c, h, l, m, p.
Holub Industries, Inc., b.
Holyoke Wire & Cable Corp., a, c, e, h, o, p, q, t.
Hunter Spring Co., Div.-American Machine & Metals, Inc., b.
Walter J. Hyatt Co., The, b, g.
Illumitronic Engrg. Co., b.
Inso Electronic Products, Inc., l.
Interstate Electronics Corp.
Interstate Electronics Inc., a, c, l, o, p, t.
Walter K. Jaros.Aircrafters, b, e, g.
Javex Electronics, g.
Jefferson Electronic Products, a.
Jefferson Wire & Cable Corp., a, c, d, o, p, q, t.
Jennings Machine Corp., l.
Joy Mfg. Co., r.
Kaiser Aluminum & Chemical Sales, Inc., a, c, d, e, h, l, m, p, t.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., e, p, t.
Kennedy Aircraft Supply Co., e.
Kickhaefer Mfg. Co., b, k.
Lab-Tronics, Inc., c, e, o, p.
Lear, Inc., a.
Lenz Electric Mfg. Co., c, e, o, p.
Lewis Engrg. Co., The, c, l.
Lieco, Inc., c, d.
Lithium Corp. of America Inc., The Fulton-Irgon Div., g, j.
Litton Industries, Inc.
Lunn Laminates, Inc., b.
MEG Products, Div.-Mandrel Industries, Inc., e, m, p.
Malco Mfg. Co., b.
Manger Electric Co., Inc., n.
Manhattan Lighting Equipment Co., Inc., c, d, k.
*MARTIN CO., THE, DENVER DIV., a, b, i, j, t.
Microdot Inc., c, d.
*MINNESOTA MINING & MFG. CO., r.
Mohawk Wire & Cable Corp., c, o, p, q, t.
New England Electrical Works, Inc., h, q.
Normandy Electric Wire Corp., a, c thru f, l, o, p, q, t.
Northeast Metals Industries, Inc., a, c.
Nugent Electronics Co., Inc., r.
Okonite Co., The, Sub.-Kennecott Copper Corp., a, c, e, m, o, p, q, t.
Ordnance Research & Development Co., Div.-Bermite Powder Co., m.
Pacific Automation Products, Inc., a, c thru f, h, k, l, m, p, q, t.
Pacific Scientific Co., g, s.
Packard Electric Div.-General Motors Corp., m, p.
Panduit Corp., b.
Phalo Plastics Corp., c, o, p, q.
Phelps Dodge Copper Products Corp., a, c thru f, l, p, q, t.
Precision Tube Co., Inc., a, d, p, q, t.
Prodelin Inc., c, d, l, t.
Propellex Chemical Div., Chromalloy Corp., j.
*RADIO CORP. OF AMERICA, a, c thru f, h, l n thru q, t.
Revere Corp. of America, Sub., Neptune Meter Co., c, e, l, m, p.
Reynolds Metals Co., t.
Robins Industries Corp., a.
Rockbestos Wire & Cable Co., Div.-Cerro de Pasco Corp., c, e, l, p, q.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp., e, p, t.
Rome Cable Div.-Alcoa, e, k, p, t.
Roovers-Lotsch Corp., n.
Royal Electric Corp., c, e, f, m, o, p, q, t.
Scintilla Div., Bendix Aviation Corp., g, m, p.
Seeger-Williams, Inc.
Servicair Co., b.
Sillcocks-Miller Co., n.
Simmonds Aerocessories, Inc., e, g.
C. Sjoberg & Son, b, n, r.
Skytronics, Inc., m, p.
E. C. Smith Mfg. Co., Inc., b, d, l.
South River Metal Products Co., Inc., e.
Southwest Products Co.,
Southwire Co., t.
Spectra-Strip Wire & Cable Corp., c, o, p.
Stanley-Judd Div.-The Stanley Works, b, k.
Stow Mfg. Co., e.
Supa Insulations Inc., c, p.
Superior Cable Corp., c, e, o, p, q, t.
Surprenant Mfg. Co., c, d, l, o, p, q, t.
TA Mfg. Corp., b.
Tamar Electronics, Inc., g.
Tape Cable Corp., p, q.
Technical Appliance Corp., a.
Telcon, Inc., a, c, f, l, q, t.
Telectro Industries Corp., a.
Teleflex Inc., e, l.
Tensolite Insulated Wire Co., Inc., c, e, l, p, q.
Texstar Plastics, Div.-The Texstar Corp., e, m, p.
Thermax Wire Corp., c, l, m, o, p, q, t.
Thomas & Betts Co., Inc., The, b, g, k, r.
Thor Ceramics, Inc., b, m.
Times Wire & Cable Co., Inc., a, c, d, e, l, o, p, q, t.
Tinnerman Products, Inc., b.
Titeflex, Inc., m.
Tober Electronic Corp., a, d, g, t.
Topper Mfg. Co., Inc., e.
Tower Construction Co., a.
Tri-Ex Tower Corp., b.
Twix Mfg. Co., Inc., b, g, h, i.
U. S. Science Corp., Div.-Topp Industries, Inc., t.
United States Steel Corp., e.
United States Wire & Cable Corp., a, c, e, o, p, t.
Vector Mfg. Co., c, e, o, p, q.
Victor Electric Wire & Cable Corp., a, c, l, o, p, t.
Warren Wire Co., c.
Weckesser Co., b.
Western Insulated Wire Co., c, e, p.
Westline Products Div.-Western Lithograph Co., n.
Westwood Cable Corp., a, c, d, e, g, h, l, o, p, q.
Whitaker Cable Corp., h.
Whitehead Stamping Co., b.
Whitso, Inc., b.
Wirecraft Products, Inc., l, p.
Zierick Mfg. Corp., b.
Zippertubing Co., The, b, c, i, k, n, p.

CABLE ASSEMBLIES, ELECTRICAL

Acme Electric Corp.
Advance Industries, Inc.
Advance Instrument Corp.
Advanced Electronics, Inc.
Aerolite Electronics Corp.
Aircraft Tools, Inc.
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
All Specs Corp.
Allen Electric & Equipment Co.
Aluminum Co. of America
American Electric Cable Co.
American Research & Mfg. Corp.
Anaconda Wire & Cable Co.
Anchor Specialty Mfg. Co. Inc.
Arnoux Corp.
Associated Engineers, Inc.
Belden Mfg. Co.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bergen Wire Rope Co.
Berkshire Electric Cable Co.
Bernco Engrg. Corp.
Birnbach Radio Co., Inc.
Brach Mfg. Corp.
William Brand, Rex Div.-American Enka Corp.
H. H. Buggie Div., Burndy Corp.
Burndy Corp., Omaton Div.
Burton-Rodgers, Inc.
CG Electronics Corp.
Cable Electric Products Inc.
Calcon Mfg. Co., Inc.
Carol Electronics Corp.
Chalco Engrg. Corp.
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Cole Electric Co.
Co-Operative Industries, Inc.
Cornish Wire Co. Inc.
Cosmic Instruments Inc.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Dale Products, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
R. E. Darling Co., Inc.
Daystrom, Inc., Military Electronics Div.
*DEL MAR ENGRG. LABS.
Dit-Mco, Inc.
Du Kane Corp.
Allen B. Du Mont Labs., Inc.
Eagle Signal Co.
Elco Corp.
Electric Autolite Co., The
Electric Cords & Supply Corp.
Electromath Corp.
Electronic Brazing Co.
Electronic Parts Mfg. Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Electronics Co., Inc.
Engrg. Specialties
Essex Wire Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Farwest Mfg. Div., Inc.
Flight Refueling, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Aniline & Film Corp., Ansco Div.
General Mills, Inc.
General Products Corp.
General Radio Co.
Gilfillan Bros. Inc.
Good Electronic Corp.
Graflex Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Gulton Industries, Inc.
Hallamore Electronics Co., Div.-Siegler Corp.
Hallett Mfg. Co.
Hammett-Mercury-Rex Div.
Harco Labs., Inc.
Hitemp Wires Inc.
Holyoke Wire & Cable Corp.
Huyck Systems Co.
ITI Electronics, Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
Indiana Gear Works, Inc.
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp.
Intercontinental Dynamics Corp.
International Electric Industries, Inc.
Interstate Electronics Corp.
Jack & Heintz, Inc.
Janco Corp.
Jefferson Electronic Products
Jeta, Inc.
Jettron Products, Inc.
Kahn & Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kings Electronics Co., Inc.
Lab-Tronics, Inc.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Lear, Inc.
Lee Electric & Mfg. Co.
Lewis Engrg. Co., The
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
Lycoming Div., Avco Corp.
Lytle Corp.
MEG Products, Div.-Mandrel Industries, Inc.
Manger Electric Co., Inc.
*MARTIN CO., THE, DENVER DIV.
Mc Donnell Aircraft Corp.
Microdot Inc.
Modelectric Products Corp.
Molded Insulation Co.
Chester Morton Electronics Corp.
Mutron Corp.
Normandy Electric Wire Corp.
Norrich Screw Machine Products
Northeast Metals Industries, Inc.
Northeastern Engrg. Inc.
Nugent Electronics Co., Inc.
Paul Nurches Co.
Opad Electric Co.
Pacific Automation Products, Inc.
Packard Electric Div.-General Motors Corp.
Paco Electronics Co., Inc.
Paraplegics Mfg. Co., Inc.
Permaflux Products Co.
Phalo Plastics Corp.
Philco Corp.-Govt. & Industrial Group
Piasecki Aircraft Corp.
Piqua Engrg. Inc.
Pomona Electronics Co., Inc.
Precise Development Corp.
Projects Unlimited, Inc.
Pyle-National Co., The
Radiaphone Co. Inc.
*RADIO CORP. OF AMERICA
*RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY
Raven Industries Inc.
Ravenna Metal Products, Div.-Standard Screw Co.
Republic Aviation Corp., Missile Systems Div.
Revere Corp. of America, Sub., Neptune Meter Co.
Rimak, Inc.
Robertshaw-Fulton Controls Co., A & I Div.
Rome Cable Div.-Alcoa
Milton Ross Metals Co., The
Royal Electric Corp.
Schaffer Air Industries, Inc.

Scintilla Div., Bendix Aviation Corp.
Seeger-Williams, Inc.
Servicair Co.
Shallcross Mfg. Co.
Sheltered Workshops
Skyline Electric & Mfg. Co.
Skytronics, Inc.
Southwestern Industrial Electronics Co.
Specialty Electronics Development Corp.
Spectra-Strip Wire & Cable Corp.
State Testing Laboratory Inc.
Stewart-Warner Electronics Div.
Sunshine Scientific Instrument
Superex Electronics Corp.
Surprenant Mfg. Co.
Taffet Electronics, Inc.
Tamar Electronics, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Telex, Inc.
Telkor, Inc.
Tensolite Insulated Wire Co., Inc.
Thomas Electronics, Inc.
Thompson Ramo Wooldridge Inc.
Thor Ceramics, Inc.
Times Wire & Cable Co., Inc.
Tober Electronic Corp.
Topper Mfg. Co., Inc.
Tucson Instrument Corp.
Twix Mfg. Co., Inc.
U. S. Plastic Molding Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Vector Mfg. Co.
Vicon Corp. Sub.-Insul-8-Corp.
Victor Electric Wire & Cable Corp.
Victor R. F. & Microwave Co.
Virginia Electronics Co., Inc.
Westwood Cable Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Whitaker Cable Corp.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.

CABLE ASSEMBLIES, THERMOCOUPLE

Advanced Electronics, Inc.
Aircraft Tools, Inc.
Arnoux Corp.
Berkshire Electric Cable Co.
Bernco Engrg. Corp.
William Brand, Rex Div.-American Enka Corp.
Calcon Mfg. Co., Inc.
Conax Corp.
Co-Operative Industries, Inc.
Cosmic Instruments Inc.
Electric Cords & Supply Corp.
Electronic Parts Mfg. Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Claud S. Gordon Co.
Hallett Mfg. Co.
Harco Labs., Inc.
Jefferson Electronic Products
Kahn & Co., Inc.
Leeds & Northrup Co.
Lewis Engrg. Co., The
MEG Products, Div.-Mandrel Industries, Inc.
***MARTIN CO., THE, DENVER DIV.**
Chester Morton Electronics Corp.
Normandy Electric Wire Corp.
Pacific Automation Products, Inc.
Piasecki Aircraft Corp.
***RADIO CORP. OF AMERICA**
Revere Corp. of America, Sub., Neptune Meter Co.
Scintilla Div., Bendix Aviation Corp.
E. C. Smith Mfg. Co., Inc.
Spectra-Strip Wire & Cable Corp.
Surprenant Mfg. Co.
Teleflex Inc.
Telkor, Inc.
Thermo Electric Co., Inc.
Thermon Mfg. Co.
Tober Electronic Corp.
Westwood Cable Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Winder Aircraft Corp. of Florida

CADMIUM

Accurate Specialties Co. Inc.
Allied Research Products, Inc.
Alloys Unlimited Inc.
American Brass Co., The
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bow Solder Products Co., Inc.
Bram Metallurgical Chemical Co.
Chromium Corp. of America
City Chemical Corp.
Delta Chemical Works, Inc.
Division Lead Co.
Eagle-Picher Co., The
Harmon, Lichtenstein & Co.
Morris P. Kirk & Son, Inc.
Semi-Elements, Inc.
Udylite Corp., The
Var-Lac-Oid Chemical Co.

CALCIUM

Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
City Chemical Corp.
Delta Chemical Works, Inc.
Metal Hydrides Inc.
Nelco Metals, Inc.
Semi-Elements, Inc.
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

CALIBRATORS

a. Crystal
b. Force
c. Frequency
d. Radar Device
e. Radar Range
f. Sweep
g. Transducer
h. Voltage
i. UHF
j. VSWR

Advance Industries, Inc., **d, e, f.**
Aeroscience, Inc., **b, g.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc. **a, c.**
Aircom Inc., **a, j.**
Airpax Electronics Inc., Cambridge Div., **c.**
Airpax Electronics Inc., Seminole Div., **c.**
All Products Co., **j.**
Allegany Instrument Co., Inc., **g.**
Allied International Corp., **d, e, i.**
Amerac Inc., **c.**
American Machine & Foundry Co., Government Products, N. Y., **c, d, e, g, h.**
Arkay Engrg., Inc., **c.**
Arnoux Corp., **g.**
B & K Instruments, Inc., **g.**
Beckman Instruments, Inc., Berkeley Div., **c.**
Beckman-Systems Div., **h.**
Bendix Aviation Corp., **c thru f, h.**
Bendix Aviation Corp., Cincinnati Div., **c, h.**
Bergen Labs., Inc., **b.**
Bruno-New York Industries Corp., **d, i.**
Budd Lewyt Electronics, Inc., **e, f.**
Bytrex Corp., **b, g.**
Calvert Electronics Inc., **c, h.**
Clegg Labs., Div.-Clegg, Inc., **c, h.**
G. L. Collins Corp., **g.**
Control Electronics Co., Inc., **a, c, d, e.**
Crescent Engrg. & Research Co., **g.**
Data-Control Systems, Inc., **c, h.**
Davenport Mfg. Co., **h.**
Daystrom Inc., Weston Instruments Div., **h.**
Dejur-Amsco Corp., Electronic Sales Div., **g.**
Designers for Industry, Inc., **a, c.**
Djeco, Div.-Djordjevic Engrg. Co., **h.**
Dorsett Electronic Labs., Inc., **g.**
Du Kane Corp., **c.**
Dynatronics, Inc., **c, h.**
Electro Instruments, Inc., **c, h.**
Electro Scientific Industries, **h.**
Electronic Applications, Inc., **a, c, f, i, j.**
Elin Div., International Electronic Research Corp., **h.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **d, e.**
Erie Resistor Corp., **c.**
John Fluke Mfg. Co., Inc., **h.**
General Communication Co., **c, d, h.**
General Radio Co., **a, c, g.**
Gilmore Industries, Inc., **b, g.**
Gulton Industries, Inc., **a, c, g.**
Gyrex Corp., The, **c, g.**
Hallamore Electronics Co., Div.-Siegler Corp., **g.**
Hammett-Mercury-Rex Div., **d, e.**
Hewlett-Packard Co., **h.**
Hickok Electrical Instrument Co., The, **f.**
Hunter Spring Co., Div.-American Machine & Metals, Inc., **b.**
I-L-S Instrument Div., The Meriam Instrument Co., **c.**
ITI Electronics, Inc., **e.**
Instruments for Industry, Inc., **c, i.**
E. F. Johnson Co., **j.**
Kay Electric Co., **h.**
Kin Tel Div.-Cohu Electronics, Inc., **h.**
James Knights Co., The, **a.**
Lab. for Electronics, Inc., **c, d.**
Lampkin Labs., Inc., M. R. Div., **c, i.**
Lear, Inc., **b, g.**
Leeds & Northrup Co., **h.**
***WALLACE O. LEONARD, INC., g.**
Loral Electronics Corp., **a, e, f.**
MB Electronics, **g.**
***MARTIN CO., THE, DENVER DIV., a, b, c, f thru j.**
Matronix, Inc., Sub.-Assembly Products, Inc., **a.**
Micro Gee Products, Inc., **c, g.**
James Millen Mfg. Co. Inc., **j.**
Mitchell Camera Corp., **g.**
Morehouse Machine Co., **b.**
Motorola, Inc., **a, c thru f, h, i, j.**
National Co., Inc., **c.**
National Instrument Laboratories, Inc., **h.**
Ernest Norrman Laboratories, **a, c.**
Northrop Corp.
Orbitran Co., Inc., **b, e.**
Palmer Instruments, **a.**
Performance Measurements Co., **b, g, j.**
Photocon Research Products, **c, g.**
Polarad Electronics Corp., **j.**
Probescope Co. Inc., **a.**
Projects Unlimited, Inc., **e.**
Radalab Inc., **a, c, d, i, j.**
Radar Design Corp., **j.**
Radio City Products Co. Inc., **e.**
***RADIO CORP. OF AMERICA, a, c thru j.**
***RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY, c, h.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **a, c.**
Rawson Electrical Instrument Co., **h, i.**
Rese Engrg., Inc., **h.**
Schaevitz Engr., **b, g.**
Scientific-Atlanta, Inc., **j.**
Sensitive Research Instrument Corp., **h.**
Servomechanisms, Inc., **g.**
Sierra Electronic Corp., Div.-Philco Corp., **j.**
Simpson Electric Co., **h.**
Skidmore-Wilhelm Mfg. Co., **b.**
Spectra Electronics Corp., **d, e; i, j.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **b, c, d, e, j.**
Statham Instruments, Inc., **g.**
Steel City Testing Machines, Inc., **c, e, i, j.**
Sun Electric Corp., Aeronautical Div.
TRG, Inc., **c.**
Technical Material Corp., The **a.**
Technology Instrument Corp., **g.**
Technoproducts, Inc., **b,g.**
Unholtz-Dickie Corp., **g.**
Valpey Crystal Corp., **a,c.**
Varo Mfg. Co., Inc., **c.**
Video Instruments Co., Inc., **g.**
Waltham Electronics Corp., **c.**
Wiancko Engrg. Co., **g.**

CALLING SYSTEMS, SELECTIVE, NAVIGATION

Advance Industries, Inc.
Allied International Corp.
Bell & Gossett Co.
Bendix Aviation Corp.
Broadview Research Corp.
Bruno-New York Industries Corp.
Collins Radio Co.
***DEL MAR ENGRG. LABS.**
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp. Defense & Engrg. Products Group.
Hammarlund Mfg. Co., The
Huyck Systems Co.
Litton Industries, Maryland Div.
Madigan Corp.
***MOTOROLA, INC.**
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Southwest Research Institute
Stromberg-Carlson Div.-General Dynamics Corp.
Varo Mfg. Co., Inc.

CAMERA AUXILIARY EQUIPMENT

American Optical Co.
Ball Brothers Research Corp.
Beattie-Coleman, Inc.
Beckman & Whitley, Inc. Instruments Div.
Belock Instrument Corp.
Benson-Lehner Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chance Vought Aircraft, Inc.
DBM Research Corp.
Joe Davidson & Associates
Dejur-Amsco Corp., Electronics Sales Div.
***DEL MAR ENGRG. LABS.**
Allen B. Du Mont Labs., Inc.
Eastman Kodak Co.
Electroid Corp.
Electronic Engrg. Co. of California
Fairchild Camera & Instrument Corp.
Fairchild Camera & Instrument Corp., Industrial Products Div.,
J.W. Fecker Div., American Optical Co.
Flight Research, Inc.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Gordon Enterprises
Guidance Controls Corp.
Herlo Corp.

Magnasync Corp.
*MARTIN CO., THE, DENVER DIV.
D.B. Milliken Co.
Northrop Corp.
Optomechanisms Inc.
Sterling Glass Corp.
Traid Corp.
U.S. Science Corp., Div.-Topp Industries, Inc.
Viewlex, Inc.
Winder Aircraft Corp. of Florida
Zoomar Inc.

CAMERA MOUNTS

Aeroflex Labs. Div., Aeroflex Corp.
American Latex Products Corp.
American Machine & Foundry Co., Greenwich Engrg. Div.
American Optical Co.
Associated Co., Inc.
Beattie-Coleman, Inc.
Benson-Lehner Corp.
Chance Vought Aircraft, Inc.
Christie Machine Works.
DBM Research Corp.
Fairchild Camera & Instrument Corp.
Fairchild Camera & Instrument Corp., Industrial Products Div.
J.W. Fecker Div., American Optical Co.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Gordon Enterprises
Herlo Corp.
Interstate Electronics Corp.
*MARTIN CO., THE, DENVER DIV.
D.B. Milliken Co.
Mitchell Camera Corp.
Northeast Metals Industries, Inc.
Optomechanisms Inc.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Traid Corp.
Vibration Isolation Products
Viewlex, Inc.
Waldick Engrg. Co.
Weba, Inc.
Winder Aircraft Corp. of Florida
Zoomar Inc.

CAMERAS

a. Data Recording
b. High Speed
c. Motion Picture
d. Oscilloscope
e. Recording, Radar & Oscilloscope
f. Sequence, Pulse
g. Television
h. X-Ray

*ABRAMS INSTRUMENT CORP., a, e.
Advance Industrial X-Ray Labs., Inc., h.
Allegany Instrument Co., Inc., a, d.
American Instrument Co., Inc., d.
American Optical Co., g.
*ASKANIA-WERKE, U.S. BRANCH OFFICE, a.
Associated Engineers, Inc., a, b, e.
Avco Corp.-Research & Advanced Development Div. a, b.
Bach Auricon, Inc., a, c, e, g.
Beattie-Coleman, Inc., a, d, e, f, h.
Beckman & Whitley, Inc., Instrument Div., b, d.
Benson-Lehner Corp., a, b, c, d, e, f.
Blonder-Tongue Labs., Inc., g.
Blonder-Tongue Labs. Inc., Special Products Div., g.
CBS Laboratories, Div.-Columbia Broadcasting System b, g, h.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp. a, c, e.
Century Electronics & Instruments, Inc., a.
Chadwick-Helmuth Co., b, f.
Christie Machine Works b.
DBM Research Corp., a, c, e.
Dage Television Div., Thompson Ramo Wooldridge, Inc., g.
Dejur-Amsco Corp., Electronic Sales Div., c.
Diamond Power Specialty Corp., g.
Allen B. Du Mont Labs., Inc., a, d, e, g.
Eastman Kodak Co., a, c, e, f.
Edgerton, Germeshausen & Grier, Inc., d.
Edmund Scientific Co.
Electro-Medical Lab., Inc., d.
Electronic Tube Corp., d, e.
*ENGIS EQUIPMENT CO., h.
Fairchild Camera & Instrument Corp., a, b, c, d, e, h.
Fairchild Camera & Instrument Corp., Industrial products Div., a, b, c, e, h.
J.W. Fecker Div., American Optical Co., a, c.
Flight Research, Inc., a, c, d, e, f, g.
Foto-Video Labs., Inc., g, h.
GPL Div.-General Precision, Inc., g.
General Electric Co., Missile & Space Vehicle Dept. Pa., a, b, c.
General Electric Co., X-Ray Dept., a, b, e, h.
Gordon Enterprises., b, c, d, e, f, g.
Hallamore Electronics Co., Div.-Siegler Corp., g.
Haloid Xerox Inc.
Hammett-Mercury-Rex Div., h.
Hathaway Instruments, Inc., d.
Herlo Corp.
Hewlett-Packard Co., d.
Image Instruments, Inc., f, g.
Instrument Div., The Budd Co., h.
Intercontinental Electronics Corp., g.
Interstate Electronics Corp., g.
Kin Tel Div.-Cohu Electronics, Inc., g.
Librascope Div., General Precision, Inc. a, b.
Lockheed Aircraft Corp., Missiles & Space Div., g.
*MARTIN CO., THE, DENVER DIV., a, b.
J.A. Maurer, Inc., a, b, c, d, e, f.
D.B. Milliken Co., a, b, c, d, e, f.
Mitchell Camera Corp., b, c,
Norden Div., United Aircraft Corp., g.
Optomechanisms Inc., a, d, e, f.
Paragon-Revolute, Div.-Charles Bruning Co., Inc.
Peerless Photo Products Inc., a.
Perkins-Elmer Corp., a.
Philco Corp.-Govt. & Industrial Group., g.
Philips Electronic Instruments h.
*RADIO CORP. OF AMERICA, e, g, h.
Resitron Labs., Inc., g.
Singer Military Products Div,-The Singer Mfg. Co., e.
Southwestern Industrial Electronics Co., e.
Specialities, Inc.
Strand Engrg. Co., a, e.
Tektronix, Inc., d.
Thompson Ramo Wooldridge Inc., g.
Tracerlab Inc., h.
Traid Corp., a, b, c, d, f.
Vicon Corp., Sub.-Insul-8-Corp., g.
Viewlex, Inc., a, b, c, d, e.
Westinghouse Electric Corp., h.
Wollensak Optical Co., a, b, c, d, e, f.
Soomar Inc., g.

CANS, HERMETICALLY SEALED

American Aluminum Co.
Morris Bean & Co.
Brooks & Perkins, Inc.
Calcor Corp.
California Stamping & Mfg. Co.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Corning Glass Works.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Deutsch Co., The, Electronic Components Div.
Double E Products Co.
George D. Ellis & Sons, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
Graflex Inc.
Heldor Mfg. Co., Inc.
Hermetic Seal Corp.
Hudson Tool & Die Co., Inc.
Lear, Inc.
*MARTIN CO., THE, DENVER DIV.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Paul & Beekman, Inc.
Portland Copper & Tank Works Inc.
Milton Ross Metals Co., The.
Royal Jet, Div.-Royal Industries, Inc.
Southwestern Industrial Electronics Co.
Sphere Co. Inc., The.
Stevens Co. Inc.
Warren Components, Div.-El-Tronics, Inc.
Wesrep Corp.
Zero Mfg. Co.

CAPACITOR SPECIALTIES MEASUREMENT

Double E Products Co.
Electro Instruments, Inc.
Electro Scientific Industries
Industrial Instruments Inc.,
*MARTIN CO., THE, DENVER DIV.
Paul & Beekman, Inc.
Radio Condenser Co.

CAPACITORS

a. Ceramic
b. Composition
c. Decade
d. Electrolytic
e. Feed-Through
f. Fixed
g. Gas-Filled
h. Glass
i. High Temperature
j. High Voltage
k. Metallized Paper
l. Mica
m. Miniature
n. Mylar
o. Oil Filled
p. Piston
q. Plastic-Insulated
r. Precision
s. Printed Circuit
t. Receiver Tuning
u. Tantalum
v. Teflon
w. Temperature Compensated
x. Transmitter Tuning
y. Trimmer
z. Vacuum Type
a-1. Variable

ACF Industries Inc., m, n, q, s.
AMP Inc., j, n, o, v, w.
Aerovox Corp., a, d, e, f, i thru o, q, s, t, u, w, x, y.
Aetna Electronics Corp., x.
Airborne Accessories Corp., e, i, k thru n, v.
All Star Products Inc., a, a-1.
American Agile Corp., q.
American Lava Corp., a, e, w, y.
American Machine & Foundry Co., Government Products Group, i.
Associated Engineers, Inc., j, k, l, s, v.
Astron Corp., a, d, e, f, i, j, k, m, n, o, q, s, u, v, w.
Atlee Corp., a-1.
Axel Electronics-Div. Axel Bros. Inc., e, f, i, j, m, n, o, q, v, w.
Barco, Inc., d, u.
Bendix Aviation Corp., a, i, l.
Bendix Aviation Corp., Cincinnati Div., q.
Bud Radio, Inc., x, a-1.
Cambridge Thermionic Corp., e, f, a-1.
Centralab, Div.-Glove-Union, Inc., a, e, f, i, j, m, q, r, s, w, y.
Chemical Micro Milling Co., s.
Consolidated Airborne Systems, Inc., r, w.
Continental Electronics Mfg. Co., Sub.-Ling-Altec Electronics Inc., j.
Cornell-Dubilier Electric Corp., a Thru f, i, Thru o, q, r, s, u, v, w.
Corning Glass Works, a, f, h, i, j, m, y.
Corson Electric Mfg. Corp., f, i, j, l, n, o, q, v.
Courter Products, Div.,-Model Engrg. & Mfg., Inc., i.
Dearborn Electronic Labs., Inc., b, f, h, i, j, m, n, o, r, v, w.
Dolinko & Wilkens, Inc., j, z.
Double E Products Co., a, b, c, e thru o, q thru t, v thru z, a-1.
Eastman Kodak Co., n.
Ed-Berl Products, Inc., d.
Efcon, Inc., c, d, f, i, j, k, m, n, q, r, s, u, v, w.
Electra Mfg. Co., a, m, r, s, w.
Electro Scientific Industries, c.
Electro-Capacitors Co., d.
Electron Products Div.-Marshall Industries, f, i, j, k, m, n, o, v.
Electronic Applications, Inc., c.
Emertron, Sub.-Emerson Radio & Phonograph Corp., s.
Epic, Inc., g, j, l.
Erie Resistor Corp., a, e, f, i, l, r, s, u, w, x, y, a-1.
Fansteel Metallurgical Corp., d, f, i, j, m, r, u.
Ferroxcube Corp. of America, a.
Film Capacitors, Inc., c, e, f, i, j, k, m, n, o, q, r, s, v, w.
Filtron Co., Inc., e, f, i, j, k, m, n, o, q, v.
Freed Transformer Co., Inc., c.
General Electric Co., Apparatus Sales Div., b, d, e, j, m, o, q, u, v.
General Laboratory Associates, Inc., f, i, j, l, n, o, v.
General Products Corp., f, q.
General Radio Co., c, f, r, a-1.
Genistron, Inc., e.
Girard-Hopkins, f, n, o.
Good-All Electric Mfg. Co., a, d, f, m, n, o, q s.,
Gudeman Co., The, d, e, f, i, j, k, m, n, o, q, r, s, v, w.
Gulton Industries, Inc., a, i, m, w.
Hallett Mfg. Co., e.
Hammarlund Mfg. Co., The j, r, t, x, y, a-1.
George E. Harris & Co., Inc., a, b, d, f, i, k, n, u.
Hi Q Div., Aerovox Corp., a, e, f, i, j, m, r, s, w, y.
Hopkins Engrg. c o. c, e, f, i, k, m, n, o, r, s, v.,
Hughes Semiconductor Div.-Hughes Aircraft Co., a-1.
ITT Components Div., International Telephone & Telegraph Corp., u.
Induction Heating Corp., o.
*INTERELECTRONICS CORP., b, f, i, j, k, m, n, o, q, v, w.
International Electronic Industries, Inc., d, e, f, m, s, u.
International Rectifier Corp., a-1.
Interstate Electronics Inc., a Thru f, h Thru r, u, v, w, y, a-1.
JFD Electronics Corp., a, g thru j, m, p thru t, w, y, z, a-1.
Jeffers Electronics Div., Speer Carbon Co., b.
Jennings Radio Mfg. Corp., j, z, a-1.
E.F. Johnson Co., i, j, m, s, x, y, a-1.
Kemet Co., Div.-Union Carbide Corp., u.
Wayne Kerr Corp., f, r, z.
La Pointe Industries Inc., s, a-1.
Lapp Insulator Co., Inc., Radio Specialties Div., f,g,j, x, a-1.
Lear, Inc., a, b, u, y.

Leeds & Northrup Co., l, r.
Line Material Industries-Mc Graw-Edison Co., j, o.
Lockheed Aircraft Corp., Missiles & Space Div., a, m.
*MAGNAVOX CO., The, d, u.
Maida Development Co., a, e, f, i, j, m, r, w, y.
P.R. Mallory & Co. Inc., a, d, e, f, i, m, o, s, u.
Mc Coy Electronics Co., a-1.
Mica Fabricated Co., l.
Micamold Electronics Mg. Corp., d, e, f, i thru o, q, s, u, v.
James Millen Mfg. Co. Inc., m, p, r, t, x, y, a-1.
*MINNESOTA MINING & MFG. CO., a-1.
Mucon Corp., a, s, w.
Muirhead Instruments Inc., c, f, l, r, a-1.
Nameplates Inc., s.
National Carbon Co., Div.-Union Carbide Corp., u.
National Co., Inc., r, t, x.
New England Scientific Instruments Co., g.
New York Coil Co., Inc., n.
Onondaga Electronics Div., Speer Carbon Co., a, f, s, w.
Packard-Bell Electronics Corp., a.
Patterson Moos Research, Div.-Leesona Corp., n, v.
Paul & Beekman, Inc., d.
Pimex, Inc., q.
Plastic Age Sales, Inc., q.
Plastic Capacitors, Inc., a, b, f, i, j, k, m, n, o, q, v, w.
Pyramid Electric Co., d, e, f, i, j, k, m, n, o, q, s, u.
Q-Circuits, Div.-Etching Co. of Calif. s.
Quality Components, Inc., b.
Radio Condenser Co., r, t, w, x, y, a-1.
*RADIO CORP. OF AMERICA, m, s, t, x.
Radio Frequency Co., Inc., a.
Radio Industries, Inc., a, e, s, w.
Resitron Labs., Inc., z.
San Fernando Electric Mfg., Co., e, f, i, k, m, n, v.
Sangamo Electric Co., b, d, e, f, i, j, l thru o, q, r, v, w.
Ray A. Scharer & Co., v.
Scintilla Div., Bendix Aviation Corp., f, i, l.
Servomechanisms, Inc., a.
W.S. Shamban & Co., s.
Solar Mfg. Corp., a, e, f, j, m, y.
Southern Electronics Corp., c, f, j, n, q, r, s, v, a-1
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co., v.
Sprague Electric Co., a, c thru f, i, thru o, q, s, u, v, w.
Stackpole Carbon Co., b, f.
Standard Condenser Corp., f, j, m, n, o, q, r, s.
Standard Pressed Steel Co., a, d, m, u.
H. W. Sullivan Ltd., c, f, l, r, a-1.
Taffet Electronics, Inc., a-1.
Transistor Electronics, Inc., u.
Technical Apparatus Builders, d, f, i thru l, o, z.
Tetrafluor, Inc., q, v.
Texas Capacitor Co., Div.-K-C-K Corp., f, m, n, q, r, v.
Texas Instruments Inc., d, f, i, j, m, n, r, s, u.
Thermon Mfg. Co., i, w.
Transitron Electronic Corp.
Underwood Electric & Mfg. Co., Inc., l, y.
Union Asbestos & Rubber Co., v.
United Electronic Mfg. Corp., d.
United Mineral & Chemical Corp
U. S. Semiconductor Products Div.-United Industrial Corp., u.
Universal Condenser Co., c, e, f, i, j, k, m, n, o, q, r, s, v.
Vacap Corp., z, a-1.
Vitramon, Inc., a, e, f, i, m, r, s.
Waterbury Companies, Inc., q.
Westinghouse Electric Corp., f, j.

CAPS, TUBE

Alden Products Co.
American Brass Co., The
Clover Industries, Inc.
Collins Mfg. Corp.
General Electric Co., Lamp Metals & Components Dept.
Hobson Brothers, Inc.
E. F. Johnson Co.
Kling Metal Spinning & Stamping Co.
James Millen Mfg. Co. Inc.
Moeller Mfg. Co. Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Ohlson Empire Inc
Paul & Beekman, Inc.
*RADIO CORP. OF AMERICA
Sillcocks-Miller Co.
Tetrafluor, Inc.
Texstar Plastics, Div.-The Texstar Corp.
United Mineral & Chemical Corp.
Warren Components, Div.-El-Tronics, Inc.
Whitehead Stamping Co.

CARBIDES

American Potash & Chemical Corp., National Northern Div.
Bergen Carbide Co.
Bram Metallurgical Chemical Co.
Carbone Corp., The
Carborundum Co., The
City Chemical Corp.
Custom Tool & Mfg. Co.
Delta Chemical Works, Inc.
Firth Sterling Inc.
B. H. Hadley, Inc.
Hughes Tool Co., Aircraft Div.
Kennametal Inc.
NUMEC Nuclear Materials & Equipment Corp.
National Cylinder Gas, Div.-Chemetron Corp.
Norton Co., New Products Dept.
Precision Lapping Co. Inc.
Semi-Elements, Inc.
Sintercast Div., Chromalloy Corp.
Sylvania-Corning Nuclear Corp.
TRG, Inc.
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Vascoloy-Ramet Corp.

CARBON

Arcair Co.
Carbone Corp., The
Custom Tool & Mfg. Co.
Delta Chemical Works, Inc.
Graphite Metallizing Corp.
Great Lakes Carbon Corp.-Electrode Div.
Helwig Carbon Products, Inc.
Morganite, Inc.
National Carbon Co., Div.-Union Carbide Corp.
Ohio Carbon Co., The
St. Marys Carbon Co.
Semi-Elements, Inc.
Southwest Research Institute
Stackpole Carbon Co.
Superior Carbon Products Inc.
United Carbon Products Co.
United States Graphite Co., The, Div.-The Wickes Corp.

CARTRIDGES, STARTER

American Rocket Co.
Amoco Chemicals Corp.
Armament Div.-Universal Match Corp.
Bendix Aviation Corp.
Bermite Powder Co.
Essex Mfg. Co., Inc.
Gabriel Co., Rocket Power-Talco
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Olin Mathieson Chemical Corp., N. Y.
Olin Mathieson Chemical Corp.,Winchester-Western Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation

CASES

a. Diode & Transistor
b. Instrument & Meter
c. Portable
d. Transformer
e. Tube

Aerocal Div., Aeronca Mfg. Corp., b, c.
Allen Electric & Equipment Co., b.
Alloys Unlimited Inc., a.
American Aerophysics Corp., c.
American Aluminum Co., b, d, e.
American Brass Co., The, b, d, e.
American Machine & Foundry Co., Government Products, N. Y., a thru d.
Anchor Metal Spinning Co., The, b, c.
Artisan Metal Works Co., c, d.
Associated Engineers, Inc., a, b, d.
Bendix Aviation Corp., a.

*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
J. F. Bingham Mfg. Co., b.
S. Blickman, Inc., c.
Brook Molding Corp., a.
Brooks & Perkins, Inc., b, c.
Bud Radio, Inc., b, c.
Calcar Corp., b, c.
California Stamping & Mfg. Co., c.
Conrad & Moser, b.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., a thru e.
Corning Glass Works, a.
Cutler Metal Products Co., b, c.
C. R. Daniels, Inc., c.
Eisler Engrg. Co., Inc., d.
Elzee Metal Products Co., Inc.
Emerson Plastics Corp., d.
Falstrom Co., b, c, d.
Farwell Metal Fabricating, b, c, d.
General Metal Products Co., b.
Goldsman, b.
Halliburton, Inc., Mfg. Div., b, c.
Hermetic Seal Corp., a, e.
Homalite Corp., The, b.
International Steel Co., c, d.
Keystone Products Co., d.
Kirk & Blum Mfg. Co., The, b.
Kling Metal Spinning & Stamping Co., d, e.
H. Koch & Sons, b, c.
*LAVELLE AIRCRAFT CORP., c.
Lunn Laminates, Inc., b, c.
*MARTIN CO., THE, DENVER DIV., b, c.
Mitronics Inc., a.
Motorola, Inc., a.
Muckle Mfg. Co., b, c.
National Vulcanized Fibre Co., b, c.
Norrich Plastics Corp., a, c, d, e.
Norrich Screw Machine Products, a, e.
Northeast Metals Industries, Inc., b, c.
Olympic Plastics Co., Inc., b, c.
P. B. R. Mfg. Co., b, c.
Pneumafil Corp., d.
Premier Metal Products Co., b.
Prewitt Aircraft Co., c.
Pry Welding & Mfg., Inc., b, c.
REF Mfg. Corp., c.
*RADIO CORP. OF AMERICA, a, e.
Rimak, Inc., a thru e.
Milton Ross Metals Co., The, a, d.
Sillcocks-Miller Co., c.
Sinclair Mfg. Co., a.
Skydyne, Inc., b, c.
TA Mfg. Corp., b.
Taffet Electronics, Inc., b.
Technical Materiel Corp., The, c.
Thor Ceramics, Inc., e.
Unified Industries, Inc., a thru e.
Waco Aircraft Co., b.
Warren Components, Div.-El-Tronics, Inc., a.
Wesrep Corp., d.
Zippertubing Co., The, e.

CASINGS

ACF Industries Inc.
A&P Metal Products Mfg. Corp.
Aerial Machine & Tool Corp.
Bethlehem Steel Co.
Kaiser Fleetwings, Inc.
Kirk & Blum Mfg. Co., The
Lukens Steel Co.
M & Q Plastic Products
*MINNESOTA MINING & MFG. CO.
Norrich Plastics Corp.
Ravenna Metal Products, Div.-Standard Screw Co.
Sillcocks-Miller Co.
Springfield Brass Co., Inc.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
United States Rubber Co.
United States Steel Corp.
Western Iron & Foundry Co., Inc.

CASTERS

Aircraft Tools, Inc.
Albion Industries, Inc.
Amco Engrg. Co.
Bassick Co., The, Div.-Stewart-Warner
Albert H. Cayne Equipment Corp.
Colson Corp., The
Darnell Corp. Ltd.
Fairbanks Co., The
Faultless Caster Corp.
Magnesium Co. of America
Nutting Truck & Caster Co.
Rapids-Standard Co., Inc., The
Regent Jack Mfg. Co., Inc.
Stewart-Warner Corp., Alemite Div.
United Supply Co.
Welded Construction Inc.

CASTINGS

a. Centrifugal, Ferrous
b. Centrifugal, Non-Ferrous
c. Die, Ferrous
d. Die, Non-Ferrous
e. Precision, Ferrous
f. Precision, Non-Ferrous
g. Sand, Ferrous
h. Sand, Non-Ferrous

ABA Tool & Die Co., c thru h.
ACF Industries Inc., d, e, g.
Acme Brass Foundry Co. of San Antonio, Inc., h.
Aero Mfg. & Mach. Co., Inc.
Alloys Unlimited Inc., f.
Aluminum Alloys Corp., f, h.
Aluminum Co. of America, d, f, h.
American Agile Corp., b.
American Brake Shoe Co., a, b, e thru h.
American Brake Shoe Co., Engineered Casting Div., e thru h.
American Car & Foundry Div., ACF Industries, Inc., g.
Ampco Metal, Inc., b, h.

Artra Aluminum Foundry & Mfg. Co. Inc., h.
Arwood Corp., e, f.
Austenal Co., Div.-Howe Sound Co., e, f.
Austenal Co., Div.-Howe Sound Co.-Microcast Products, e, f.
Auto Specialties Mfg. Co., Inc., e, g.
Avondale Marine Ways, Inc., g, h.
Badger Die Casting Corp., d.
Morris Bean & Co., e, f.
Bearium Metals Corp., h.
Bendix Aviation Corp., f.

*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., h.
Bethlehem Steel Co., g, h.
Carl H. Biggs Co., f.
Blackstone Corp., g.
E. W. Bliss Co., g.
Bohn Aluminum & Brass Corp., f.
Bridgeport Brass Co., d.
Budd Co., The, g.
Bunting Brass & Bronze Co., The, b, h.
California Stamping & Mfg. Co., g, h.
Casting Engineers Div., Consolidated Foundries & Mfg. Corp., e, f.
Chambersburg Engrg. Co., g.
Chance Vought Aircraft, Inc., c, d, g, h.
Clark Equipment Co., g, h.
Collins Mfg. Corp., c thru f.
Colonial Aircraft Corp., h.
Crane Co., Special Products Div., g.
Curtiss-Wright Corp., Metals Processing Div., a, e, g.
Curtiss-Wright Corp.-Wright Aeronautical Div., f, h.
Dalton Foundries Inc., The, e, g.
Decatur Casting Co., The, g.
Derby Castings Co., The, a, b, h.
Division Lead Co., b, d, h.
Dollin Corp., d.
Double E Products Co., f.
Dow Chemical Co., The, d, f, h.
Electric Autolite Co., The, d, g.
Electric Steel Foundry Co., a, e, g.
Engineered Precision Casting Co., e, f.
FXR, Inc., f.
Falcon Machine & Tool Co., e, f.
Gar Products Corp., f, h.
General Alloys Co., a, g.
General Communication Co., c, d.
Gorham Electronics-Div.-Gorham Mfg. Co., b, f, h.
Gries Reproducer Corp., d, f.
Hamilton Foundry Inc., g.
Haynes Stellite Co., Div.-Union Carbide Corp., e, f, h.
Hills-Mc Canna Co., h.
Hitchiner Mfg. Co., Inc., e, f.
Huntington Alloy Products Div.-The International Nickel Co., Inc., b, f, h.
Investment Casting Co., e, f.
Jan Hardware Mfg. Co., Inc., c thru h.
Janco Corp., b.
Jessop Steel Co., g.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., a, b, e, f.
Kwikset Powdered Metal Products, e, f.
Light Metals, Inc., d, h.
Lindgren Foundry Co., g.
Link-Belt Co., g, h.
Magline Inc., d, h.
Mc Pherson Corp., e, f, h.
Metals Div., Kelsey-Hayes Co., b.
Misco Precision Casting Co., e, f.
Monarch Governor Co., d.
C. A. Morgren Co., d.
Napier Engines Inc., e, f.
Nelson Electric Mfg. Co., g, h.
Nilsen Mfg. Co., a, b, e, f.
Nordberg Mfg. Co., g.
Ohio Precision Castings, Inc., f, h.
Ohio Steel Foundry Co., The, a, g.
R. H. Osbrink Mfg. Co., f, h.
Perfecto Cast, e, g.
Pettibone Mulliken Corp., g.
Precision Castings, Inc., b, f, h.
Precision Metalsmiths, Inc., f.
Randall Graphite Bearings, Inc., b, f, h.
Ravenna Metal Products, Div.-Standard Screw Co., a thru h.
Rimak, Inc., c.
Joseph T. Ryerson & Son, Inc., a.
Saginaw Bearing Co., b, e, h.
Roy A. Scharer & Co., a, b, h.
Scovill Mfg. Co., h.
Shaw Process Development Corp., Div.-British Industries Corp., e, f.
Shenango Furnace Co., The, Centrifugally Cast Products Div., a, b.
Sims Castings Corp., f.
Solon Foundry, Inc., h.
Springfield Brass Co., Inc., b, f, h.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp., g.
Stearns-Roger Mfg. Co., The, g.
Superior Carbon Products Inc., c thru f.
Swayne, Robinson & Co., e thru h.
T. O. D. Mfg. Co. Inc., c, d, e.
Techni-Cast Corp., b.
Arthur Tickle Engrg. Works, Inc., f, h.
Titan Metal Mfg. Co., Div.-Cerro de Pasco Corp., d.
True Alloys Inc., b, h.
United Shoe Machinery Corp., e thru h.
U. S. Pipe & Foundry Co., Steel & Tubes Div., a, b.
Vascoloy-Ramet Corp., a, b, e, f.
Vilter Mfg. Co., The, g.
Wai Met Alloys Co., g, h.
Waukesha Foundry Co., g, h.
Wayne Foundry & Stamping Co., h.
Wellman Bronze & Aluminum Co., h.
Western Automatic Machine Screw Co., Div.-Standard Screw Co., g, h.
Western Iron & Foundry Co., Inc., c, g.
Westinghouse Electric Corp., c thru f.
Wheel Craft Inc., b, f.
Wisconsin Aluminum Foundry Co., Inc., f, h.
Worthington Corp., g, h.

CATAPULTS

ACF Industries Inc.
All American Engrg. Co.
Arnolt Corp.
Beacon Steel Corp.
E. W. Bliss Co.
A. M. Byers Co.
Colonial Aircraft Corp.
Gabriel Co., Rocket Power-Talco
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Link-Belt Co.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lofstrand Co., The
Mechanics Research Div., American Machine & Foundry Co.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Southwest Research Institute
Thiokol Chemical Corp., Hunter-Bristol Div.
Van Zelm Associates, Inc.
Weatherhead Co., The
Westinghouse Electric Corp.
Young Development Div., Hercules Powder Co.

CATHODES

Associated Engrg. & Mfg. Corp.
Belmont Smelting & Refining Works, Inc.
J. Bishop & Co., Platinum Works
Engelhard Industries, Inc.
Hammett-Mercury-Rex Div.
Huyck Systems Co.
*RADIO CORP. OF AMERICA
Research Development Mfg. Inc.
Stromberg-Carlson, San Diego, General Dynamic Corp.
Superior Tube Co.
Thermionic Products Co.

CELLS, PHOTOELECTRIC

Clairex Corp.
Continental Electric Co.
Eastman Kodak Co.
Electron-Radar Products
General Electric Co., Apparatus Sales Div.
Hoffman Electronics Corp., Semiconductor Div.
Infrared Industries, Inc.
International Rectifier Corp.
JEM Electronics Corp.
Lockheed Aircraft Corp., Missiles & Space Div.
*RADIO CORP. OF AMERICA
Resitron Labs., Inc.
Special Products Dept., Melpar, Inc.
Sundstrand Turbo
Transitron Electronic Corp.
Vickers Inc., Electric Products Div.
Wells Industries Corp.

CELLS, STANDARD

Leeds & Northrup Co.
Muirhead Instruments Inc.

CEMENT

a. Asbestos
b. Pipe-Joint
c. Plastic
d. Rivet
e. Rubber
f. Rubber-to-Metal
g. Wood

Allied Plastics Supply Corp., b, c.
American Latex Products Corp., a thru g.
American Products Mfg. Co., e, f, g.
Anchor Packing Co., The, a, b, c, e.
Armstrong Cork Co., c, e, f, g.
Avondale Co., The, e, f, g.
Carl H. Biggs Co., c, f, g.
Bjorksten Research Labs. for Industry, Inc.
Bloomingdale Rubber Co., f.
Borden Chemical Co., b, c, e, f, g.
Cadillac Plastic & Chemical Co., c.
Carborundum Co., The
Connecticut Hard Rubber Co., The, e, f.
DBM Research Corp., c.
Dennis Chemical Co., g.
E. I. Du Pont de Nemours & Co. Inc., c, e, f, g.
Eagle-Picher Co., The, a.
Eco Engr. Co., b.
Emerson & Cuming, Inc., c.
Epoxy Products, Inc., Div.-Joseph Waldman & Sons, c.
L. W. Ferdinand & Co. Inc., c, e, f, g.
Furane Plastics, Inc., b, c, f, g.
G-C Electronics Co., c, f.
B. F. Goodrich Aviation Products, e, f.
B. F. Goodrich Industrial Products Co., c, e, f, g.
Goodyear Tire & Rubber Co., The, Aviation Products Div., e.
Hastings Plastics, Inc., c, f.
R. M. Hollingshead Corp., b, c, e.
Homalite Corp., The, c.
Horsey, Robson & Co. Inc., c.
Johns-Manville Sales Corp., a.
Krylon, Inc., g.
Lam-Ply, Inc., f.
Lamtex Industries Inc., c.
Maas & Waldstein Co., c.
Marblette Corp., The, c.
*MINNESOTA MINING & MFG. CO., c thru g.
C. P. Moyen Co., c, e, f, g.
New England Tape Co., Div.-United-Carr Fastener Corp., c.
Norrich Plastics Corp., c thru f.
Nureco, Inc., c, f.
Parker Fittings & Hose Div., Parker-Hannifin Corp., b.
Permacel, e, f, g.
Permatex Co., Inc., b, c, e, f.
Raybestos-Manhattan, Inc., c, e, f.
Ren Plastics, Inc., c.
Roberts Toledo Rubber Co., The, e, f.
Rubbercraft Corp. of California, e, f.
Sauereisen Cements Co., a, b, c, e, f, g.
Roy A. Scharer & Co., e, f.
Topper Mfg. Co., Inc., c, e, f, g.
U B S Chemical Co., Div.-A. E. Staley Mfg. Co., a, c, e, f.
Union Asbestos & Rubber Co., a.
United Shoe Machinery Corp., e.
United States Plywood Corp., g.
United States Rubber Co., e, f.
United States Steel Corp.
X-Pando Corp., b.
Xylos Rubber Co., Div.-The Firestone Tire & Rubber Co., c, e, f, g.
Zophar Mills Inc., a, b, c.

CERAMICS

Alite Div., U. S. Stoneware Co.
Aluminum Co. of America
American Feldmuehle Corp.
American Lava Corp.
Avco Corp.-Research & Advanced Development Div.
B G Corp., The
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bergen Carbide Co.
Bermite Powder Co.
Bettinger Corp.
Birnbach Radio Co., Inc.
Bjorksten Research Labs. for Industry, Inc.
Carborundum Co., The
Carborundum Co., Latrobe Plant, Refractories Div.
Carborundum Co., Refractories Div.
Centralab, Div.-Globe-Union, Inc.
*CONSOLIDATED ELECTRODYNAMICS CORP.
Corning Glass Works
Curtiss-Wright Corp., Santa Barbara Div.
Diamonite Products Mfg. Co.
Double E Products Co.
Du-Co Ceramics Co.
Duramic Products, Inc.
Edo Corp.
Electric Autolite Co., The
Emerson & Cuming, Inc.
Erie Resistor Corp.
Ferroxcube Corp. of America
Frenchtown Porcelain Co.
General Ceramics Div., Indiana General Corp.
General Electric Co., Insulator Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Magnetic Corp.
Gladding, McBean & Co.
W. R. Grace & Co., Davison Chem. Div., Nuclear Reactor Mat. Plant

Gulton Industries, Inc
Harbison-Walker Refractories Co.
Hermetic Seal Corp. & Thermal Controls, Inc.
Hughes Tool Co., Aircraft Div.
Isolantite Mfg. Corp.
M. Kirchberger & Co., Inc.
Lapp Insulator Co., Inc., Radio Specialties Div.
Metal Carbides Corp.
Metallizing Co. of Los Angeles Inc.
Mica Fabricating Co.
James Millen Mfg. Co. Inc.
*MINNESOTA MINING & MFG. CO.
Mitronics Inc.
Morganite, Inc.
Motorola, Inc.
NUMEC-Nuclear Materials & Equipment Corp.
National Beryllia Corp.
National Ceramic Co.
Norton Co., New Products Dept.
Ohlson Empire Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pittsburgh Corning Corp.
Quartzite Processing Inc.
*RADIO CORP. OF AMERICA
Refractories Div., The Ferro Corp., Louthan Plant
Rogers Corp.
Saxonburg Ceramics, Inc.
Sheridan-Gray, Inc.
Sintercast Div., Chromalloy Corp.
Solar Mfg. Corp.
Southwest Research Institute
Star Porcelain Co., The
Superior Steatite & Ceramic Corp.
Thor Ceramics, Inc.
Topper Mfg. Co., Inc.
U. S. Sonics Corp.
Vascoloy-Ramet Corp.
Western Gold & Platinum Co
Westinghouse Electric Corp.
Zirconium Corp. of America

CESIUM

American Potash & Chemical Corp.
American Potash & Chemical Corp., National Northern Div.
Bio-Rad Labs.
Bram Metallurgical Chemical Co.
Budd Co., The
City Chemical Corp.
Delta Chemical Works, Inc.
Instrument Div., The Budd Co.
Semi-Elements, Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

CHAIN, SMALL DRIVE

Bead Chain Mfg. Co., The
Boston Gear Works
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Diamond Chain Co. Inc.
Dodge Mfg. Corp.
Lear, Inc
Link-Belt Co.
Robot Industries Inc.
Sierra Engrg. Co.

CHAINS

Acme Chain Corp.
American Chain Div., American Chain & Cable Co., Inc.
Bead Chain Mfg. Co., The
Campbell Chain Co.
Columbus Mc Kinnon Chain Corp.
Dodge Mfg. Corp
Eastern Rotorcraft Corp.
Electric Steel Foundry Co.
Jeffrey Mfg. Co., The
Link-Belt Co.
McKay Co., The
National Screw & Mfg. Co., The

CHAMBERS

a. Acoustic
b. Alpha, Nuclear
c. Environmental
d. Ionization
e. Shielded Screen
f. Temperature & Humidity
g. Test

Ace Engrg. & Machine Co., Inc., **c, e.**
Aero-Test Equipment Co., Inc., **c, f, g.**
Aerotest Laboratories, Inc., **g.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **c.**
American Car & Foundry Div., ACF Industries, Inc., **g.**
American Instrument Co., Inc., **c, f, g.**
American Latex Products Corp., **c, f.**
American Machine & Foundry Co., **g.**
American Research Corp., **c, f, g.**
Anchor Specialty Mfg. Co. Inc., **c, f, g.**
Applied Physics Corp., **d.**
Associated Testing Labs., Inc., **a, c, f, g.**
Auto-Control Labs. Inc., **c, f, g.**
Beacon Steel Corp., **a, c, e, f, g.**
Belmar Wheel & Machine Co., Inc., **e, f, g.**
Bendix Aviation Corp., Cincinnati Div., **d.**
CBS Laboratories, Div.-Columbia Broadcasting System, **a.**
Chance Vought Aircraft, Inc., **e, f.**
Chicago Bridge & Iron Co., **c, f, g.**
Cincinnati Sub Zero Products, **c, f, g.**
Conrad, Inc., **c, f, g.**
Consolidated Vacuum Corp., **c.**
Cryogenerators, Inc., **c, f.**
Daystrom, Inc., Military Electronics Div., **a.**
Dean Products, Inc., **c.**
Development Engrg. Co., Inc., **c, f, g.**
Double E Products Co., **c, e, g.**
Emerson & Cuming, Inc., **a, e.**
Emhart Mfg. Co., Maxim Div., **a.**
Enfab Inc., **a.**
Engrg. Specialties, **d.**
Flight Support, Inc., **g.**
Frick Co., **c thru f.**
Garlock Packing Co.
General Electric Co., Apparatus Sales Div., **d.**
General Electric Co., X-Ray Dept., **d.**
General Vacuum Corp., **c.**
Guardite Co., Div.-American-Marietta Co., **c, f, g.**
Gyrex Corp., The, **c.**
Hahn & Clay, **g.**
Harris Refrigeration Co., **c, f, g.**
Haskel Engrg. & Supply Co., **g.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., **c, d, f, g.**
Highland Engrg. Co., **g.**
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., **c, g.**
I-L-S Instrument Div., The Meriam Instrument Co., **g.**
Ideal-Aerosmith, Div.-Royal Industries, Inc., **g.**
Industrial Acoustics Co., Inc., **a.**
Industrial Filter & Pump Mfg. Co., **c, f, g.**
International Electronic Research Corp., **d.**
International Steel Co., **a thru g.**
Interstate Electronics Corp., **b, d.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **b, d.**
Jack & Heintz, Inc., **f.**
Jamison Cold Storage Door Co., **a, c, f, g.**
Janke & Co. Inc., **a, c, e, g.**
Kahn & Co., Inc., **g.**
Kaiser Fleetwings, Inc., **g.**
James Knights Co., The, **f.**
Magee-Bralla & Associates, **c.**
*MARTIN CO., THE, DENVER DIV., **a, c, e, f, g.**
McMillan Companies, The, **a, e, g.**
Mechanics Research Div., American Machine & Foundry Co., **c.**
Missimers Inc., **c, f, g.**
John Mohr & Sons, **c.**
Murphy & Miller Inc., **c, f, g.**
Nooter Corp., **g.**
Northeast Metals Industries, Inc., **f, g.**
Northrop Corp., **c, f, g.**
Nuclear Corp. of America, **b, d.**
Nuclear Development Corp. of America, **a, e.**
Nuclear Development Lab., **d.**
Nuclear Measurements Corp., **b, d.**
Nuclear-Chicago Corp., **b, d.**
Ohmart Corp., The, **b, d.**
Opelika Welding, Machine & Supply Inc., **c, g.**
Owens-Corning Fiberglas Corp., **a.**
Patterson Moos Research, Div.-Leesona Corp., **d.**
Pittsburgh Corning Corp., **a, f, g.**
Portland Copper & Tank Works Inc., **c, f.**
*RADIO CORP. OF AMERICA, **a thru g.**
Research, Inc., **c, f, g.**
Rimak, Inc., **c, e.**
Rotock Inc., **g.**
Rototest Labs., Inc., **a.**
Schaevitz Engrg., **c.**
Scientific Engrg. Labs., Inc., **c.**
Shielding, Inc., **a, c, e, f, g.**
South Wind Div., Stewart Warner Corp., **g.**
Southwest Research Institute, **a.**
State Testing Laboratory Inc., **g.**
Statham Development Corp., **c, f, g.**
Statham Instruments, Inc., **c, f, g.**
F. J. Stokes Corp., **c, g.**
Stromberg-Carlson Div.-General Dynamics Corp., **a.**
Swift Textile Metalizing & Laminating Corp., **e.**
Temperature Engrg. Corp., **c, f, g.**
Tenney Engrg., Inc., **c, f, g.**
Texstar Plastics, Div.-The Texstar Corp., **g.**
Thermon Mfg. Co., **c, f.**
Topatron, Inc., **e, g.**
Uni-Flex Mfg. & Engrg. Inc., **c.**
United States Testing Co., Inc., **c, f, g.**
Universal Dynamics Corp., **f.**
Vacuum Specialties Co., Inc., **b, c, f, g.**
Victoreen Instrument Co., **b.**
Warren Components, Div.-El-Tronics, Inc., **f.**
Webber Engrg. Corp., **c, f, g**
Webber Mfg. Co., Inc., **c, f, g.**
Zippertubing Co., The, **a, e.**

CHARGES, BATTERY

Allen Electric & Equipment Co.
American Rectifier Corp.
Automatic Switch Co.
Bogue Electric Mfg. Co.
Carol Electronics Corp.
Chatham Electronics Div.-Tung-Sol Electric Inc.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Consolidated Diesel Electric Corp.
Cornell-Dubilier Electric Corp.
Joe Davidson & Associates
Deltron Inc.
Djeco, Div.-Djordjevic Engrg. Co.
Dresser Electric Co.
Electric Autolite Co., The
*EQUIPMENT DIV., RAYTHEON CO.
Esso Standard, Div.-Humble Oil & Refining Co.
Fisher Scientific Co., Maryland
John Fluke Mfg. Co., Inc.
Gates Electronic Co.
General Electric Co., Apparatus Sales Div.
Gulton Industries, Inc.
Hammett-Mercury-Rex Div.
Hathaway Instruments, Inc.
Hobart Brothers Co.
Hoffman Electronics Corp., Semiconductor Div.
Hol-Gar Mfg. Corp.
Homelite, Div.-Textron Inc.
ITI Electronics, Inc.
*INTERELECTRONICS CORP.
Jeta, Inc.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Lincoln Electric Co., The
Macarr, Inc.
Madigan Corp.
P. R. Mallory & Co. Inc.
*MARTIN CO., THE, DENVER DIV.
Model Rectifier Corp.
J. J. Monaghan Co., Inc.
Motor Appliance Corp.
Motor Generator Corp.
D. W. Onan & Sons Inc.
Opad Electric Co.
Power Supplies Inc.
Radio Development & Research Corp.
Snap-On-Tools Corp.
Sonotone Corp.
Stewart & Stevenson Services, Inc.
Sun Electric Corp., Aeronautical Div.
Technical Apparatus Builders
Telkor, Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.
Westinghouse Electric Corp.
Wickes Engrg. & Construction Co.
Winder Aircraft Corp. of Florida

CHASSIS, CABINET

A&P Metal Products Mfg. Corp.
Aircraft Tools, Inc.
Alden Products Co.
Allen Electric & Equipment Co.
Amco Engrg. Co.
Artisan Metal Works Co
Associated Engineers, Inc.
Basic Tool Industries, Inc
Beacon Steel Corp.
Brooks & Perkins, Inc
Bud Radio, Inc.
Calcar Corp.
California Stamping & Mfg. Co.
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Conrad & Moser
Cutler Metal Products Co.
Doak Aircraft Co. Inc.
Donnelly Mfg. Co.
Eljay Corp.
Elzee Metal Products Co., Inc.
Falstrom Co.
Farwell Metal Fabricating
Fouch Electric Mfg. Co., Inc.
General Metal Products Co.
Gremco, Inc.
Henry & Miller Industries, Inc.
Ludwig Honold Mfg. Co
Jeta, Inc.
Kellett Aircraft Corp.
Kelsey-Hayes Co.
Kirk & Blum Mfg. Co., The
Laminated Shim Co., Inc.
Leemath Inc.
Lofstrand Co., The
R. H. Lynch Mfg. Co.
*MARTIN CO., THE, DENVER DIV.
Meridian Metalcraft, Inc.
Metal Fabricators Corp.

Northeast Metals Industries, Inc.
Piasecki Aircraft Corp.
Pneumafil Corp.
Portland Copper & Tank Works Inc.
Premier Metal Products Co.
Projects Unlimited, Inc.
Pryor Mfg. Co.
REF Mfg. Corp.
*RADIO CORP. OF AMERICA
Rimak, Inc.
Royal Jet, Div.-Royal Industries, Inc.
Sheridan-Gray, Inc.
Southwestern Industrial Electronics Co.
Standard Electronics Div.-Reeves Instrument Corp.
Sun Electric Corp., Aeronautical Div.
Telkor, Inc.
Templet Industries Inc.
Tober Electronic Corp.
Twin Coach Co., Aircraft-Missiles
Twix Mfg. Co., Inc.
Unified Industries, Inc.
United Aircraft Products, Inc.
United States Chemical Milling Corp.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Weber Aircraft Corp.
Wells Industries Corp.
Western Devices Inc.
Westholt Mfg. Inc.
Winder Aircraft Corp. of Florida
Wyco Metal Products
Zero Mfg. Co.

CHASSIS, METAL

A & E Metal Specialties Inc.
A&P Metal Products Mfg. Corp.
Aircraft Tools, Inc.
Alden Products Co.
Allen Electric & Equipment Co.
Amco Engrg. Co.
American Aluminum Co.
Artisan Metal Works Co.
Associated Engineers, Inc.
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Belmar Wheel & Machine Co., Inc.
Brooks & Perkins, Inc.
Bud Radio, Inc.
Calcor Corp.
California Stamping & Mfg. Co.
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Conrad & Moser
Crane Carrier Corp.
Cutler Metal Products Co.
Doak Aircraft Co. Inc.
Doehler-Jarvis Div., National Lead Co.
Donnelly Mfg. Co.
Eljay Corp.
Elzee Metal Products Co., Inc.
*EXCELCO DEVELOPMENTS INC.
Falstrom Co.
Farwell Metal Fabricating
Flight Refueling, Inc.
Fouch Electric Mfg. Co., Inc.
General Metal Products Co.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Ludwig Honold Mfg. Co.
Jeta, Inc.
Kaiser Fleetwings, Inc.
Kellett Aircraft Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kelsey-Hayes Co.
Kirk & Blum Mfg. Co., The
*LAVELLE AIRCRAFT CORP.
Leemath Inc.
Lofstrand Co., The
R. H. Lynch Mfg. Co.
*MARTIN CO., THE, DENVER DIV.
Meridian Metalcraft, Inc.
Metal Fabricators Corp.
Northeast Metals Industries, Inc.
P. B. R. Mfg. Co.
Parts Engrg. Co., Inc.
Paul & Beekman, Inc.
Piasecki Aircraft Corp.
Pneumafil Corp.
Portland Copper & Tank Works Inc.
Premier Metal Products Co.
Projects Unlimited, Inc.
Pryor Mfg. Co.
REF Mfg. Corp.
*RADIO CORP. OF AMERICA
Rimak, Inc.
Royal Jet, Div.-Royal Industries, Inc.
Sheridan-Gray, Inc.
Skyline Products, Inc.
Southwestern Industrial Electronics Co.
Specialty Electronics Development Corp.
Spincraft, Inc.
Stamping Div.-Rockwell Standard Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Telkor, Inc.
Templet Industries Inc.
Tober Electronic Corp.
Twin Coach Co., Aircraft-Missiles
Twix Mfg. Co., Inc.
Unified Industries, Inc.
United Aircraft Products, Inc.
United States Chemical Milling Corp.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Weber Aircraft Corp.
Wells Industries Corp.
Western Devices Inc.
Westholt Mfg. Inc.
Wickes Engrg. & Construction Co.
Winder Aircraft Corp. of Florida
Wyco Metal Projects
Zero Mfg. Co.

CHECKER, CABLE

Barker Sales Co.
Beacon Steel Corp.
Bendix Aviation Corp.
Briggs Associates, Inc.
Calvert Electronics Inc.
Dale Products, Inc.
Dit-Mco, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
I-L-S Instrument Div., The Meriam Instrument Co.
Intercontinental Dynamics Corp.
Kay Electric Co.
Leemath Inc.
*MARTIN CO., THE, DENVER DIV.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Muirhead Instruments Inc.
George L. Nankervis Co.
Northrop Corp.
Optimized Devices, Inc.
Pacific Automation Products, Inc.
*RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY
Sierra Electronic Corp., Div.-Philco Corp.
Special Products Dept., Melpar, Inc.
Specialty Electronics Development Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Sunshine Scientific Instrument
Technical Electronics Co., Div.-Consolidated Electronic Industries
Wickes Engrg. & Construction Co.

CHECKERS, CATHODE RAY TUBE

Calvert Electronics Inc.
Hammett-Mercury-Rex Div.
*MARTIN CO., THE, DENVER DIV.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Paco Electronics Co., Inc.
Pioneer Industries Div., Almar-York Co. Inc.
*RADIO CORP. OF AMERICA

CHECKERS, CRYSTAL RECTIFIER

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Calvert Electronics Inc.
General Radio Co.
*MARTIN CO., THE, DENVER DIV.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Motorola, Inc.
Munston Electronic Mfg. Corp.
Paco Electronics Co., Inc.
*RADIO CORP. OF AMERICA

CHECKERS, KLYSTRON TUBE

Calvert Electronics Inc.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Paco Electronics Co., Inc.
*RADIO CORP. OF AMERICA
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.

CHEMICALS

a. Dehumidifying
b. Electroplating
c. Radioactive
d. Tube
e. Wire Stripper

Allied Chemical Corp., General Chemical Div., **b, d.**
Allied Research Products, Inc., **b.**
Aluminum Co. of America, **a.**
American Oil & Supply Co., **a, b.**
American Potash & Chemical Corp., National Northern Div., **c.**
American Smelting & Refining Co., **b.**
Anderson Chemical Co., Div.-Stauffer Chemical Co.
Antara Chemicals, Div.-General Aniline & Film Corp., **b.**
Armour Industrial Chemical Co.
Associated Engrg. & Mfg. Corp.
J. T. Baker Chemical Co., **c, d.**
Barco Chemical Products Co., **b, d.**
Barium & Chemicals, Inc., **a, b, d.**
Becco Chemical Div.-Food Machinery & Chemical Corp., **b.**
Better Finishes & Coatings Inc., **b.**
Bio-Rad Labs., **c.**
J. Bishop & Co., Platinum Works, **b.**
Bjorksten Research Labs. for Industry, Inc.
Budd Co., The, **c.**
Callery Chemical Co.
City Chemical Corp., **a, b.**
Clarkson Labs., Inc., The, **b.**
Commercial Services Co., Inc., **a.**
Cowles Chemical Co., **b.**
DBM Research Corp., **a.**
Delta Chemical Works, Inc., **a thru e.**
Division Lead Co., **e.**
Dow Chemical Co., The, **a.**
Driaire, Inc., **a.**
E. I. Du Pont de Nemours & Co. Inc., **b.**
Enthone Inc., **b, e.**
Fidelity Chemical Products Corp., **b, d, e.**
Fisher Scientific Co., **b.**
Fisher Scientific Co., Maryland
Food Machinery & Chemical Corp.-Chemical & Plastics Div.
Food Machinery & Chemical Corp.-Dapon Dept.
Food Machinery & Chemical Corp.-Epoxy Dept.
Food Machinery & Chemical Corp.-Mineral Products Div.
Foote Mineral Co., **a.**
General American Transportation Corp., **b.**
General Electric Co., Lamp Metals & Components Dept., **d.**
W. R. Grace & Co., Davison Chem. Div., Nuclear Reactor Mat. Plant, **c.**
Hanson-Van Winkle-Munning Co., **b.**
Hercules Powder Co., Chemical Propulsion Div.
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **c.**
Kelite Corp.
Lea Mfg. Co., The, **b.**
Lithium Corp. of America Inc., The Fulton-Irgon Div., **a.**
London Chemical Co., Inc., **e.**
Merix Chemical Co., **a.**
Metal Hydrides Inc., **a.**
Metal & Thermit Corp., **b.**
*MINNESOTA MINING & MFG. CO., **c.**
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
NUMEC-Nuclear Materials & Equipment Corp., **c.**
Nuclear-Chicago Corp., **c.**
Olin Mathieson Chemical Corp., N. Y. **b, d, e.**
Reynolds Metals Co., **a.**
Robbins Aviation, Inc., **a.**
Trinity Equipment Corp., **a.**
Trio Chemical Works, Inc., **a.**
Turco Products, Inc.
United Mineral & Chemical Corp., **a.**
United States Radium Corp., **c.**
Universal Dynamics Corp., **a.**
Var-Lac-Oid Chemical Co., **b, d.**
Wells Industries Corp., **a.**
Wyandotte Chemicals Corp., **b.**

CHOKES

ACDC Electronics, Inc.
ADC Inc.
AMP Inc.
Acme Electric Corp.
Aerovox Corp.
Aladdin Electronics, Div.-Aladdin Industries Inc.
American Rectifier Corp.
Arnold Magnetics Corp.
Barwood Electronics Inc.
Bendix Aviation Corp.
S. Blickman, Inc.
Bogue Electric Mfg. Co.
Bud Radio, Inc.
Caledonia Electronics & Transformer Corp.
Central Transformer Co.
Chicago Electronic Engrg. Co., Inc.
Chicago Standard Transformer Corp.
Coil Co. of America
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Daystrom, Inc., Military Electronics Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Delevan Electronics Corp.
Double E Products Co.
Electronic Transformer Co., Inc.

***EQUIPMENT DIV., RAYTHEON CO.**
Fisher Engrg., Inc.
Forbes & Wagner, Inc.
Fugle-Miller Labs, Inc.
Gates Electronic Co.
Genistron, Inc.
Paul E. Gerst & Co.
Donald C. Harder Co.
George E. Harris & Co., Inc.
Induction Heating Corp.
***INTERELECTRONICS CORP.**
James Electronics Inc.
Keystone Products Co.
Langevin Div., The W. L. Maxson Corp.
Lear, Inc.
Magnetic Circuit Elements, Inc.
Mid-West Coil & Transformer Co.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
Sanford Miller Co.
Motorola, Inc.
National Coil Co.
Nytronics, Inc., Essex Electronics Div.
Opad Electric Co.
Ortho Filter Corp.
Penn-East Engrg. Corp.
Permoflux Products Co.
Precise Development Corp.
Radio Development & Research Corp.
Sangamo Electric Co.
Servomechanisms, Inc.
Southwestern Industrial Electronics Co.
Standard Electronics Div.-Reeves Instrument Corp.
Sun Electric Corp., Aeronautical Div.
Superex Electronics Corp.
Technical Apparatus Builders
Telex, Inc.
Torwico Electronics, Inc.
Transformers, Inc.
Tresco, Inc.
Triad Transformer Corp.
Universal Toroid Coil Winding, Inc.
Universal Transistor Products Corp.
Valor Instruments, Inc.
Vanguard Electronics Co.
Varo Mfg. Co., Inc.
Virginia Electronics Co., Inc.
Wahlgren Magnetics, Div.-Marshall Industries
Westinghouse Electric Corp.

CHROMATOGRAPHS

American Instrument Co., Inc.
Bio-Rad Labs.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Fischer & Porter Co.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Gardner Laboratory, Inc.
Hallikainen Instruments
Hamilton Watch Co., Military Products Div.
Jarrell-Ash Co.
Leeds & Northrup Co.
Perkin-Elmer Corp.
Scientific & Process Instruments Div.-Beckman Instruments, Inc.
Southwest Research Institute

CHROMATOGRAPHS, VAPOR PHASE

American Instrument Co., Inc.
Bio-Rad Labs.
Central Scientific Co.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Hallikainen Instruments
Jarrell-Ash Co.
Leeds & Northrup Co.
Perkin-Elmer Corp.
Southwest Research Institute

CHROMIUM

Belmont Smelting & Refining Works, Inc.
Bram Metallurgical Chemical Co.
Chicago Development Corp.
Chromium Corp. of America
City Chemical Corp.
Delta Chemical Works, Inc.
Hughes Tool Co., Aircraft Div.
Metal & Thermit Corp
Southwest Research Institute
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Van der Horst Corp. of America
Vanadium Corp. of America
Var-Lac-Oid Chemical Co.

CHRONOGRAPHS

Bergen Labs., Inc.
M. Ducommun Co
Electro-Medical Lab., Inc.
Epic, Inc.
Garwin, Inc.
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div.
Jardur Aviation Co.
Jardur Import Co.
Herman H. Sticht Co., Inc.

CHRONOMETERS

Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div.
Herman H. Sticht Co., Inc.

CHRONOSCOPES

Presin Co.
Herman H. Sticht Co., Inc.

CIRCUITS

a. Computer, Logic
b. Computer, Packaged
c. Plated
d. Plug-In

ACDC Electronics, Inc., **d.**
ACF Industries Inc.,**a, b, d.**
ACF Electronics Div., ACF Industries Inc., **b.**
Accurate Electronics Corp., **a thru d.**
Adage, Inc., **a, b, c.**
Advance Industries, Inc., **a thru d.**
Aeronca Mfg. Corp.-Aerospace Div., **a, b.**
Alwac Computer, Div.-El-Tronics Inc., **a, b.**
Analogue Controls, Inc., **b.**
Arthur Ansley Mfg. Co., **c, d.**
Avien, Inc., **b.**
E. Bauches S. A., Freeport Engrg. Co., **d.**
Becker Electronics Mfg. Corp., **a, b, d.**
Belock Instrument Corp., **a, b, d.**
Bendix Aviation Corp., **a, b, d.**
Bendix Aviation Corp., Cincinnati Div., **a, b, d.**
Briggs Associates, Inc., **a.**
Broadview Research Corp., **a, b.**
Bruno-New York Industries Corp., **a, b, d.**
Budd Lewyt Electronics, Inc., **a, b, d.**
Burr-Brown Research Corp., **b, d.**
Burton-Rodgers, Inc., **a, b, d.**
CBS Laboratories, Div.-Columbia Broadcasting System, **a.**
CG Electronics Corp., **c, d.**
CGS Labs., Inc., **a.**
C & K Components, Inc., **a, b, d.**
California Plasteck Inc., **c, d.**
Cambridge Thermionic Corp., **b.**
Chalco Engrg. Corp., **b, c, d.**
Chance Vought Aircraft, Inc., **a, b, c.**
Cleveland Metal Specialties Co., Electronics Div., **a, b, d.**
Clevite Ordnance, Div.-Clevite Corp., **a, d.**
Colorado Research Corp., **b, c, d.**
Combined Electronics Inc., **c.**
Computer Control Co., Inc., **a, b.**
Computer Control Co., Inc., Western Div., **a, b.**
Control Circuits Inc., **b, d.**
Control Electronics Co., Inc., **b.**
Croname Inc., **c.**
Curtiss-Wright Corp., Electronics Div., IMI Branch, **d.**
Curtiss-Wright Corp., Santa Barbara Div., **d.**
Daystrom, Inc., Military Electronics Div., **a thru d.**
Daystrom Inc., Pacific Div., **b.**
Delco Radio Div.-General Motors Corp., **a thru d.**
Digitronics Corp., **a, d.**
Djeco, Div.-Djordjevic Engrg. Co., **a.**
Du Kane Corp., **d.**
Dynatronics, Inc., **a, d.**
Eldorado Electronics, **d.**
Electro-Pulse, Inc., **d.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **a thru d.**
Erie Resistor Corp., **a, b, d.**
Fischer & Porter Co., **b.**
Ford Instrument Co., Div.-Sperry Rand Corp., **a thru d.**
Foto-Video Labs., Inc., **d.**
General American Transportation Corp., **c.**
General Electric Co., Ordnance Dept., **a, b.**
General Mills, Inc., **a, b.**
General Radio Co., **b.**
Good Electronic Corp., **e, d.**
Graphik Circuits, Div.-Cinch Mfg. Co., **c, d.**
Gulton Industries, Inc., **a thru d.**
Hammett-Mercury-Rex Div., **a, b.**
George E. Harris & Co., Inc., **c.**
Hathaway Instruments, Inc., **d.**
Hoffman Electronics Corp., Semiconductor Div., **a, d.**
ITT Federal Div., International Telephone & Telegraph Corp., **a, b, d.**
***KEARFOTT DIV., GENERAL PRECISION, INC., b.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **d.**
James Knights Co., The, **d.**
La Pointe Industries Inc., **c.**
Lear, Inc., **a thru d.**
Librascope Div., General Precision, Inc., **a, b, c.**
Litton Industries, Inc., **a, b, c.**
Lockheed Aircraft Corp., Missiles & Space Div., **a, b, c.**
Lytle Corp., **c.**
Madigan Corp., **a thru d.**
***MAGNAVOX CO., THE, a.**
P. R. Mallory & Co. Inc., **d.**
Marquardt Corp., The, **d.**
Metaplast Co., Inc., **c.**
Micro Gee Products, Inc., **a, b, d.**
Milgo Electronic Corp., **a, b, d.**
James Millen Mfg. Co. Inc., **d.**
Modern Design Div.-H. C. Schloer, Inc., **a thru d.**
Motorola, Inc., **a thru d.**
National Co., Inc., **a, b, d.**
Navigation Computer Corp., **a, b, d.**
Northrop Corp., **a, b.**
Packard Bell Computer Corp., **a thru d.**
Packard-Bell Electronics Corp., **a thru d.**
Performance Measurements Co., **d.**
Radiation, Inc., **a.**
Radio Condenser Co., **a, b, d.**
***RADIO CORP. OF AMERICA, a thru d.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, b, d.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **a thru d.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., b, d.**
Reeves Instrument Corp., **b.**
Republic Aviation Corp., Missile Systems Div., **a thru d.**
Rese Engrg., Inc., **a, b, d.**
Milton Ross Metals Co., The. **b, c.**
***SEMICONDUCTOR DIV., RAYTHEON CO., b.**
Servomechanisms, Inc., **a, b, d.**
Sibley Co., The., **a thru d.**
Skiatron Electronics & Television Corp., **a.**
Southwest Research Institute
Southwestern Industrial Electronics Co., **a, b, c.**
Special Products Dept., Melpar, Inc., **a, b, d.**
Sprague Electric Co., **a, b, d.**,
Stewart-Warner Electronics Div., **a, d.**
Superex Electronics Corp., **d.**,
Tap-A-Line Mfg. Co., **d.**
Technical Electronics Co., Div.-Consolidated Electronic Industries, **d.**
Telechrome Mfg. Corp., **a, d.**.
Telectro Industries Corp., **a, d.**
Telex, Inc., **a, b, d.**
Tempo Instrument Inc., **a**
Thompson Ramo Wooldridge Inc., **b.**,
Tingstol Co., **a, c, d.**
Topper Mfg. Co., Inc., **d.**
Transistor Electronics Corp., **a**
U.S. Science Corp., Div.-Topp Industries, Inc., **b, d.**
Universal Transistor Products Corp., **d.**
Valor Instruments, Inc., **b, d.**
Vector Electronic Co., Inc., **d.**
Virginia Electronics Co., Inc., **d.**
Walkirt Co., **a, b, d.**
Wang Labs., Inc., **a thru d.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **d.**
Zacharias Electronics Corp., **a, b, d.**

CIRCUITS-PRINTED, STAMPED, ETCHED

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
A.R.F. Products, Inc.
Accurate Electronics Corp.
Acme Electric Corp.
Adept Industries Inc.
Air Logistics Corp.
Airflyte Electronics Co.
All American Engrg. Co.
Amatom Electric Hardware Co. Inc.
American Printed Circuits Co., Inc.
Arthur Ansley Mfg. Co.
Arnoux Corp
Associated Engineers, Inc.
E. Bauches S.A., Freeport Engrg. Co.
Beech Aircraft Corp.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., York Div.
Bjorksten Research Labs. for Industry, Inc.
Blonder-Tongue Labs. Inc., Special Products Div.
Bo Myte Co., Inc., The
W.H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.,
Burr-Brown Research Corp.
Burton-Rodgers, Inc.
CG Electronics Corp.
California Plasteck Inc.,
Centralab, Div.-Globe-Union, Inc.
Chalco Engrg. Corp.
Chance Vought Aircraft, Inc.

Chemical Micro Milling Co.
Cleveland Metal Specialties Co., Electronics Div .
Clevite Ordnance, Div.-Clevite Corp.
Colorado Research Corp.
Combined Electronics Inc.
Corning Glass Works
Croname Inc.
Curtiss-Wright Corp., Santa Barbara Div.
Dale Products, Inc.
Delco Radio Div.-General Motors Corp.
Electralab Printed Electronics Corp.
Electro Instruments, Inc.
Electronic Circuits
Elektro-Serv Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Farwest Mfg. Div., Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
Gates Radio Co.
Gladding, McBean & Co.
Good Electronic Corp.
B.F. Goodrich Aviation Products
Graphik Circuits, Div.-Cinch Mfg. Co.
Gulton Industries, Inc.
W. & L. E. Gurley
Hansen Electronics Co.
George E. Harris & Co., Inc.
I-L-S Instrument Div., The Meriam Instrument Co.
Joclin Mfg. Co., The
Keil Engrg. Products Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lab. for Electronics, Inc.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
La Pointe Industries Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
Litton Industries, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Lytle Corp.
***MAGNAVOX CO., THE**
Marquardt Corp., The
Mc Donnell Aircraft Corp.
Mechanical Felt & Textiles Co.
***MINNESOTA MINING & MFG. CO.**
Mitronics Inc.
Modern Design Div.-H.C. Schloer, Inc.
Molded Insulation Co.
Motorola, Inc.
Mycalex Corp. Of America
Nameplates Inc..
National Scientific Labs., Inc..
Navigation Computer Corp.,
Northrop Corp.
Owens-Corning Fiberglas Corp.
Packard Bell Computer Corp.
Packard Bell Electronics Corp.
Patterson Moos Research, Div.-Leesona Corp.
Piasecki Aircraft Corp.
Precision Circuits, Inc.
Q-Circuits, Div.-Etching Co. of Calif.
***RADIO CORP. OF AMERICA**
***RADIO CORPORATION OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
***RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Republic Aviation Corp., Missile Systems Div.
Rogers Corp.
Milton Ross Metals Co., The
Sanders Associates, Inc.
Sibley Co., The
Sillcocks-Miller Co.
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Sunair Electronics, Inc.
Superex Electronics Corp.
Synthane Corp.
Taylor Fibre Co.
Telechrome Mfg. Corp.,
Thompson Ramo Wooldridge Inc.
Tingstol Co.
Trepac Corp. of America
Twix Mfg. Co., Inc.
U.S. Science Corp., Div.-Topp Industries, Inc.
United States Chemical Milling Corp.
Voi-Shan Electronics
Zenith Optical Laboratory

CLAMPS

a. Conduit
b. Ground
c. Harness
d. Hose
e. Special
f. Tube
g. Wire Rope

Abbot Screw & Mfg. Co., **e.**
Adel Precision Products, Div.-General Metals Corp., **a, b, c, e.,**
Adel Precision Products of Calif., Div.-General Metals Corp., **a, c, e, f.**
Aero Spares, Inc., **d, f, g.,**
Airhardware, Inc., **a, c, d, f.**
Alden Products Co., **f.**
All Specs Corp., **d, f.**
Aluminum Co. of America, **a.**
Amatom Electronic Hardware Co. Inc., **e.**
American Chain & Cable Co., Inc., **g.**
Anchor Coupling Co. Inc., **d.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **e.**
Associated Engineers, Inc., **c.**
Augat Brothers, Inc., **f.**
Wallace Barnes Div., Associated Spring Corp.
Belmar Wheel & Machine Co., Inc., **b.**
Bergen Wire Rope Co., **g.**
Best Aircraft Corp., **a, b, e, f.**
Birnbach Radio Co., Inc., **f, e, f.**
Birtcher Corp., The, **e, f.**
Blaco Mfg. Co., **b.**
Breeze Corporations, Inc., **d.**
Burklyn Co., **e.**
Burndy Corp., Omation Div., **d, c, g.**
Cal Connector Co., **a.**
California Stamping & Mfg. Co., **d, e, g.**
Cambridge Thermionic Corp., **f.**
Camloc Fastener Corp., **c, e.**
Capewell Mfg. Co., **c, e.**
Carr Fastener Co., Div.-United-Carr Fastener Corp., **d.**
Continental Rubber Works., **d.**
Custom Products Corp., **e.**
D.S.D. Mfg. Co., The, **e.**
George W. Dahl Co., Inc., **f.**
Detroit Stamping Co.
Deutsch Co., The, Electronic Components Div., **a, c.**
Dial Products Co., **e.**
Eaton Mfg. Co., Reliance Div., **d.**
Eljay Corp., **e.**
Essex Mfg. Co., Inc., **a, c thru f.**
FAE Instrument Corp., **e.**
Fidelity Chemical Products Corp., **g.**
Flexible Tubing Corp., **d.**
Foursome Mfg. Co., Inc., **d.**
George K. Garrett Co., Inc., **d.**
Hallett Mfg. Co., **a, b, c, e.**
Harco Labs., Inc., **c, e.**
Haskel Engrg. & Supply Co., **c, d, f.**
Holub Industries, Inc., **a, c, d.**
Hunter Spring Co., Div.-American Machine & Metals, Inc., **c, e.**
Walter J. Hyatt Co., The, **a, d, e, f.**
Illumitronic Engrg. Co., **c.**
Janitrol Aircraft Div.-Midland-Ross Corp., **e, f.**
Walter K. Jaros Aircrafters, **a thru g.**
Joclin Mfg. Co., The, **d, e, f.**
Kickhaefer Mfg. Co., **a, c, e, f.**
Laminated Shim Co., Inc.
Arthur S. La Pine & Co., **e.**
Lincoln Electric Co., The, **b.**
Link-Belt Co.
M&Q Plastic Products, **a, c thru f.**
***MARMAN DIV., AEROQUIP CORP., a, d, e, f.**
***MARTIN CO., THE, DENVER DIV., a thru d.**
James Millen Mfg. Co. Inc., **f.,**
Motorola, Inc., **e.**
North & Judd Mfg. Co., **g.**
Ohlson Empire Inc., **d, f.**
Olympic Plastics Co., Inc., **a, c, e.**
Panduit Corp., **c, f.**
Parker Fittings & Hose Div., Parker-Hannifin Corp., **f.**
Parts Engrg. Co., Inc., **e.**
Paul & Beekman, Inc., **f.**
Peerless Electronics Inc., **e, f.**
Prestole Corp., **e, f, g.**
***RADIO CORP. OF AMERICA, g.**
Rattan Mfg. Co., The, **a, b.**
Remler Co., **f.**
Fred T. Roberts & Co., **a, c thru f.**
Milton Ross Metals Co., The, **c.**
Servicair Co., **a, c.,**
C. Sjoberg & Son, **a, b, c, e.**
Skytronics, Inc., **a, c.**
Specialty Products Corp., **d, e.**
TA Mfg. Corp., **a, b, c, e, f, g.,**
Thomas & Betts Co., Inc., The, **a. ,**
Tinnerman Products, Inc., **a, c thru f.**
Titeflex, Inc., **a, d, e, f.,**
Twix Mfg. Co., Inc., **b thru e.,**
United Supply Co., **c.,**
Victor Tool & Mfg., Inc., **e..**
Western Control Corp., **a.**
Wilcox-Crittenden Div., North & Judd Mfg. Co., **g..**
Winder Aircraft Corp. of Florida, **a, b, c, e.**
Wittek Mfg. Co., **d.,**
Wollam Aircraft & Marine Products Co., **e.**
Zippertubing Co., The, **c, e, f.**

CLEANERS, CONTACT

Amchem Products Inc.
Barco Chemical Products Co.,
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Caig Labs.,
Chlor-Alkali Div.-Food Machinery & Chemical Corp.,
Cincinnati Cleaning & Finishing Machinery
Clarkson Labs., Inc., The.
Cobehn, Inc.
Del's Tumbling Service
Drill Mfg. Co.,
Ed-Berl Products, Inc.
FMC Chlor-Alkali Div.
Fidelity Chemical Products Corp.
Kano Labs.
Kelite Corp.
L&R Mfg. Co.
London Chemical Co., Inc.
Magnus Chemical Co., Inc.
Penetone Co., The
Quietrole Co.
Superex Electronics Corp.
Turco Products, Inc.
Vapor Blast Mfg. Co.
Wyandotte Chemicals Corp.
Wye Industries

CLEANERS, ULTRASONIC

Aircraft Porous Media, Inc.
Bearing Inspection, Inc.
Bendix Aviation Corp.,
Bendix Aviation Corp., Pioneer-Central Div.
Blackstone Corp.
Branson Instruments, Inc..
Cincinnati Cleaning & Finishing Machinery
Circo Equipment Co.
Circo Ultrasonic Corp.
Clarkson Labs., Inc., The
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.,**
Curtiss-Wright Corp., Princeton Div.
Curtiss-Wright Corp., Santa Barbara Div.
Detrex Chemical Industries, Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp., Defense & Engrg. Products Group
General Kinetics Inc.
Gulton Industries, Inc.
L&R Mfg. Co.
London Chemical Co., Inc.
Mc Kenna Labs
Narda Ultrasonics Corp., The
National Ultrasonic Corp.
Penetone Co., The
Phillips Mfg. Co.
Standard Electronics Div.-Reeves Instrument Corp.
Topper Mfg. Co., Inc.
Turco Products, Inc.
Westinghouse Electric Corp.
Wyandotte Chemicals Corp.
Wye Industries

CLINOMETERS

A. Biederman, Inc..
Engis Equipment Co.
Opto-Metric Tools, Inc.
Warren-Knight Co.,

CLIPS

a. Alligator
b. Battery
c. Conduit
d. Crystal Diode
e. Special
f. Spring
g. Test
h. Tube
i. Wire Rope

Abbott Screw & Mfg. Co., **b, f.**
Adel Precision Products of Calif., Div.-General Metals Corp., **c, e.**
Airhardware, Inc., **h.**
Alden Products Co., **h.**
Allen Electric & Equipment Co., **b, e, f, g.**
Alpitec, Inc., **f..**
Amatom Electric Hardware Co. Inc., **a.**
American Chain & Cable Co., Inc., **i.**
Anchor Specialty Mfg. Co. Inc., **e, g.**
Associated Co., Inc., **b.**
Associated Engineers, Inc., **a.**
Associated Spring Corp., Ohio Div., **f.**
Atlee Corp., **e, f, h.**
Augat Brothers, Inc., **b. d, f. h..**

Wallace Barnes Div. Associated Spring Corp., **f.**
Belmar Wheel & Machine Co., Inc.
Bethlehem Steel Co., **i.**
Birnbach Radio Co., Inc., **a, b, f, g.**
Birtcher Corp., The, **d, e, h.**
Burndy Corp., Omation Div., **i.**
Cable Electric Products Inc., **b.**
California Stamping & Mfg. Co., **e.**
Calinoy-Div.-Illinois Tool Works, **e, f.**
Cambridge Thermionic Corp., **b, d.**
Carr Fastener Co., Div.-United-Carr Fastener Corp., **e, f.**
Custom Products Corp., **e.**
E-Z-Hook Test Products, **b, e, g.**
Federal Screw Products Inc., **a, b.**
G-C Electronics Co., **a, b.**
George K. Garrett Co., Inc., **f.**
Gatewood Products, Inc., **e, f.**
Gemex Corp., The, Indsl. Div., **e.**
General Scientific Equipment Co., **b.**
Grayhill, Inc., **g.**
Hobson Brothers, Inc., **f.**
Holub Industries, Inc., **c.**
Hunter Spring Co., Div.-American Machine & Metals, Inc., **e, f.**
Walter J. Hyatt Co., The, **c.**
Industrial Devices, Inc., **g.**
Walter K. Jaros Aircrafters, **h, i.**
Javex Electronics, **a, g.**
Keystone Electronics Corp., **d.**
Kickhaefer Mfg. Co., **c, e, h.**
Laminated Shim Co., Inc., **e.**
James Millen Mfg. Co. Inc., **h.**
Chester Morton Electronics Corp., **a, e, g.**
Mueller Electric Co., **a, b, g.**
New England Spring Mfg. Co., Inc., **f.**
North & Judd Mfg. Co., **i.**
Ohlson Empire Inc., **h, i.**
Parker Fittings & Hose Div., Parker-Hannifin Corp., **h.**
Peerless Electronics Inc., **e, h.**
Prestole Corp., **f, h, i.**
Reliable Spring & Wire Forms Co., **e, f.**
Remler Co., **h.**
Rockwood Sprinkler Co., Div.-The Gamewell Co., **f.**
Rohn Mfg. Co., **i.**
Servicair Co.
Sur-Lok Corp., **e.**,
C. Sjoberg & Son, **c, e.**
Stanley-Judd Div.-The Stanley Works, **f.**
Thomas & Betts Co., Inc., The, **c.**
Thor Ceramics, Inc., **a, e, f.**
Tinnerman Products, Inc., **e, f.**
Vector Electronic Co., Inc., **a, g.**
Victor Tool & Mfg., Inc., **e.**
Waldick Engrg. Co., **e, f, g.**
Warren Components, Div.-El-Tronics, Inc., **h.**
Wasley Products, Inc., **a, b, f, i.**
Western Control Corp., **c.**
Wilcox-Crittenden Div., North & Judd Mfg. Co., **i.**
Winder Aircraft Corp. of Florida, **e.**
Zierick Mfg. Corp., **e, f.**

CLOCKS, TIME

Aeronca Mfg. Corp.-Aerospace Div.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div
A. Biederman, Inc.
Cubic Corp
Datex Corp.
Digital Sensors Inc
M. Ducommun Co.
Electro Instruments, Inc.
Electronic Engrg. Co. of California
Fisher Scientific Co., Maryland
General Controls Co.
A.W. Haydon Co., The
Industrial Timer Corp
Jardur Aviation Co.
Jadur Import Co.
Librascope Div., General Precision, Inc.
Ernest Norrman Laboratories
Porabam, Inc.
Resdel Engrg. Corp.
Sangamo Electric Co.
Standard Electric Time Co., The.,
Sunshine Scientific Instrument
Valpey Crystal Corp.
Wickes Engrg. & Construction Co.

CLOTH, GLASS

American Machine & Foundry Co., Government Products Group
Aviation Textile Associates
Bar-Ray Products, Inc.
Bemis Bro. Bag Co
Birma Mfg. Co Inc.
Bo Myte Co., Inc., The
Coast Mfg. & Supply Co.
Cordo Chemical Corp
C.R. Daniels, Inc
Duracote Corp.
Flightex Fabrics Inc.
Hastings Plastics, Inc.
Insulation Mfrs. Corp.
Natvar Corp.
Owens-Corning Fiberglas Corp.
Rezolin, Inc.
Sawyer Coated Fabrics, Div.-Farrington Textol Corp.
F.M. Stevenson Co., Inc.
E. F. Timme & Son Inc.
Uniform Hood Lace Co.

CLOTH, PLASTIC

Abesto Corp.
American Latex Products Corp.
Auburn Mfg. Co., The
Aviation Textile Associates
Bar-Ray Products, Inc.
Birma Mfg. Co. Inc.
Blossom Mfg. Co. Inc.
Bo Myte Co., Inc., The
Cordo Chemical Corp.
C.R. Daniels, Inc.
Duracote Corp
B.F. Goodrich Industrial Products Co.
Insulation Mfrs. Corp.
***MINNESOTA MINING & MFG. CO.**
Plastic Age Sales, Inc.
Reeves Bros. Inc., Vulcan Rubber Div
Sawyer Coated Fabrics, Div.-Farrington Texol Corp.
F.M. Stevenson Co., Inc.
Swedlow Inc.
Tetrafluor, Inc.,
E.F. Timme & Son Inc.
Uniform Hood Lace Co.
United States Rubber Co.

CLOTH, RUBBERIZED

Abesto Corp.
Anchor Packing Co., The
Auburn Mfg. Co., The
Aviation Textile Associates
Birma Mfg. Co. Inc.
Blossom Mfg. Co. Inc.
Cordo Chemical Corp.
C.R. Daniels, Inc.
E.I. Du Pont De Nemours & Co. Inc
Garlock Packing Co.
B.F. Goodrich Industrial Products Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
Raybestos-Manhattan, Inc
Reeves Bros. Inc., Vulcan Rubber Div.
Rubbercraft Corp. of California
Sawyer Coated Fabrics, Div.-Farrington Texol Corp.
F.M. Stevenson Co., Inc.
Thermoid Div.-H.K. Porter Co., Inc.
United States Rubber Co
Wasley Products, Inc

CLOTHS, GRILL

Aviation Textile Associates
Bestcraft Products Co. Inc.
Chase Brass & Copper Co., Inc.
Croname Inc.
Kentucky Metal Products Co.
F.M. Stevenson Co., Inc.

CLOTHS, SPEAKER GRILLE

Aviation Textile Associates
Bestcraft Products Co. Inc
Croname Inc.
G-C Electronics Co.
Kendall Co., The
Kentucky Metal Products Co.
F.M. Stevenson Co., Inc.
E.F. Timme & Son Inc.

CLOTHS, WOVEN WIRE

Aviation Textile Associates
Bendix Filter Div., Bendix Aviation Corp
Bestcraft Products Co Inc.
J. Bishop & Co., Platinum Works
Buffalo Wire Works Co., Inc
Cambridge Wire Cloth Co., The
Chase Brass & Copper Co., Inc.
Hastings Plastics, Inc
Kentucky Metal Products Co.
Mechanical Felt & Textiles Co.
National-Standard Co
Newark Wire Cloth Co.
Pequot Wire Cloth Co
Reed Research Inc.
Rolock Inc.
Schlegel Mfg. Co.
United States Steel Corp.

CLUTCHES, MAGNETIC

***ABRAMS INSTRUMENT CORP.**
Actuator Products Div., Geartronics Corp.
Autotronics Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bogue Electric Mfg. Co.
Joe Davidson & Associates
Dial Products Co.
Dynamic Instrument Corp.
Eaton Mfg. Co.
Electroid Corp.
FAE Instrument Corp.
Fairfield Engrg. Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
General Electro-Mechanical Corp.
Gordon Enterprises
Guidance Controls Corp.
Hilliard Corp., The
Hobbs Mfg. Co.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollmorgen Optical Corp.
Lear, Inc.
Magtrol, Inc.
Radio Development & Research Corp.
Raymond Engrg. Lab., Inc.
Reeves Instrument Corp.
Sealol Corp.
Technology Instrument Corp.
U.S. Industries, Inc.
U.S. Science Corp., Div.-Topp Industries, Inc.
Valcor Engrg. Corp.
Vickers Inc., Electric Products Div.
Wesrep Corp.
Zurn Industries, Inc.

CLUTCHES, MOTOR & GENERATOR

Dana Corp.
Joe Davidson & Associates
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
George E. Harris & Co., Inc.
Hilliard Corp., The
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Lear, Inc.
Overload Control Co.
Precision Specialties, Inc.
Radio Development & Research Corp.
Russell Mfg. Co.
Talley Corp., The
U.S. Industries, Inc.
Vickers Inc., Electric Products Div.
Waste King Corp., Technical Products Div.
Westinghouse Electric Corp.
Zurn Industries, Inc

COATINGS

a. Conductive-Tube Interior
b. Finishing
c. High Temperature
d. Printed Circuit
e. Protective
f. Salt Spray Resistance
g. Special Purpose

Acheson Colloids Co., Div.-Acheson Industries, Inc., **a thru d.**
***AEROJET-GENERAL CORP., g.**
Allied Research Products, Inc., **b, e, f.**
Amchem Products Inc., **b, e, f.**
American Agile Corp., **e, f.**
American Latex Products Corp., **c, e, f, g.,**
American Machine & Foundry Co., Government Products Group, **c.**
American Oil & Supply Co., **e, f.**
American Smelting & Refining Co., **b, e.**
American Solder & Flux Co., **e, f.**
Anderson Oil & Chemical Co., Inc., **f.**
Arco Co., The, **b, e, f, g.**
Aries Laboratories, Inc., **e.**
Armstrong Products Co., **e.**
Associated Engineers, Inc., **f.**
Avco Corp.-Research & Advanced Development Div., **c.**
Avondale Co., The, **b, d, e, f, g.**
George Basch Co., The, **b, e, f, g.**
Bel Fuse Inc., **a, d.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c, f, g.**
Better Finishes & Coatings Inc., **b, e, f, g.**
Bettinger Corp., **b, c, d, e, f, g.**
Carl H. Biggs Co., **c thru g.**
Bjorksten Research Labs. For Industry, Inc., **a thru g.**
Blossom Mfg. Co. Inc., **e.**
Bogart Mfg. Corp.
Bonny Mfg. Corp., **c, g.,**
Borden Chemical Co., **b, c, e, f, g.**
CBS Laboratories, Div.-Columbia Broadcasting System, **g.**
Carboline Co., **b, c, e, f, g.**
Carborundum Co., The, **c, g.**

Carborundum Co., Refractories Div., **c.**
Chemical Products Corp., **b, d thru g.**
Cincinnati Cleaning & Finishing Machinery, **b.**
Clarkson Labs., Inc., The, **d, e, g.**
Coast Mfg. & Supply Co., **b.**
***CONSOLIDATED ELECTRODYNAMICS CORP., c.**
Consolidated Vacuum Corp., **b, g.**
Cordo Chemical Corp., **b, e, f, g.**
Cowles Chemical Co., **f.**
Dennis Chemical Co., **b thru g.**
Division Lead Co., **d.**
Double E Products Co., **c, g.**
Douglas Aircraft Co., Inc., **c.**
Dow Corning Corp., **c, d.**
E.I. Du Pont De Nemours & Co. Inc., **d thru g.**
Duracote Corp., **c, e, g.**
Dyna-Therm Chemical Corp., **c, e, g.**
Electrofilm, Inc., **c, e.**
Emerson & Cuming, Inc., **c thru g.**
***EQUIPMENT DIV., RAYTHEON CO., c, g.**
Esso Standard, Div.-Humble Oil & Refining Co., **e, f.**
Fidelity Chemical Products Corp., **b, e, g.**
Food Machinery & Chemical Corp.-Epoxy Dept., **c thru g.**
Furane Plastics, Inc., **b thru g.**
General American Transportation Corp., **e, f, g.**
General Plastics Corp., **c, e, f, g.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **e.**
Grant-Lehr Corp., **c, e, f, g.**
Gulton Industries, Inc., **c, e.**
W. & L. E. Gurley, **d, g.**
Handy & Harman, **a, d.**
Hanson-Van Winkle-Munning Co., **e.**
Harper-Leader, Inc., **c, g.**
Hastings Plastics, Inc., **e, f.**
Heil Process Equipment Corp., **e.**
Hitchiner Mfg. Co., Inc., **g.**
R.M. Hollingshead Corp., **e.**
O. Hommel Co., The, **c, d, g.**
Horsey, Robson & Co., Inc., **e, f, g.**
Hughes Tool Co., Aircraft Div., **c, e.**
Industrial Metal Protectives, Inc., **b, e, f, g.**
Infrared Industries, Inc., **g.**
Insulation Mfrs. Corp., **c, e.**
Jennings Machine Corp., **c.**
Joclin Mfg. Co., The, **c, f, g.**
Kaiser Aluminum & Chemical Sales, Inc., **c.**
Kano Labs., **e.**
Kelite Corp., **b, d, e, f.**
Kickhaefer Mfg. Co., **e.**
Kish Industries, Inc., **b, e, f, g.**
Krylon, Inc., **b, d, e, f.**
Lam-Ply, Inc., **c, e, g.**
Libbey-Owens-Ford Glass Co., **c, e, f, g.**
Lockheed Aircraft Corp., Missiles & Space Div., **c, d, f, g.**
London Chemical Co., Inc., **d thru g.**
Lord Mfg. Co., **g.**
Luzerne Rubber Co., **e.**
Lycoming Div., Avco Corp., **c, g.**
Maas & Waldstein Co., **a, b, d thru g.**
Marblette Corp., The, **c thru f.**
Marquardt Corp., The, **b thru g.**
Merix Chemical Co. **a, b, e, g.**
Metal & Thermit Corp., **b, e, g.**
Metallizing Co. of Los Angeles Inc., **c, e, f.**
Metaplast Co., Inc., **a, g.**
Metz Refining Co., **a.**
Micro-Circuits Co., **a thru g.**
Midland Paint & Varnish Co., The, **b, c.**
James Millen Mfg. Co. Inc., **e.**
***MINNESOTA MINING & MFG. CO., b thru g.**
***MINNESOTA MINING & MFG. CO.-ADHESIVES, COATING & SEALERS DIV., e, f, g.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV., c, d, g.**
Mitchell Rand Mfg. Corp., **d.**
Mitronics Inc., **c, d, e.**
Monsanto Chemical Co., **e, f.**
NUMEC-Nuclear Materials & Equipment Corp., **a, b, c, e, g.**
Narmco Materials Div., Narmco Industries, Inc., **e.**
Naz-Dar Co., **d, e, g.**
New England Tape Co., Div.-United-Carr Fastener Corp., **e, f, g.**
Nooter Corp., **e.**
Norrich Screw Machine Products, **c.**
Northeast Metals Industries, Inc., **b.**
Norton Co., New Products Dept., **c, e, g.**
Nu Steel Co., **e, f.**
Optical Coating Lab., Inc., **g.**
Pacific Universal Products Corp., **g.**
Parker Rust Proof Co., **b, e, f.**
Penetone Co., The, **e, f, g.**
Pennsalt Chemicals Corp., **e, f.**
Permacel, **b thru g.**
Permatex Co., Inc., **g.**
Pfaudler Div., Pfaudler Permutit Inc., **c, e, f, g.**
Philadelphia Quartz Co., **a, c, e.**
Polymer Corp., The, **b, e, f, g.**
Portland Copper & Tank Works Inc., **c, f, g.**
Protex-A-Cote, Inc., **b, c, e, f, g.**
Q-Circuits, Div.-Etching Co. of Calif., **d.**
Radar Relay, Inc., **e.**
***RADIO CORP. OF AMERICA, a thru e.**
Raffi & Swanson, Inc., **b, e, f, g.**
Raybestos-Manhattan, Inc., **e.**
Reeves Brothers, Inc., **c, e, f, g.**
Research, Inc., **c, e, g.**
Rezolin, Inc.
Roto Finish-Ransohoff, **b, f, g.**
Rust-Oleum
Saran Protective Coatings Co., **b, e, f, g.**
Sauereisen Cements Co., **c, e.**
Schenectady Varnish Co., Inc., **b thru g.**
Seal-Peel, Inc., **e, g.**
Sheridan-Gray, Inc., **c.**
Silicone Products Dept., General Electric Co., Dept. C., **c, d, e.**
Silicones Div.-Union Carbide Corp., **c, e, f.**
Sillcocks-Miller Co., **b, d thru g.**
Smooth-On Mfg. Co., **e, f, g.**
Solar Aircraft Co., **c, e, g.**
Southwest Research Institute, **c, g.**
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co., **g.**
Special Products Dept., Melpar, Inc., **c thru g.**
Spectracoat, Inc., **a, c, g.**
Spraylat Corp., **e, f, g.**
Standard-Toch Chemicals, Inc., **b, c, e, f, g.**
Stevenson Bro. & Co., **f, g.**
Stonhard Co., Inc., **e, f.**
Swedlow Inc., **c.**
Swift Textile Metalizing & Laminating Corp., **g.**
Switzer Brothers, Inc., **g.**
Technic Inc., **c, e, f, g.**
Teleflex Inc., **c.**
Temco Aircraft Corp., **c, d, g.**
Tempil Corp., **c, e.**
Thompson & Co., **a, b, e, f, g.**
Topper Mfg. Co., Inc., **a thru g.**
Trio Chemical Works, Inc., **g.**
Turco Products, Inc., **e, f, g.**
United Shoe Machinery Corp., **b, e, g.**
United States Plywood Corp., **b.**
Van der Horst Corp. of America, **b, e, f, g.**
Vapor Blast Mfg. Co., **b.**
Vorac Co., The, **a, b, c, e, f.**
Wall Colmonoy Corp., Stainless Processing Div., **e.**
Western Coating Co., **e, f, g.**
Western Sealant of Conn., **b, c, e, f, g.**
Wilbur & Williams Co., Inc., The, **e, f, g.**
X-Pando Corp., **e, f.**
Zenith Optical Laboratory, **d.**
Zippertubing Co., The, **a, f, g.**
Zirconium Corp. of America, **c.**
Zophar Mills Inc., **f.**

COBALT

Belmont Smelting & Refining Works, Inc.
Bethlehem Steel Co.
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
City Chemical Corp.
Delta Chemical Works, Inc.
Foote Mineral Co.
Instrument Div., The Budd Co.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Wai Met Alloys Co.

CODE & TAB MARKERS

Duralith Corp.
Duramark, Inc.
Sillcocks-Miller Co.

COIL ASSEMBLIES

ACDC Electronics, Inc.
Ace Coil & Electronics Co.
Acme Electric Corp.
Advanced Electronics, Inc.
Aerolite Electronics Corp.
All-Tronics, Inc.
Barker & Williamson Inc.
Bendix Aviation Corp.
Coil Co. of America
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Communication Accessories Co.
Cord Products Co.
Del Electronics Corp.
Deluxe Coils Inc.
De Witt Development Co.
Eagle Signal Co.
Electro-Winders Co. Inc.
Forbes & Wagner, Inc.
Fugle-Miller Labs. Inc.
Gates Radio Co.
General Coil Products Corp.
Paul E. Gerst & Co.
Hagen Mfg. Co.
Walter J. Hyatt Co., The
E. F. Johnson Co.
Johnson Electronics Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc.
Leece-Neville Co., The
Leetronics, Inc.
G. W. Lisk Co. Inc.
Magnetic Circuit Elements, Inc.
***MARTIN CO., THE, DENVER DIV.**
James Millen Mfg. Co. Inc.
National Coil Co.
National Co., Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Precision, Inc.
Projects Unlimited, Inc.
Radio Condenser Co.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Milton Ross Metals Co., The
Sage-Craft, Inc.
Sheltered Workshops
Standard Winding Co., Inc.
Stanwyck Winding Co., Inc.
Stewart-Warner Electronics Div.
Superex Electronics Corp.
Talley Corp., The
Transformers, Inc.
Tur-Bo Jet Products Co., Inc.
U. E. Electronics Corp.
Valcor Engrg. Corp.
Varo Mfg. Co., Inc.
Virginia Electronics Co., Inc.
Wesrep Corp.
Westinghouse Electric Corp.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

COIL DOPE

Emerson & Cuming, Inc.
G-C Electronics Co.
James Millen Mfg. Co. Inc.
C. P. Moyen Co.
Norrich Plastics Corp.
Schenectady Varnish Co., Inc.

COIL FORMS

Alloys Unlimited Inc.
American Insulator Corp.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Bonny Mfg. Corp.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Delevan Electronics Corp.
Emerson Plastics Corp.
Form-It Products, Inc.
Gladding, McBean & Co.
Gries Reproducer Corp.
Halogen Insulator & Seal Corp.
Henry & Miller Industries, Inc.
Hobson Brothers, Inc.
Lamtex Industries Inc.
Leece-Neville Co., The
Thomas J. Long, Inc.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
***MINNESOTA MINING & MFG. CO.**
National Ceramic Co.
National Coil Co.
National Moldite Co.
New England Spring Mfg. Co., Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Quality Components, Inc.
Milton Ross Metals Co., The
Stanwyck Winding Co., Inc.
Stevens Products, Inc.
Superex Electronics Corp.
Tele Coil Co.
Thor Ceramics, Inc.
Topper Mfg. Co., Inc.
Tucson Instrument Corp.
U. E. Electronics Corp.
Waters Mfg., Inc.
Westinghouse Electric Corp.

COIL WINDING MACHINES, TOROIDAL

Allied International Corp.
American Machine & Foundry Co., Greenwich Engrg. Div.
Arnold Magnetics Corp.
Associated American Winding Machinery Inc.
CG Electronics Corp.
Double E Products Co.
Paul E. Gerst & Co.
Gulton Industries, Inc.
Donald C. Harder Co.

Carl Hirschmann Co., Inc.
Lumen, Inc.
Mico Instrument Co.
Richard Philip Co.
*RADIO CORP. OF AMERICA
Standard Electronics Div.-Reeves Instrument Corp.
Universal Mfg. Co., Inc.

COILS

a. Booster
b. Choke
c. IF
d. Printed Circuit
e. RF Transmitting
f. Solenoid
g. Transducer

ACDC Electronics, Inc., a thru g.
ACF Industries Inc., b, d.
ADC Inc., b.
A. P. W. Co., f.
Ace Coil & Electronics Co., b thru e.
Acme Wire Co., b, f.
Acoustica Associates, Inc., g.
Advanced Electronics, Inc., f.
Aerolite Electronics Corp., a, b, c, e, f.
Aetna Electronics Corp., e.
Aladdin Electronics, Div.-Aladdin Industries Inc., b, c, e.
Allied Control Co., Inc., f.
All-Tronics, Inc., b.
Arnold Magnetics Corp., d.
Associated Engineers, Inc., b.
Atlas Engrg. Co. Inc., b.
Automatic Timing & Controls, Inc., g.
Barker & Williamson Inc., b thru e.
Bel-Tronics Corp., a thru g.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., f.
Bud Radio, Inc., e.
Burnell & Co., Inc., d.
Cable Electric Products Inc., f.
Cambridge Thermionic Corp., b thru f.
Carol Electronics Corp., b.
Central Transformer Co., b.
Chemical Micro Milling Co., d.
Cleveland Metal Specialties Co., Electronics Div., d.
Coil Co. of America, a thru g.
G. L. Collins Corp., g.
Colvin Labs., Inc., g.
Comar Electric Co., d, f.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., b, c, f, g.
Communication Accessories Co., b.
Courter Products, Div.-Model Engrg. & Mfg., Inc., b, c, f.
Crescent Engrg. & Research Co., g.
Cycle Transformer Corp., b, f.
Daystrom, Inc., Military Electronics Div., a, b.
Del Electronics Corp., b.
Delevan Electronics Corp., b thru f.
Deluxe Coils Inc., d, f.
De Witt Development Co., b, f.
Double E Products Co., b thru e.
Eagle Signal Co., f.
Electroid Corp., f.
Electronic Coils, Inc., b, f.
Electro-Winders Co. Inc.
Epco Products Inc., a, b, d.
Ferroxcube Corp. of America, b, g.
Filtron Co., Inc., b.
Fisher Engrg., Inc., b, e, f.
Five Star Co., The, a, b, f, g.
Forbes & Wagner, Inc., b, c, f.
Ford Instrument Co., Div.-Sperry Rand Corp., g.
Fugle-Miller Labs. Inc., b thru g.
Gates Radio Co., e.
General Coil Products Corp., b thru f.
Genistron, Inc., b, d.
Paul E. Gerst & Co., b, f.
Glassco Instrument Co., g.
Graphik Circuits, Div.-Cinch Mfg. Co., d.
B. H. Hadley, Inc., f.
Hammett-Mercury-Rex Div., f.
Donald C. Harder Co., b, f.
George E. Harris & Co., Inc., b, d, g.
Haskel Engrg. & Supply Co., f.
Hi-G Inc., b thru f.
Hoover Electric Co., f.
Walter J. Hyatt Co., The, f.
Hydra-Power Corp., f.
Illumitronic Engrg. Co., e.
Induction Heating Corp., b.
Intercontinental Electronics Corp., a
JFD Electronics Corp., c, d, e.
James Electronics Inc., b, d, f.
Jeffers Electronics Div., Speer Carbon Co., e, f.
E. F. Johnson Co., e.
Johnson Electronics Inc., a thru d.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., b.
Keystone Products Co., b.
Knopp Inc., f.
Koontz-Wagner Electric Co., Inc., f.
Lab. for Electronics, Inc., b, c.
La Pointe Industries Inc., d.
Leece-Neville Co., The, f.
Leetronics, Inc., f.
G. W. Lisk Co. Inc., f.
Lumen, Inc., g.
Magnetic Circuit Elements, Inc., b.
*MARTIN CO., THE, DENVER DIV., b, c, f, g.
Merit Coil & Transformer Corp., a thru g.
Mid-West Coil & Transformer Co., b, f.
James Millen Mfg. Co. Inc., b thru e.
J. W. Miller Co., b thru e.
Modelectric Products Corp., c, e, f.
Motorola, Inc., c, d, e, g.
National Coil Co., b, c, d, f.
National Co., Inc., a, b, c, e, f, g.
Networks Electronic Corp., b.
New York Coil Co., Inc., a, b, c, e, f.
New York Transformer Co. Inc., b.
Nothelfer Winding Labs. Inc., b, e.
Nytronics, Inc., Essex Electronics Div., b thru e.
Opad Electric Co., b.
Ortho Filter Corp., b, f.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y., f.
Paul & Beekman, Inc.
Pickering & Co., Inc., f, g.
Polyphase Instrument Co., b.
Potter Aeronautical Corp., g.
Precise Development Corp., a thru f.
Precision, Inc., f.
Projects Unlimited, Inc., f.
Radex Corp., b.
Radio Condenser Co., g.
*RADIO CORP. OF AMERICA, a thru g.
Radio Industries, Inc., c, d.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., b, d.
Redman Electronics Corp., b, c.
J. R. Robbins Co.
Rytron Co., Inc., b, d, g.
Sage-Craft, Inc., b, f.
Sangamo Electric Co., b, f.
Schaevitz Engrg., g.
Servomechanisms, Inc., b.
Shallcross Mfg. Co., c.
Southwestern Industrial Electronics Co., b, d, f, g.
Standard Electronics Div.-Reeves Instrument Corp., a, b, c, e.
Standard Winding Co., Inc., a thru f.
Stanwyck Winding Co., Inc., b, c, d, f.
Stewart-Warner Electronics Div., b, c, e, f.
Stratfield Co., The, b, f.
Superex Electronics Corp., b, d.
Telechrome Mfg. Corp., b, c, f.
Tele Coil Co., b thru f.
Telex, Inc., b, d, g.
Topper Mfg. Co., Inc., c.
Torwico Electronics, Inc., b.
Transformer Design, Inc. of Milwaukee, b.
Transformers, Inc., b.
Transistor Electronics Corp., b.
Tresco, Inc., b.
Triad Transformer Corp., b, d.
Tur-Bo Jet Products Co., Inc., f.
U. E. Electronics Corp., b, c, e, f, g.
Universal Toroid Coil Winding, Inc., b, c, e, g.
Valcor Engrg. Corp., f.
Valor Instruments, Inc., b thru e.
Vanguard Electronics Co., b, c.
Varo Mfg. Co., Inc., a thru g.
Virginia Electronics Co., Inc., b thru f.
Wahlgren Magnetics, Div.-Marshall Industries
A. W. Welch Mfg. Co., Inc., b, d, e.
Wesrep Corp., c, e.
Westinghouse Electric Corp., a, b, f, g.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., f.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., b, d, f.
Winatic Corp., The, f.

COILS, HEATING

J. Bishop & Co., Platinum Works
Blue M Electric Co.
Chase Brass & Copper Co., Inc.
Coil Co. of America
Crane Co., Special Products Div.
Dean Products, Inc.
Wilbur B. Driver Co.
Frick Co.
General Electric Co., Apparatus Sales Div.
Griscom-Russell Co., The
Heil Process Equipment Corp.
Induction Heating Corp.
Lepel High Frequency Labs. Inc.
Lucifer Furnaces Inc.
Manning & Lewis Eng. Co.
*MARTIN CO., THE, DENVER DIV.
Nothelfer Winding Labs. Inc.
Piqua Engrg. Inc.
Precision, Inc.
Rome-Turney Radiator Co., The
Shaw Burner Co.
Thermionic Products Co.
Trane Co., The
Tranter Mfg., Inc.
Worthington Corp.
York Div., Borg-Warner Corp.

COILS, HIGH TEMPERATURE

ACDC Electronics, Inc.
A. P. W. Co.
Advanced Electronics, Inc.
Atlas Engrg. Co. Inc.
J. Bishop & Co., Platinum Works
Coil Co. of America
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Crescent Engrg. & Research Co.
Cycle Transformer Corp.
Electroid Corp.
Electronic Coils, Inc.
Electro-Winders Co. Inc.
Five Star Co., The
Griscom-Russell Co., The
Keystone Products Co.
Koontz-Wagner Electric Co., Inc.
G. W. Lisk Co. Inc.
Lucifer Furnaces Inc.
Manning & Lewis Eng. Co.
*MARTIN CO., THE, DENVER DIV.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
National Coil Co.
New York Transformer Co. Inc.
Norrich Plastics Corp.
Nothelfer Winding Labs. Inc.
Polyphase Instrument Co.
Thermionic Products Co.
Transformers, Inc.
Tranter Mfg., Inc.
Tur-Bo Jet Products Co., Inc.
U. E. Electronics Corp.
Varo Mfg. Co., Inc.
Westinghouse Electric Corp.
Winatic Corp., The

COILS, IGNITION

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS
ACDC Electronics, Inc.
Acme Electric Corp.
Acme Wire Co.
Coil Co. of America
Electric Autolite Co., The
Five Star Co., The
Hallett Mfg. Co.
George E. Harris & Co., Inc.
Lear, Inc.
Leece-Neville Co., The
Mid-West Coil & Transformer Co.
Modelectric Products Corp.
Skytronics, Inc.
Southwest Research Institute
U. E. Electronics Corp.
Varo Mfg. Co., Inc.

COILS, SPEAKER

Acme Wire Co.
Coil Co. of America
Five Star Co., The
General Coil Products Corp.
*MAGNAVOX CO., THE
Merit Coil & Transformer Corp.
Telex, Inc.
U. E. Electronics Corp.
University Loudspeakers, Inc.

COLLECTOR RINGS

Airflyte Electronics Co.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Crane Co., Special Products Div.
Electro-Miniatures Corp.
Lear, Inc.
Lone Star Plastics Co. Inc.
Magnetic Controls Co.
Nippert Electric Products Co., The
Poly-Scientific Corp.
Texas Instruments Inc.
Toledo Commutator Co.
Waco Aircraft Co.

COLLIMATORS

American Optical Co., Instrument Div.
A. Biederman, Inc.
Brunson Instrument Co.

Dalmo Victor Co., Div.-Textron, Inc.
Davidson Optronics, Inc.
Eastman Kodak Co.
***ENGIS EQUIPMENT CO.**
Epic, Inc.
J. W. Fecker Div., American Optical Co.
Fisher Scientific Co., Maryland
Gordon Enterprises
Infrared Industries, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Librascope Div., General Precision, Inc.
Opto-Metric Tools, Inc.
Pacific Scientific Co.
Philips Efectronic Instruments
Tinsley Labs., Inc.

COLORIMETERS

All American Engrg. Co.
American Instrument Co., Inc.
Bausch & Lomb Optical Co.
Chemalloy Electronics Corp.
***ENGIS EQUIPMENT CO.**
Fischer & Porter Co.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Gardner Laboratory, Inc.
Hallikainen Instruments
Instrument Development Labs., Inc.
Librascope Div., General Precision, Inc.
Photovolt Corp.
Scientific & Process Instruments Div.-Beckman Instruments, Inc.
Specialties, Inc.
Telechrome Mfg. Corp.
Thermal American Fused Quartz Co., Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

COLORIMETERS, PHOTOELECTRIC

All American Engrg. Co.
American Electronic Labs., Inc.
American Instrument Co., Inc.
Bausch & Lomb Optical Co.
Central Scientific Co.
Coleman Instruments, Inc.
***ENGIS EQUIPMENT CO.**
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Gardner Laboratory, Inc.
General Electric Co., Apparatus Sales Div.
Hallikainen Instruments
Instrument Development Labs., Inc.
Photobell Co., Inc.
Photovolt Corp.
Spectra Electronics Corp.
Telechrome Mfg. Corp.
United States Testing Co., Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

COLORIMETERS, SPECIAL PURPOSE

All American Engrg. Co.
Bausch & Lomb Optical Co.
Electronic Control Corp.
Ellison Draft Gage Co., Inc.
Fisher Scientific Co.
Instrument Development Labs., Inc.
Librascope Div., General Precision, Inc.
Photobell Co., Inc.
Spectra Electronics Corp.
Telechrome Mfg. Corp.

COLUMBIUM METALS

Alloys Unlimited Inc.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Delta Chemical Works, Inc.
E. I. Du Pont de Nemours & Co. Inc.
Fansteel Metallurgical Corp.
Foote Mineral Co.
Harvey Aluminum
Hughes Tool Co., Aircraft Div.
Kennametal Inc.
NUMEC-Nuclear Materials & Equipment Corp.
F. H. Paul & Stein Brothers, Inc.
Rembar Co., Inc., The
Rodney Metals Inc.
Stauffer Chemical Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Universal-Cyclops Steel Corp.
Var-Lac-Oid Chemical Co.
Wah Chang Corp.
Wai Met Alloys Co.
Westinghouse Electric Corp.
Wyman-Gordon Co.

COMBUSTION CHAMBER COVERS

Allison Div., General Motors Corp.
American Latex Products Corp.
Basic Tool Industries, Inc.
Colonial Aircraft Corp.
Crane Co., Special Products Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
International Steel Co.
C. B. Kaupp & Sons, Inc.
Kirk & Blum Mfg. Co., The
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
***LAVELLE AIRCRAFT CORP.**
Marquardt Corp., The
McGregor Mfg. Corp.
Portland Copper & Tank Works Inc.
Edw. Renneburg & Sons Co.
Sedco
Shaw Burner Co.
Southwest Research Institute

COMBUSTION CHAMBERS

***AEROJET-GENERAL CORP.**
Allison Div., General Motors Corp.
American Car & Foundry Div., ACF Industries, Inc.
Arde-Portland, Inc.
Basic Tool Industries, Inc.
Colonial Aircraft Corp.
Corning Glass Works
Crane Co., Special Products Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Custom Tool & Mfg. Co.
***EXCELCO DEVELOPMENTS INC.**
General American Transportation Corp.
Hughes Tool Co., Aircraft Div.
International Steel Co.
Kaiser Fleetwings, Inc.
C. B. Kaupp & Sons, Inc.
***LAVELLE AIRCRAFT CORP.**
Marquardt Corp., The
McGregor Mfg. Corp.
Missimers Inc.
Norton Co., New Products Dept.
Penn-Michigan Mfg. Corp.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Edw. Renneburg & Sons Co.
Shaw Burner Co.
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Spaceatomics Div., The Budd Co.
Thermal Research & Eng. Corp.
Zirconium Corp. of America

COMBUSTORS

Allison Div., General Motors Corp.
Colonial Aircraft Corp.
Gabriel Co., Rocket Power-Talco
***LAVELLE AIRCRAFT CORP.**
Lycoming Div., Avco Corp.
Marquardt Corp., The
McGregor Mfg. Corp.
Portland Copper & Tank Works Inc.
Edw. Renneburg & Sons Co.
Solar Aircraft Co.
Thermal Research & Eng. Corp.

COMMUNICATION SYSTEMS

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Admiral Corp.
Advance Industries, Inc.
Allied International Corp.
Arnoux Corp.
Automatic Electric Sales Corp.
Avco Corp., Crosley Div.
Avco Corp.-Research & Advanced Development Div.
Barker Sales Co.
Bell & Gossett Co.
Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Budelman Electronics Corp.
Burton-Rodgers, Inc.
Chalco Engrg. Corp.
Chance Vought Aircraft, Inc.
David Clark Co., Inc.
Clegg Labs., Div.-Clegg, Inc.
Collins Radio Co.
Colorado Research Corp.
Communications Co.
Crosby-Teletronics Corp.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Military Electronics Div.
Decker Corp., The
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
Du Kane Corp.
Allen B. Du Mont Labs., Inc.
Dynatronics, Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
Emertron, Sub.-Emerson Radio & Phonograph Corp
***EQUIPMENT DIV., RAYTHEON CO.**
Executone, Inc.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Fla. Aircraft Radio & Marine
GPL Div.-General Precision, Inc.
Gates Radio Co.
General Devices, Inc.
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense & Engrg. Products Group
Guided Missile Div., The Firestone Tire & Rubber Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Hallicrafters Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
Hoffman Electronics Corp., Military Products Div.
Hoover Electronics Co.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
E. F. Johnson Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Langevin Div., The W. L. Maxson Corp.
Lear, Inc.
Lel, Inc.
Lenkurt Electric Co., Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Group
Manson Labs., Inc.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Northrop Corp.
Pacific Automation Products, Inc.
Packard-Bell Electronics Corp.
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
Racon Electric Co. Inc.
Radiation, Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Rimak, Inc.
Seiscor, Div.-Seismograph Service Corp.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Specialty Electronics Development Corp.
Spectra Electronics Corp.
Stewart-Warner Electronics Div.
Stromberg-Carlson Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Tamar Electronics, Inc.
Technical Materiel Corp., The
Television Utilities Corp.
Telkor, Inc.
Texas Instruments Inc.
Trepac Corp. of America
Tri-Ex Tower Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
United States Instrument Corp.
Vicon Corp. Sub.-Insul-8-Corp.
Virginia Electronics Co., Inc.
Western Union Telegraph Co., The
Westinghouse Electric Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Wickes Engrg. & Construction Co.

COMMUNICATION SYSTEMS, COMMERCIAL

Aeronautical Electronics, Inc.
Allied International Corp.
Automatic Electric Sales Corp.
Barker Sales Co.
Bell & Gossett Co.
Bendix Aviation Corp.
Budelman Electronics Corp.
David Clark Co., Inc.
Collins Radio Co.
Communications Co.
Daystrom, Inc., Military Electronics Div.
Decker Corp., The
Designers for Industry, Inc.
Du Kane Corp.

*EQUIPMENT DIV., RAYTHEON CO.
Executone, Inc.
Fla. Aircraft Radio & Marine
GPL Div.-General Precision, Inc.
Gates Radio Co.
General Devices, Inc.
Hallicrafters Co., The
Huyck Systems Co.
E. F. Johnson Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Langevin Div., The W. L. Maxson Corp.
Lel, Inc.
Lenkurt Electric Co., Inc.
Lynch Carrier Systems Inc.
Madigan Corp.
*MARTIN CO., THE, DENVER DIV.
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Northrop Corp.
Philco Corp.-Govt. & Industrial Group
Racon Electric Co. Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Seiscor, Div.-Seismograph Service Corp.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Standard Electronics Div.-Reeves Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Tamar Electronics, Inc.
Technical Materiel Corp., The
Technology Instrument Corp.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Trepac Corp. of America
Tri-Ex Tower Corp.
United States Instrument Corp.
Western Union Telegraph Co., The
Westinghouse Electric Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

COMMUNICATION SYSTEMS, INTERCOM

Allied International Corp.
Arnoux Corp.
Automatic Electric Sales Corp.
Barker Sales Co.
Bruno-New York Industries Corp.
Chalco Engrg. Corp.
Chance Vought Aircraft, Inc.
David Clark Co., Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
Du Kane Corp.
Electromation Co., Div.-Del Mar Engrg. Labs.
Executone, Inc.
Fla. Aircraft Radio & Marine
Gates Radio Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Huyck Systems Co.
Interstate Electronics Corp.
E. F. Johnson Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Langevin Div., The W. L. Maxson Corp.
Lear, Inc.
J. M. Loge, Sound Engineers
Madigan Corp.
*MARTIN CO., THE DENVER DIV.
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
Racon Electric Co. Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Seiscor, Div.-Seismograph Service Corp.
Southwest Research Institute
Stromberg-Carlson Div.-General Dynamics Corp.
Technology Instrument Corp.
Telectro Industries Corp.
Telkor, Inc.
United States Instrument Corp.
Virginia Electronics Co., Inc.
Vocaline Co. of America Inc.
Westinghouse Electric Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Winder Aircraft Corp. of Florida

COMMUTATORS, SWITCHING

Airflyte Electronics Co.
Applied Electronics Corp. of N. J
Arnoux Corp.
Bendix Aviation Corp.
CG Electronics Corp.
Collectron Corp.
Computer Instruments Corp.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
James Cunningham Son & Co., Inc.
Cushman Precision Industries
Electro Tec Corp.
Electro-Miniatures Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Devices, Inc.
Genisco, Inc.
Genisco, Inc., Instrument Div.
Graphite Metallizing Corp.
Instrument Development Labs., Inc.
Lamtex Industries Inc.
Lear, Inc.
Leece-Neville Co., The
Librascope Div., General Precision, Inc.
Mason Electric Corp.
Mira Corp., The
Motorola, Inc.
Mycalex Corp. of America
National Co., Inc.
Nippert Electric Products Co., The
Pacific Scientific Co.
Packard Bell Computer Corp.
Poly-Scientific Corp.
Slip Ring Co. of America
Southwest Research Institute
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Telechrome Mfg. Corp.
Telex, Inc.
Texas Instruments Inc.
Thompson Ramo Wooldridge Inc.
Toledo Commutator Co.
Unison Products, Inc.

COMPARATORS

a. Capacitance
b. Circuit Linearity
c. Dielectric
d. Iron Core
e. Q
f. Voltage

Aeronca Mfg. Corp.-Aerospace Div., **f.**
Avien, Inc., **f.**
B & K Instruments, Inc., **a, d.**
Barnes Development Co., **a.**
Bausch & Lomb Optical Co.
Bendix Aviation Corp., **f.**
Benson-Lehner Corp.
Clegg Labs., Div.-Clegg, Inc., **a thru d, f.**
Consolidated Airborne Systems, Inc., **a, c.**
Datascan Inc., **f.**
Davenport Mfg. Co., **f.**
Daystrom Inc., Weston Instruments Div., **f.**
Decker Corp., The, **a, c.**
Delsen Corp., **c.**
Djeco, Div.-Djordjevic Engrg. Co., **f.**
Dytronics Co., **a.**
Electro Instruments, Inc., **a, c, f.**
Electro Scientific Industries, **a, e.**
Electronic Applications, Inc., **a.**
General Radio Co., **a, c, e.**
Gray Instrument Co., **f.**
ITI Electroniçs, Inc., **f.**
Industrial Instruments Inc., **a, c.**
Industrial Test Equipment Co., **a.**
Kepco, Inc., **f.**
Wayne Kerr Corp., **a, c.**
Kin Tel Div.-Cohu Electronics, Inc., **f.**
Lear, Inc., **f.**
Liquidometer Corp., The, **a.**
Magnetic Circuit Elements, Inc., **f.**
*MARTIN CO., THE, DENVER DIV., **a, b, f.**
James Millen Mfg. Co. Inc., **a, c thru f.**
National Co., Inc., **f.**
Non-Linear Systems, Inc., **f.**
Northrop Corp., **f.**
Optimized Devices, Inc., **f.**
Otis Elevator Co., Defense & Industrial Div.
Packard Bell Computer Corp., **f.**
Sensitive Research Instrument Corp., **f.**
Southwest Research Institute
Sunshine Scientific Instrument
Technical Electronics Co. Div.-Consolidated Electronic Industries, **a, b, c, f.**
Technology Instrument Corp., **a.**
Tempo Instrument Inc., **f.**
Transformers, Inc., **f.**
Trio Laboratories, Inc., **f.**
Universal Mfg. Co., Inc.
Voi-Shan Electronics, **f.**

COMPARATORS, AUTOMATIC RESISTANCE

Analogue Controls, Inc.
Applied Electronics Corp. of N. J.
Avien, Inc.
Barnes Development Co.
Bendix Aviation Corp.
Bergen Labs., Inc.
Dytronics Co.
Electro Instruments, Inc.
General Radio Co.
Industrial Instruments Inc.
Lear, Inc.
*MARTIN CO., THE, DENVER DIV.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Non-Linear Systems, Inc.
Optimized Devices, Inc.
Packard Bell Computer Corp.
Technical Electronics Co. Div.-Consolidated Electronic Industries
United Process Assemblies, Inc.

COMPASSES

a. Electronic Gyro
b. Gyro
c. Magnetic
d. Radio
e. Remote Indicating

Allied International Corp., **d.**
Belock Instrument Corp., **a, b, c, e.**
Bendix Aviation Corp., **b thru e.**
Bendix Aviation Corp.-Montrose Div., **e.**
A. Biederman, Inc., **b thru e.**
Bruno-New York Industries Corp., **d.**
Chance Vought Aircraft, Inc., **a, b.**
Collins Radio Co., **c, d, e.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **d.**
Daystrom Inc., Pacific Div., **a, b.**
Eclipse-Pioneer Div., Bendix Aviation Corp., **a, b, d, e.**
Emerfron, Sub.-Emerson Radio & Phonograph Corp., **d.**
Fla. Aircraft Radio & Marine, **d.**
General Electric Co., Instrument Dept., **b, e.**
W. & L. E. Gurley, **c.**
Integrated Dynamics Div., Globe Industries, Inc., **b.**
*KEARFOTT DIV., GENERAL PRECISION, INC., **a, b, c.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **c.**
Lear, Inc., **a thru e.**
A. Lietz Co., The, **c.**
*MAGNAVOX CO., THE, **d.**
Motorola, Inc., **d.**
Northrop Corp., **b.**
*RADIO CORP. OF AMERICA, **d.**
Sperry Gyroscope Co., Div.-Sperry Rand Corp., **b.**
Warren-Knight Co., **c.**
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., **c.**
Whittaker Gyro. Div.-Telecomputing Corp., **b.**
Winder Aircraft Corp. of Florida, **a, c.**

COMPOUNDS, CLEANING

American Oil & Supply Co.
Anderson Oil & Chemical Co., Inc.
Avondale Co., The
Barco Chemical Products Co.
George Basch Co., The
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bios Labs., Inc.
Borden Chemical Co.
Clayton Mfg. Co.
Cobehn, Inc.
Delta Chemical Works, Inc.
Detrex Chemical Industries, Inc.
Diversey Corp., The
Dow Chemical Co., The
Drill Mfg. Co.
E. I. Du Pont de Nemours & Co. Inc.
Eastern Chemical Div., Hooker Chemical Corp.
Ed-Berl Products, Inc.
Enthone Inc.
FMC Chlor-Alkali Div.
Fidelity Chemical Products Corp.
Food Machinery & Chemical Corp.-Mineral Products Div.
Grant-Lehr Corp.
Hanson-Van Winkle-Munning Co.
Hastings Plastics, Inc.
R. M. Hollingshead Corp.
Kano Labs.
Kelite Corp.
L & R Mfg. Co.
London Chemical Co., Inc.
Magnus Chemical Co., Inc.
Merix Chemical Co.
Narda Ultrasonics Corp., The
Nu Steel Co.
Parker Rust Proof Co.
Penetone Co., The
Philadelphia Quartz Co.
Ransohoff Co.
Roto Finish-Ransohoff
Ruby Chemical Co.
Southwest Research Institute

Topper Mfg. Co., Inc.
Trio Chemical Works, Inc.
Turco Products, Inc.
Udylite Corp., The
Vapor Blast Mfg. Co.
Wheelabrator Corp.
Wye Industries
Zophar Mills Inc.

COMPOUNDS

a. Calking & Sealing
b. Cleaning
c. Electrical Insulating & Sealing
d. Encapsulation
e. Impregnating
f. Mica
g. Phenolic Molding
h. Potting
i. Waterproofing

Acheson Colloids Co., Div.-Acheson Industries, Inc., **a.**
Acme Wire Co., **c, d, e, h.**
Airflyte Electronics Co., **d.**
Allied Chemical Corp., National Aniline Div., **b.**
Allied International Corp., **h.**
Allied Research Products, Inc., **b.**
American Latex Products Corp., **c, d, h, i.**
American Oil & Supply Co., **b.**
American Smelting & Refining Co., **b.**
Arco Co., The, **a, i.**
Aries Laboratories, Inc., **c, d, e, h, i.**
Armour Industrial Chemical Co.
Armstrong Cork Co., **a.**
Associated Engineers, Inc., **d, h.**
Avondale Co., The, **a thru e, i.**
Barco Chemical Products Co., **b.**
George Basch Co., The, **b, e.**
Bendix Aviation Corp., **b.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., b.**
Better Finishes & Coatings Inc., **a, i.**
Carl H. Biggs Co., **a, c, d, e, f, h, i.**
Bios Labs., Inc., **b, d, e, i.**
Biwax Corp., **c, d, e, h, i.**
Bjorksten Research Labs. for Industry, Inc., **a thru i.**
Bloomingdale Rubber Co., **b.**
Borden Chemical Co., **a thru d, h, i.**
Brook Molding Corp., **g, h.**
Carborundum Co., The, **c, d, h.**
Carborundum Co., Refractories Div., **h.**
Carmer Industries Inc., **d.**
Chemical Products Corp., **c, d, h, i.**
Clarkson Labs., Inc., The, **b, e, i.**
Coast Pro-Seal & Mfg. Co., **a, c, h.**
Cobehn, Inc., **b.**
Connecticut Hard Rubber Co., The, **a.**
Cordo Chemical Corp., **a.**
DBM Research Corp., **h, i.**
Del's Tumbling Service, **b.**
Delta Chemical Works, Inc., **a, b, f, h, i.**
Dennis Chemical Co., **a, d, e, h, i.**
Detrex Chemical Industries, Inc., **b.**
Dow Corning Corp., **a, c, d, e, h, i.**
Drill Mfg. Co., **b.**
E. I. Du Pont de Nemours & Co. Inc., **a, b, d, e, i.**
Duracote Corp., **e, i.**
Durez Plastics Div.-Hooker Chemical Corp., **g.**
Eastern Chemical Div., Hooker Chemical Corp., **b, g.**
Eco Engrg. Co., **a.**
Ed-Berl Products, Inc., **h. i.**
Electronic Mechanics, Inc., **c, f.**
Emerson & Cuming, Inc., **c, d, e, h, i.**
Enthone Inc., **b.**
Epoxy Products, Inc., Div.-Joseph Waldman & Sons, **c, d, e.**
L. W. Ferdinand & Co. Inc., **a.**
Food Machinery & Chemical Corp.-Dapon Dept., **c, d, e.**
Food Machinery & Chemical Corp.-Epoxy Dept., **a, c, d, e, h, i.**
Foote Mineral Co., **d, f.**
General American Transportation Corp., **g.**
B. F. Goodrich Aviation Products, **h.**
B. F. Goodrich Industrial Products Co., **a, h, i.**
Grafo Colloids Corp., **e.**
Grant-Lehr Corp., **b.**
Hanson-Van Winkle-Munning Co., **b.**
Hastings Plastics, Inc., **a, d, e, h.**
Hitchinger Mfg. Co., Inc., **c, d, e, h, i.**
R. M. Hollingshead Corp., **b.**
Homalite Corp., The, **i.**
Instrument Div., The Budd Co., **d.**
Insulation Mfrs. Corp., **c thru f, h.**
Johns-Manville Sales Corp., **a, c.**
Kano Labs., **b.**
Kish Industries, Inc., **c, d, e, h.**
Lam-Ply, Inc., **c, d, e, h, i.**
Lockheed Aircraft Corp., Missiles & Space Div., **g, h.**
London Chemical Co., Inc., **b, c, i.**
Lone Star Plastics Co. Inc., **g.**
Magnus Chemical Co., Inc., **b.**
Marblette Corp., The, **a, c, d, e, h.**
Merix Chemical Co., **b.**
Midland Industrial Finishes Co., **d, e.**
Midland Paint & Varnish Co., The, **a, c, i.**
James Millen Mfg. Co. Inc., **e.**
***MINNESOTA MINING & MFG. CO., a, c thru i.**
***MINNESOTA MINING & MFG. CO.-ADHESIVES, COATING & SEALERS DIV., a, c, h, i.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV., c, d, e, g, h.**
Mitchell Rand Mfg. Corp., **a, c, d, e, h.**
Monsanto Chemical Co., **e.**
Narmco Materials Div., Narmco Industries, Inc., **a, d, g, h.**
National Engrg. Products, Inc., **a, c, d, h.**
Naugatuck Chemical Div.-U. S. Rubber Co., **a, c, d, h.**
New England Tape Co., Div.-United-Carr Fastener Corp., **d, e, i.**
Nopco Chemical Co., Plastics Div., **h.**
Norrich Plastics Corp., **d.**
Norrich Screw Machine Products, **d, g, h.**
Nu Steel Co., **b.**
Parker Rust Proof Co., **b.**
Penetone Co., The, **b.**
Pennsalt Chemicals Corp., **b, h.**
Permacel, **c, d, e, h, i.**
Permatex Co., Inc., **a.**
Philadelphia Quartz Co., **b, e.**
Philco Corp.-Govt. & Industrial Group, **d, h.**
Plastic Age Sales, Inc., **g.**
Products Research Co., **a, c, d, e, h, i.**
Protex-A-Cote, Inc., **a, c, d, h, i.**
Reichhold Chemicals, Inc., **g.**
Rezolin, Inc., **c, d.**
J. R. Robbins Co., **c, d, e, h.**
Rogers Corp., **g.**
Milton Ross Metals Co., The, **d, h.**
Roto Finish-Ransohoff, **b.**
Ruby Chemical Co., **b.**
Sauereisen Cements Co., **a, c, d, h.**
Schenectady Varnish Co., Inc., **c, e, i.**
Seal-Peel, Inc., **a, h.**
Silicone Products Dept., General Electric Co., Dept. C, **a, c, d, e, h, i.**
Silicones Div.-Union Carbide Corp., **a, c thru i.**
Smooth-On Mfg. Co., **a, c, d, h, i.**
Southwest Research Institute, **d.**
Special Products Dept., Malpar, Inc., **c, d, h.**
Spraylat Corp., **i.**
Standard-Toch Chemicals, Inc., **c, e, h, i.**
Stevenson Bro. & Co., **a, c, d, e, h, i.**
Stonhard Co., Inc., **a, b, i.**
Thermon Mfg. Co., **c, h.**
Topper Mfg. Co., Inc., **d, h.**
Trio Chemical Works, Inc., **b, i.**
Turco Products, Inc., **b.**
United Mineral & Chemical Corp., **c.**
United Shoe Machinery Corp., **a, i.**
Vapor Blast Mfg. Co., **b.**
Wesrep Corp., **c, d, h.**
Wheelabrator Corp., **b.**
Wyandotte Chemicals Corp., **b.**
Wye Industries, **b.**
X-Pando Corp., **a, c, d, h, i.**
Zophar Mills Inc., **a thru e, h, i.**

COMPRESSOR ASSEMBLIES

Accessory Controls & Equipment Corp.
Air Logistics Corp.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allis-Chalmers
Allison Div., General Motors Corp.
American Instrument Co., Inc.
Applied Dynamics Corp.
Beach-Russ Co.
Budd Lewyt Electronics, Inc.
Calcor Corp.
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Cornelius Co., The, Aero Div.
Eastern Industries Inc.
Ex-Cell-O Corp.
Fluoro-Chem Corp.
Great Lakes Mfg. Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Halocarbon Products Corp.
Hamilton Standard, Div.-United Aircraft Corp.
Haskel Engrg. & Supply Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
ITE Circuit Breaker Co., Special Products Div.
Jarvis Corp.
Joy Mfg. Co.
Kerns Mfg. Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
McGregor Mfg. Corp.
Pioneer Industries Div., Almar-York Co. Inc.
Solar Aircraft Co.
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Stearns-Roger Mfg. Co., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Task Corp.
Thompson Ramo Wooldridge Inc.
Van der Horst Corp. of America
Wells Industries Corp.
Winder Aircraft Corp. of Florida
Worthington Corp.
York Div., Borg-Warner Corp.

COMPRESSOR ASSEMBLIES, AXIAL FLOW

Air Logistics Corp.
***AIRESEARCH MFG. OF ARIZONA**
Allis-Chalmers
Allison Div., General Motors Corp.
American Instrument Co., Inc.
Beach-Russ Co.
Calcor Corp.
Carrier Corp.
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Dean & Benson Research, Div.-Benson Mfg. Co.
Ex-Cell-O Corp.
George E. Harris & Co., Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Jarvis Corp.
Joy Mfg. Co.
Kerns Mfg. Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Napier Engines Inc.
Schellens-True Corp.
Solar Aircraft Co.
Sundstrand Turbo
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
Wells Industries Corp.
Westinghouse Electric Corp.

COMPRESSOR ASSEMBLIES, CENTRIFUGAL FLOW

Air Logistics Corp.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allis-Chalmers
Allison Div., General Motors Corp.
Calcor Corp.
Carrier Corp.
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
General American Transportation Corp.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Jarvis Corp.
Joy Mfg. Co.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
McGregor Mfg. Corp.
Napier Engines Inc.
Sundstrand Turbo
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
Wells Industries Corp.
Wickfield, Inc.
Worthington Corp.
York Div., Borg-Warner Corp.

COMPRESSOR ASSEMBLIES, MOBILE

Air Logistics Corp.
***AIRESEARCH MFG. OF ARIZONA**
Allis-Chalmers
American Instrument Co., Inc.
Beach-Russ Co.
Budd Lewyt Electronics, Inc.
Calcor Corp.
Carrier Corp.
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Consolidated Diesel Electric Corp.
Continental Aviation & Engrg. Corp.
Cornelius Co., The, Aero Div.
Dean & Benson Research, Div.-Benson Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Haskel Engrg. & Supply Co.
Highland Engrg. Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Joy Mfg. Co.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Stearns-Roger Mfg. Co., The
United Mfg. Co., Div., The W. L. Maxson Corp.
Wells Industries Corp.
Wickfield, Inc.
Worthington Corp.

COMPRESSORS, AIR

Accessory Controls & Equipment Corp.
Air Logistics Corp.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO.,DIV.-THE GARRETT CORP.**

Allis-Chalmers
American Instrument Co., Inc.
Applied Dynamics Corp.
Beach-Russ Co.
Binks Mfg. Co.
Budd Lewyt Electronics, Inc.
Carrier Corp
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Cleco Air Tools, Div.-Reed Roller Bit Co.
Cobehn, Inc.
Cornelius Co., The, Aero Div.
Dalmo Victor Co., Div.-Textron, Inc.
De Vilbiss Co., The
Eastern Industries Inc.
Fuller Co.
Gardner-Denver Co.
General American Transportation Corp.
Great Lakes Mfg. Corp.
Hamilton Standard, Div.-United Aircraft Corp.
Haskel Engrg. & Supply Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Joy Mfg. Co.
Kahn & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Leiman Brothers, Inc.
M. C. Mfg. Co.
M-D Blowers, Inc.
Mico Instrument Co.
Olin Mathieson Chemical Corp., N. Y.
Quincy Compressor Co.
Schutte & Koerting Co.
Solar Aircraft Co.
Stewart-Warner Corp., Alemite Div.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Superior Pneumatic & Mfg., Inc.
Van der Horst Corp. of America
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Wells Industries Corp.
Westinghouse Electric Corp.
Wickfield, Inc.
Worthington Corp.

COMPRESSORS, GAS

Accessory Controls & Equipment Corp.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allis-Chalmers
American Instrument Co., Inc.
Beach-Russ Co.
Budd Lewyt Electronics, Inc.
Carrier Corp.
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Cornelius Co., The, Aero Div.
Eastern Industries Inc.
Frick Co.
Fuller Co.
General American Transportation Corp.
Great Lakes Mfg. Corp.
Haskel Engrg. & Supply Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Joy Mfg. Co.
Leiman Brothers, Inc.
M. C. Mfg. Co.
M-D Blowers, Inc.
McGregor Mfg. Corp.
Schutte & Koerting Co.
Solar Aircraft Co.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Vilter Mfg. Co., The
Wells Industries Corp.
Westinghouse Electric Corp.
Worthington Corp.

COMPRESSORS, PORTABLE

Accessory Controls & Equipment Corp.
Air Logistics Corp.
***AIRESEARCH MFG. OF ARIZONA**
Allis-Chalmers
American Instrument Co., Inc.
Beach-Russ Co.
Binks Mfg. Co.
Budd Lewyt Electronics, Inc.
Carson Mach & Supply Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Cobehn, Inc.
Cornelius Co., The, Aero Div.
De Vilbiss Co., The
Eastern Industries Inc.
Gardner-Denver Co.
Haskel Engrg. & Supply Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Joy Mfg. Co.
Kahn & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Leiman Brothers, Inc.
M-D Blowers, Inc.
Olin Mathieson Chemical Corp., N. Y.
Quincy Compressor Co.
Solar Aircraft Co.
Superior Pneumatic & Mfg., Inc.
Wells Industries Corp.
Wickfield, Inc.
Worthington Corp.

COMPUTER INPUT EQUIPMENT

Alwac Computer, Div.-El-Tronics Inc.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
Autonetics, Div.-North American Aviation, Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Computer Div.-Bendix Aviation Corp.
Benson-Lehner Corp.
Bogue Electric Mfg. Co.
Bruno-New York Industries Corp.
Budd Co., The
Budd Lewyt Electronics, Inc.
Burroughs Corp.
Burroughs Corp., Electrodata Div.
California Computer Products, Inc.
Chance Vought Aircraft, Inc.
Curtiss-Wright Corp., Electronics Div., IMI Branch
Digital Sensors Inc.
Donner Scientific Co.
Electronic Computer Co., Inc.
Electronic Engrg. Co. of California
FAE Instrument Corp.
Fenske, Fedrick & Miller Inc.
General Electric Co., Heavy Military Electronics Dept.
General Kinetics Inc.
Gilfillan Bros. Inc.
Gyrex Corp., The
Huyck Systems Co.
Lear, Inc.
***WALLACE O. LEONARD INC.**
Librascope Div., General Precision, Inc.
Lundy Mfg. Corp.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div.
Motorola, Inc.
Navigation Computer Corp.
Northrup Corp.
Parabam, Inc.
Penn Keystone Corp.
Philco Corp.-Govt. & Industrial Group
Precision Specialties, Inc.
***RADIO CORP. OF AMERICA**
Remington Rand Univac Div.-Sperry Rand Corp.
Soroban Engrg., Inc.
Southwest Research Institute
Stromberg-Carlson Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Tally Register Corp.
Union Switch & Signal, Div.-Westinghouse Air Brake Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Wang Labs., Inc.

COMPUTER OUTPUT EQUIPMENT

Alwac Computer, Div.-El-Tronics Inc.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
Autonetics, Div.-North American Aviation, Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Computer Div.-Bendix Aviation Corp.
Benson-Lehner Corp.
Budd Co., The
Budd Lewyt Electronics, Inc.
Burroughs Corp.
Burroughs Corp., Electrodata Div.
California Computer Products, Inc.
Chance Vought Aircraft, Inc.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Donner Scientific Co.
Eastman Kodak Co.
Electro Instruments, Inc.
Electronic Computer Co., Inc.
Electronic Engrg. Co. of California
FAE Instrument Corp.
Fenske, Federick & Miller Inc.
GPL Div.-General Precision, Inc.
General Electric Co., Heavy Military Electronics Dept.
General Kinetics Inc.
Gilfillan Bros. Inc.
Huyck Systems Co.
Lear, Inc.
Leetronics, Inc.
Librascope Div., General Precision, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Motorola, Inc.
Navigation Computer Corp.
Northrop Corp.
Penn Keystone Corp.
Philco Corp.-Govt. & Industrial Group
Precision Specialties, Inc.
***RADIO CORP. OF AMERICA**
Remington Rand Univac Div.-Sperry Rand Corp.
Soroban Engrg., Inc.
Southwest Research Institute
Stromberg-Carlson Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Tally Register Corp.
Union Switch & Signal, Div.-Westinghouse Air Brake Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Wang Labs., Inc.

COMPUTERS

a. Analog
b. Digital
c. Navigation
d. Offset Track
e. Storage, Electrostatic
f. Storage, Ferroelectric
g. Storage, Magnetic

ACF Electronics Div., ACF Industries Inc., **a, b.**
ACF Industries Inc., **a, b.**
Acoustica Associates, Inc., **a, b.**
Advance Industries, Inc., **a thru d, g.**
Aeroflex Labs. Div., Aeroflex Corp., **a.**
Aeronca Mfg. Corp.-Aerospace Div., **a, b.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a.**
Airpax Electronics Inc., Cambridge Div., **a, b.**
Airpax Electronics Inc., Seminole Div., **a, b.**
Allegany Instrument Co., Inc., **a, b.**
Alwac Computer, Div.-El-Tronics Inc., **b, g.**
American Electronics, Inc., **a.**
Ampex Data Products Co., **g.**
Analogue Controls, Inc., **c.**
Applied Electronics Corp. of N. J., **a, b.**
Applied Research Labs., Inc., **a.**
Arrow Tool Co. Inc., **g.**
Atlas Precision Products, Co.
Autometric Corp., **a, b, g.**
Autonetics, Div.-North American Aviation, Inc., **a, b, c.**
Avco Corp., Crosley Div., **b.**
Avien, Inc., **g.**
Beckman Instruments, Inc., Berkeley Div., **a.**
Bell & Gossett Co., **a.**
Belock Instrument Corp., **a, b, c.**
Bendix Aviation Corp., **a thru d, f, g.**
Bendix Aviation Corp., Cincinnati Div., **a, b.**
Bendix Computer Div.-Bendix Aviation Corp., **b, g.**
Bendix Corp., The, Eclipse-Pioneer Div., **a thru d.**
Bowmar Instrument Corp., **a, c.**
Briggs Associates, Inc., **a, b, g.**
***BRISTOL CO., THE, a.**
Broadview Research Corp., **a thru g.**
Budd Co., The
Budd Lewyt Electronics, Inc., **a, b, c.**
Bulova Research & Development Labs., Inc., **a, b.**
Burroughs Corp., **a thru g.**
Burroughs Corp., Electrodata Div., **b, g.**
CGS Labs., Inc., **a, b.**
California Computer Products, Inc., **b, c.**
Chance Vought Aircraft, Inc., **a, b, c.**
Clifton Precision Products Co., Inc., **c.**
Collins Radio Co., **c.**
Colorado Research Corp., **a.**
Computer Control Co., Inc., **b, g.**
Computer Control Co., Inc., Western Div., **b, g.**
Computer Systems, Inc., **a.**
Consolidated Airborne Systems, Inc., **b.**
Control Data Corp., **b, g.**
Control Electronics Co., Inc., **b.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **b.**
Curtiss-Wright Corp., Electronics Div., **a, b.**
Curtiss-Wright Corp., Santa Barbard Div., **a, b.**
Dalmo Victor Co., Div.-Textron, Inc., **c.**
Daystrom, Inc., Control Systems Div., **b.**
Daystrom, Inc., Military Electronics Div., **a, b, c.**
Daystrom Inc., Pacific Div., **a.**
Daystrom Inc., Transicoil Div., **a, c.**
Delco Radio Div.-General Motors Corp., **b, c, g.**
Designers for Industry, Inc., **a, b, g.**
Detecto Scales, Inc., **b.**
Device Development Corp., **a.**
Djeco, Div.-Djordjevic Engrg. Co., **a, b.**
Donner Scientific Co., **a, b, c.**
Electro Precision Corp., **a, g.**
Electro Scientific Industries, **a.**
Electro-Mec Lab. Inc., **a, b.**
Electronics Div.-The National Cash Register Co., **b.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **a, c, g.**
Ensco, Inc., **a.**
Epsco Inc., **a thru g.**
***EQUIPMENT DIV., RAYTHEON CO., a thru d.**

Ex-Cell-O Corp., **g.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **a, b, c.**
Falstrom Co.
Feedback Controls, Inc., **a, c, d.**
Fenske, Federick & Miller Inc., **a, b.**
Ferroxcube Corp. of America, **f, g.**
Fischer & Porter Co., **a, b.**
Flight Support, Inc., **a, b.**
Forbes, George F., Industrial Mathematician, **a, b.**
Ford Instrument Co., Div.-Sperry Rand Corp., **a, b, c.**
GPL Div.-General Precision, Inc., **a, c, d.**
General Devices, Inc., **a, b.**
General Electric Co., Apparatus Sales Div., **a, b, g.**
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept., **a, b.**
General Electric Co., Computer Dept., **a, b.**
General Electric Co., Heavy Military Electronics Dept., **a, b.**
General Electric Co., Light Military Electronics Dept., **a, g.**
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Electric Co., Ordnance Dept., **a, b.**
General Instrument Corp., Defense & Engrg. Products Group, **a, b, c.**
General Mills, Inc., **b, c.**
Gilfillan Bros. Inc., **a, b, c.**
Gilmore Industries, Inc., **a.**
Goodyear Aircraft Corp., **a.**
Gulton Industries, Inc., **a, b.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co., **g.**
Hagan Chemicals & Controls Inc., **a, b.**
Hammett-Mercury-Rex Div., **a thru g.**
Hazeltine Electronics Div.-Hazeltine Corp.
Huyck Systems Co., **a, b, c.**
ITT Federal Div., International Telephone & Telegraph Corp., **a, b, c.**
Industrial Control Co., **a, e.**
Jardur Aviation Co., **c.**
Jardur Import Co., **c.**
***KEARFOTT DIV., GENERAL PRECISION, INC., a, b, c.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **a, b, c.**
Lab. for Electronics, Inc., **a, b, c, g.**
Lear, Inc., **a thru f.**
Leeds & Northrup Co., **a, b.**
Leemath Inc., **a.**
***WALLACE O. LEONARD, INC., a, b.**
Librascope Div., General Precision, Inc., **a, b, c, g.**
Litton Industries, Inc., **a, b, c.**
Lockheed Aircraft Corp., Missiles & Space Div., **a, b, c.**
Lockheed Electronics Co., Stavid Div., **a thru d.**
Loral Electronics Corp., **a, c.**
Lytle Corp., **c.**
MB Electronics, **a.**
Madigan Corp., **a thru g.**
Maico Electronics, Inc., **g.**
W. L. Maxson Corp., The, **a, b, c.**
Mc Donnell Aircraft Corp., **a.**
Midwestern Instruments, Inc., **b.**
Milgo Electronic Corp., **a, b.**
Minneapolis-Honeywell Regulator Col., Aeronautical Div., **a thru d.**
Minneapolis-Honeywell Regulator Co., Industrial Div., **a, b.**
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., **g.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **a thru g.**
***MINNESOTA MINING & MFG. CO., g.**
Motorola, Inc., **a thru f.**
National Co., Inc., **b, c.**
Navigation Computer Corp., **b.**
New London Instrument Co. Inc., **a.**
Newton Co., The, **b.**
Norden Div., United Aircraft Corp., **a, b, c.**
Northrop Corp., **b, c, g.**
Norton Associates, Inc., **g.**
Nortronics, Div.-Northrop Corp., **b, c, g.**
Otis Elevator Co., Defense & Industrial Div., **a.**
Packard Bell Computer Corp., **a, b, c.**
Patterson Moos Research, Div.-Leesona Corp., **a.**
Performance Measurements Co., **b.**
Philco Corp.-Govt. & Industrial Group, **b, c, e, f, g.**
Potter Instrument Co., Inc., **b, g.**
Production Research Corp., Sub.-Radio Condenser Co., **a, b, c.**
***RADIO CORP. OF AMERICA, b, c, d, g.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a, b, c, f, g.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **a, b, c.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **b.**
Reeves Instrument Corp., **a.**
Reflectone Electronics, Inc., **a.**
Remington Rand Univac Div.-Sperry Rand Corp., **b.**
Republic Aviation Corp., Missile Systems Div., **a, b, c.**
Rese Engrg., Inc., **b, g.**
Research, Inc., **a.**
Scientific-Atlanta, Inc., **a.**
Seiscor, Div.-Seismograph Service Corp., **a, c.**
Servomechanisms, Inc., **a, b.**
Sillcocks-Miller Co., **c.**
Singer Military Products Div.-The Singer Mfg. Co., **a, g.**
Skiatron Electronics & Television Corp., **a, b.**
Solar Aircraft Co., **b.**
Soroban Engrg., Inc., **a, c.**
Southwest Research Institute, **a, b.**
Southwestern Industrial Electronics Co.
Special Products Dept., Melpar, Inc., **a, b.**
Sperry Farragut Co., Div.-Sperry Rand Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp., **b, c, g.**
Strand Engrg. Co., **a, b.**
Stromberg-Carlson Div.-General Dynamics Corp., **b, c, e, f, g.**
Sun Electric Corp., Aeronautical Div., **a thru d.**
Systron Corp., **b.**
TRG, Inc., **a thru d.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a.**
Technitrol Engrg. Co., **b.**
Telechrome Mfg. Corp., **a, b.**
Telectro Industries Corp., **a, b, g.**
Telex, Inc., **b, g.**
Texas Instruments Inc., **a, b, c.**
Thompson Ramo Wooldridge Inc., **a, b.**
Thompson-Ramo-Wooldridge Products Co., The, **b, g.**
Trio Laboratories, Inc., **a, c.**
U. S. Science Corp., Div.-Topp Industries, Inc., **a.**
Wang Labs., Inc., **a, b.**
Westinghouse Electric Corp., **a, b, c.**

COMPUTERS, AIR DATA

ACF Industries Inc.
Advance Industries, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
Atlas Precision Products Co.
Autometric Corp.
Autonetics, Div.-North American Aviation, Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Broadview Research Corp.
Budd Co., The
Budd Lewyt Electronics, Inc.
Chance Vought Aircraft, Inc.
Daystrom Inc., Pacific Div.
Daystrom Inc., Transicoil Div.
Epsco Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Falstrom Co.
Feedback Controls, Inc.
Fenske, Federick & Miller Inc.
Flight Support, Inc.
GPL Div.-General Precision, Inc.
General Devices, Inc.
General Instrument Corp., Defense & Engrg. Products Group
Gulton Industries, Inc.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hammett-Mercury-Rex Div.
George E. Harris & Co., Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Huyck Systems Co.
Jardur Aviation Co.
Jardur Import Co.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
Librascope Div., General Precision, Inc.
Litton Industries, Inc.
Lytle Corp.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola, Inc.
Norden Div., United Aircraft Corp.
Northrop Corp.
Philco Corp.-Govt. & Industrial Group
Potter Instrument Co., Inc.
***RADIO CORP. OF AMERICA**
Remington Rand Univac Div.-Sperry Rand Corp.
Republic Aviation Corp., Missile Systems Div.
Servomechanisms, Inc.
Southwestern Industrial Electronics Co.
Specialties, Inc.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Thompson Ramo Wooldridge Inc.
United Control Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Western Gear Corp.-Precision Products Div.

CONDUITS

a. Electric
b. Fiber
c. Ignition Wire
d. Metal, Flexible
e. Metal, Non-Flexible

Aeroquip Corp., Jackson Div.
Aluminum Co. of America, **a, e.**
American Brass Co., The, **a, d.**
Anaconda Metal Hose Div., The American Brass Co., **a, c, d.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **d.**
Breeze Corporations, Inc., **c, d.**
Chase Brass & Copper Co., Inc., **e.**
Cobra Metal Hose Div. DK Mfg. Co., **d.**
Collins Mfg. Corp., **a.**
Co-Operative Industries, Inc., **c, d.**
Craig Systems, Inc., **e.**
Federal Metal Hose Corp., **d.**
Flexible Metal Hose Mfg. Co., **a, c, d.**
Flexible Tubing Corp., **a.**
Flexonics Corp., **d.**
Hallett Mfg. Co., **a, c, d, e.**
George E. Harris & Co., Inc., **c, d.**
Harvey Aluminum, **e.**
Johnson Metal Hose, Inc., **c, d.**
Kaiser Aluminum & Chemical Sales, Inc., **a, e.**
Lamtex Industries Inc., **b.**
Line Material Industries-Mc Graw-Edison Co., **b.**
Marco Industries Co., **a, d.**
Marman Div., Aeroquip Corp., **d, e.**
***MARTIN CO., THE, DENVER DIV., a, d.**
***MINNESOTA MINING & MFG. CO., a, b, d, e.**
Reynolds Metals Co., **a, e.**
Rogers Corp., **b.**
Rome Cable Div.-Alcoa, **a, e.**
Saylor Electric Products Corp., **b.**
Scintilla Div., Bendix Aviation Corp., **a, c, d, e.**
Servicair Co., **c, d.**
Skytronics, Inc., **a, c, d.**
Thor Ceramics, Inc., **c.**
Titeflex, Inc., **d.**
Union Asbestos & Rubber Co., **b.**
United Wire & Supply Corp., **e.**
Western Control Corp., **d.**
Western Div., Aeroquip Corp.
Wiremold Co., The, **a.**
Woolf Aircraft Products, Inc., **e.**
Zippertubing Co., The, **a, d.**

CONES, EXHAUST

Allison Div., General Motors Corp.
Alloy Products Corp.
American Welding & Mfg. Co., The
Anchor Metal Spinning Co., The
Arde-Portland, Inc.
Associated Co., Inc.
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Bethlehem Steel Co.
Brighton Corp.
Brook Molding Corp.
Bruce Engrg. Co.
Brunswick Balke Collender Co., The, Defense Products Div.
Calcor Corp.
California Stamping & Mfg. Co.
Carborundum Co., The
Colonial Aircraft Corp.
Commercial Shearing & Stamping Co.
Crane Co., Special Products Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Delta Corp.
***EXCELCO DEVELOPMENTS INC.**
Ex-Cell-O Corp.
Fansteel Metallurgical Corp.
B. F. Goodrich Aviation Products
H & H Mfg. Co. Inc.
Hanlon & Wilson Co., The
Henry & Miller Industries, Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
ITE Circuit Breaker Co., Special Products Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
C. B. Kaupp & Sons, Inc.
Kelsey-Hayes Co.
Kerns Mfg. Corp.
Ladish Co.
Lamtex Industries Inc.
***LAVELLE AIRCRAFT CORP.**
Le Fiell Mfg. Co.
Lycoming Div., Avco Corp.

McGregor Mfg. Corp.
***MINNESOTA MINING & MFG. CO.**
National Carbon Co., Div.-Union Carbide Corp.
Norris-Thermador Corp.
Pastushin Industries, Inc.
Penn-Michigan Mfg. Corp.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Prewitt Aircraft Co.
Raybestos-Manhattan, Inc.
Edw. Renneburg & Sons Co.
Rimak, Inc.
Solar Aircraft Co.
Superior Spinning & Stamping Co.
Swedlow Inc.
Taylor Fibre Co.
Thermionic Aeronautical Div.
C. W. Torngren Co., Inc.
Twin Coach Co., Aircraft-Missiles
Unified Industries, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Chemical Milling Corp.
Young Development Div., Hercules Powder Co.

CONES, METAL

Allison Div., General Motors Corp.
Alloy Products Corp.
Aluminum Co. of America
American Aluminum Co.
American Welding & Mfg. Co., The
Ampco Metal, Inc.
Anchor Metal Spinning Co., The
Associated Co., Inc.
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Belmar Wheel & Machine Co., Inc.
Bethlehem Steel Co.
S. Blickman, Inc.
Brighton Corp.
Brooks & Perkins, Inc.
Calcor Corp.
California Stamping & Mfg. Co.
G. O. Carlson, Inc.
Central Safety Equip. Co.
Colonial Aircraft Corp.
Colorado Fuel & Iron Corp., The
Commercial Shearing & Stamping Co.
Crane Co., Special Products Div.
Cromer Mfg. & Engrg., Inc.
Custom Tool & Mfg Co.
Cutler Metal Products Co.
Delta Corp.
Elzee Metal Products Co., Inc.
Ex-Cell-O Corp.
Fansteel Metallurgical Corp.
General Electric Co., Missile & Space Vehicle Dept.
H & H Mfg. Co. Inc.
Hahn & Clay
Hamilton Standard, Div.-United Aircraft Corp.
Hanlon & Wilson Co., The
Henry & Miller Industries, Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hughes Tool Co., Aircraft Div.
Hydroforming Co. of America Inc.
ITE Circuit Breaker Co., Special Products Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
C. B. Kaupp & Sons, Inc.
Kellett Aircraft Corp.
Kelsey-Hayes Co.
Kentucky Metal Products Co.
Kirk & Blum Mfg. Co., The
Kling Metal Spinning & Stamping Co.
***LAVELLE AIRCRAFT CORP.**
Le Fiell Mfg. Co.
Lycoming Div., Avco Corp.

***MARTIN CO., THE, DENVER DIV.**
McGregor Mfg. Corp.
Nooter Corp.
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
Ohlson Empire Inc.
Pastushin Industries, Inc.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Edw. Renneburg & Sons Co.
Rimak, Inc.
Solar Aircraft Co.
Spincraft, Inc.
Stamping Div.,-Rockwell Standard Corp.
Superior Spinning & Stamping Co.
C. W. Torngren Co., Inc.
Tube-Turns Div., Chemetron Corp.
Twin Coach Co., Aircraft-Missiles
Unified Industries, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Chemical Milling Corp.
Waste King Corp., Technical Products Div.

CONES, SPEAKER

Belmar Wheel & Machine Co., Inc.
Kling Metal Spinning & Stamping Co.
***MAGNAVOX CO., THE**
Parsons Corp., Special Products Div.
Paul & Beekman, Inc.
Rimak, Inc.
Stamping Div.-Rockwell Standard Corp.
Unified Industries, Inc.

CONNECTOR, OXYGEN EQUIPMENT

Aerotec Industries Inc., Aircraft Equipment Div.
Airaterra
All Specs Corp.
American Latex Products Corp.
Anaconda Metal Hose Div., The American Brass Co.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
Bruning Co., The
Essex Mfg. Co., Inc.
B. H. Hadley, Inc.
Hofman Labs., Inc.
National Cylinder Gas, Div.-Chemetron Corp.
On Mark Couplings, Inc.
Richard Philip Co.
Roylyn Inc.
Weatherhead Co., The

CONNECTORS, ELECTRICAL

a. Explosion-Proof
b. High Voltage
c. Microphone
d. Miniature
e. Power
f. Pressurized
g. Printed Circuit
h. Rack & Panel
i. Subminiature

AMP Inc., **d, g, h.**
A. P. M. Corp., **e.**
Accurate Electronics Corp., **b thru e, g, h, i.**
Aerolite Electronics Corp., **b, c, d.**
Airaterra
Aircom Inc., **c.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., b, e.**
Airwork Corp., **d, f, h.**
Alden Products Co., **b, d, e, h.**
All Specs Corp., **d.**
American Research & Mfg. Corp., **b, d.**
Armel Electronics, Inc., **d, e, g, h.**
Arnoux Corp., **d, f thru i.**
Avco Corp., Crosley Div., **d, g, i.**
Avnet Corp., **b, d, e, f, h.**
Wallace Barnes Div. Associated Spring Corp., **d.**
Bead Chain Mfg. Co., The, **d, g.**
Bendix Aviation Corp., **a thru f, h, i.**
Birnbach Radio Co., Inc., **c, d, h, i.**
Bo Myte Co., Inc., The, **g.**
Richard D. Brew & Co., Inc., **b.**
H. H. Buggie Div., Burndy Corp., **a, b, d thru i.**
Burndy Corp., Omaton Div., **b, d thru i.**
Cable Electric Products Inc., **b, d, e.**
Cal Connector Co., **a thru f, h, i.**
Cambridge Thermionic Corp., **d, g.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **a thru d, h, i.**
Cannon Electric Co., **a thru i.**
Carborundum Co., Latrobe Plant, Refractories Div., **b.**
Carol Electronics Corp., **e.**
Ceramaseal, Inc., **b.**
Coaxial Connector Co. Inc., **b, d thru i.**
Cole Electric Co., **a, b, e, h.**
***CONSOLIDATED ELECTRODYNAMICS CORP., d.**
Continental Connector Corp., **b, d thru i.**
Dejur-Amsco Corp., Electronic Sales Div., **b, d thru i.**
Deutsch Co., The, Electronic Components Div., **b thru f, h, i.**
Dialight Corp., **c, d, i.**
R. C. Dudek & Co., **d, g, i.**
E-Z-Hook Test Products, **d.**
Eagle Electric Mfg. Co. Inc., **e.**
Elco Corp., **c, d, e, g, h, i.**
Electro Tec Corp., **d.**
Electro-Miniatures Corp., **d, i.**
Epoxy Products, Inc., Div.-Joseph Waldman & Sons, **d, g.**
Federal Screw Products Inc., **c.**
G-C Electronics Co., **c.**
Garde Mfg. Co., **g, h.**
Garlock Packing Co., The-Electronic Products, **d, i.**
General Products Corp., **d, h.**
General Radio Co., **h.**
General RF Fittings, Inc., **d, f.**
Good Electronic Corp., **g.**
Gorn Electric Co., Inc., Aircraft Controls Div., **b, d, e, g, h.**
Gorn Electric Co., Inc., Gorn Electronics Div., **b, d, e, g, h.**
Graphik Circuits, Div.-Cinch Mfg. Co., **g, h.**
Gulton Industries, Inc., **d, i.**
Hammett-Mercury-Rex Div., **a, b, e.**
Harco Labs., Inc., **d, e.**
George E. Harris & Co., Inc., **a, d, g, h, i.**
Hermetic Seal Corp., **a thru d, f, h, i.**
Hermetic Seal Corp. & Thermal Controls, Inc., **a thru i.**
Hi-Shear Rivet Tool Co., **a.**
Hobson Brothers, Inc., **b.**
Huyck Systems Co.
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp., **h.**
Javex Electronics, **d, e, h.**
Jettron Products, Inc., **d, i.**
Joclin Mfg. Co., The, **b, d.**
E. F. Johnson Co., **b, d, e, g, h, i.**
Howard B. Jones Div.-Cinch Mfg. Corp., **c, d, e, g, h, i.**
Joy Mfg. Co., **b, e, f.**
Kings Electronics Co., Inc., **b, c, d, f, g, i.**
Kolton Electric Mfg. Co., **e.**
Kulka Electric Corp., **e, g, i.**
Lab-Tronics, Inc., **c, d, e, h.**
Lear, Inc., **a, g, i.**
Leviton Mfg. Co., Inc., **d, e.**
Liquidometer Corp., The, **d, i.**
MEG Products, Div.-Mandrel Industries, Inc.
Modigan Corp., **a.**
Malco Mfg. Co., **d, g.**
***MARTIN CO., THE, DENVER DIV., h.**
Mc Cormick Selph Associates, **f.**
Microdot Inc., **d, f, g, i.**
James Millen Mfg. Co. Inc., **b, d.**
Molded Insulation Co., **d, i.**
Molding Corp. of America, **b, d, f, i.**
Frank W. Morse Co., **d.**
Motorola, Inc., **g.**
Norrich Plastics Corp., **b, c, d, g.**
Norrich Screw Machine Products, **d, i.**
Nugent Electronics Co., Inc., **d, g, i.**
On Mark Couplings, Inc., **a, e, f, h.**
Pacific Scientific Co., **d, g, i.**
Piasecki Aircraft Corp., **c, d, g, h.**
Harold H. Powell Co., **d, f, h.**
Pyle-National Co., The, **a, d, e, f.**
Q-Circuits, Div.-Etching Co. of Calif., **g.**
Radalab Inc., **c.**
Refractories Div., The Carborundum Co.
Remler Co., **c, f.**
Research Development Mfg. Inc., **d, i.**
Robins Industries Corp., **c.**
Rogers Corp., **g.**
Milton Ross Metals Co., The, **a, b, d thru i.**
Roylyn Inc.
Rye Sound Corp., **c, d, g, i.**
Scintilla Div., Bendix Aviation Corp., **b, d, e, f, h, i.**
Sealectro Corp., **i.**
Sealtron Corp., **d, h.**
C. Sjoberg & Son, **c, d, i.**
Specialty Electronics Development Corp., **e.**
Superior Electric Co., The, **e.**
Telechrome Mfg. Corp., **e, h.**
Tetrafluor, Inc.
Thermo Electric Co., Inc., **h.**
Thomas & Betts Co., Inc., The
Thor Ceramics, Inc., **b, i.**
Titeflex, Inc., **a, b, d, e.**
Tru-Connector Corp., **b, e, f, i.**
United Shoe Machinery Corp., **d, g.**
U. S. Components Inc., **b, d thru i.**
United Supply Co.
Vector Mfg. Co.
Viking Industries Inc., **b, d, thru i.**
Western Insulated Wire Co.
Winchester Electronics, Inc., **b, d thru i.**
Winder Aircraft Corp. of Florida, **a, b.**

CONNECTORS, ELECTRICAL FIREWALL

***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
All Specs Corp.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Avnet Corp.
Bendix Aviation Corp.
H. H. Buggie Div., Burndy Corp.
Cable Electric Products Inc.
Cal Connector Co.
California Plasteck Inc.
Cannon Electric Co.
Coaxial Connector Co. Inc.
Cole Electric Co.
Deutsch Co., The, Electronic Components Div.
Hermetic Seal Corp.
Janco Corp.
Norrich Screw Machine Products
On Mark Couplings, Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Milton Ross Metals Co., The
Scintilla Div., Bendix Aviation Corp.
Skytronics, Inc.
Texstar Plastics, Div.-The Texstar Corp.
Thor Ceramics, Inc.

Viking Industries Inc.

CONNECTORS, RF

Airtron, Div.-Litton Industries
***ANDREW CORP.**
Arnoux Corp.
Avnet Corp.
Bendix Aviation Corp.
H. H. Buggie Div., Burndy Corp.
Burndy Corp., Omaton Div.
Cal Connector Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Cannon Electric Co.
Coaxial Connector Co. Inc.
Cole Electric Co.
Connector Corp. of America
Dage Electric Co., Inc.
Deutsch Co., The, Electronic Components Div.
Don-Lan Electronics Inc.
Dow-Key Co.
Electronic Specialty Co.
General Communication Co.
General Radio Co.
General RF Fittings, Inc.
Good-All Electric Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hallett Mfg. Co.
Hermetic Seal Corp.
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp.
Instruments for Industry, Inc.
Interstate Electronics Inc.
Jettron Products, Inc.
Kings Electronics Co., Inc.
Microdot Inc.
Microlab
Nugent Electronics Co., Inc.
Phelps Dodge Copper Products Corp.
Harold H. Powell Co.
Prodelin Inc.
Radalab Inc.
Milton Ross Metals Co., The
Tamar Electronics, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Telcon, Inc.
Thompson Ramo Wooldridge Inc.
Tober Electronic Corp.
Tru-Connector Corp.
Tucson Instrument Corp.
Victor R. F. & Microwave Co.
Weatherhead Co., The

CONNECTORS, SKID & SLED

American Instrument Co., Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
H. H. Buggie Div., Burndy Corp.
Burndy Corp., Omaton Div.
Cal Connector Co.
Cannon Electric Co.
Capewell Mfg. Co.
Coaxial Connector Co. Inc.
B. H. Hadley, Inc.
On Mark Couplings, Inc.

CONSOLES, AUDIO

A&P Metal Products Mfg. Corp.
Amco Engrg. Co.
Brooks & Perkins, Inc.
Bud Radio, Inc.
Calcor Corp.
Chalco Engrg. Corp.
Chance-Vought Aircraft, Inc.
Dahlstrom Metallic Door Co.
Du Kane Corp.
Electronic Applications, Inc.
Elzee Metal Products Co., Inc.
Folstrom Co.
Fouch Electric Mfg. Co., Inc.
Gates Radio Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Corp.
Magnasync Corp.
***MAGNAVOX CO., THE**
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
Pneumafil Corp.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Remler Co.
Rimak, Inc.
Sonex, Inc.
Technical Materiel Corp., The
Technical Products Co.
Telectro Industries Corp.
Unified Industries, Inc.
Virginia Electronics Co., Inc.
Waco Aircraft Co.
Wickes Engrg. & Construction Co.

CONSOLES, LIGHTING CONTROL

A&P Metal Products Mfg. Corp.
Amco Engrg. Co.
American Machine & Foundry Co., Government Products, N.Y.
Anchor Specialty Mfg. Co. Inc.
Chance Vought Aircraft, Inc.
Dahlstrom Metallic Door Co.
Elzee Metal Products Co., Inc.
Folstrom Co.
Fouch Electric Mfg. Co., Inc.
Grimes Mfg. Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kirk & Blum Mfg. Co., The
Lear, Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Motorola, Inc.
Pneumafil Corp.
Rimak, Inc.
Standard Electric Time Co., The
Technical Products Co.
Tucson Instrument Corp.
Vickers Inc., Electric Products Div.
Waco Aircraft Co.
Wells Industries Corp.
Westinghouse Electric Corp.
Wickes Engrg. & Construction Co.

CONTACTORS

Allied Precision Products, Inc.
Automatic Switch Co.
Clark Controller Co., The
Electro-Mechanical Specialties Co., Inc.
Fansteel Metallurgical Corp.
General American Transportation Corp.
General Electric Co., Apparatus Sales Div.
General Radio Co.
Hammett-Mercury-Rex Div.
Leach Corp.
Mason Electric Corp.
Ohio Carbon Co., The
Vap-Air Aeronautical Products Div., Vapor Heating Corp.
Weltronic Co.
Westinghouse Electric Corp.

CONTAINERS

ACF Industries Inc.
A&P Metal Products Mfg. Corp.
Aerocal Div., Aeronca Mfg. Corp.
Air Logistics Corp.
American Aluminum Co.
American Brass Co., The
American Car & Foundry Div., ACF Industries, Inc.
American Machine & Foundry Co., Government Products, N.Y.
American Welding & Mfg. Co., The
Applied Design Co.
Arnalt Corp.
Aro Equipment Corp., The
Atkins & Merrill, Inc.
Cyril Bath Co., The
Brooks & Perkins, Inc.,
Buffalo Metal Container Corp.
Butler Mfg. Co.
Champion Co., The
Clover Industries Inc.
Container Labs., Inc.
Craig Systems, Inc.
Cromer Mfg. & Engrg., Inc.
Cutler Metal Products Co.
Dempster Brothers, Inc.
Douglas Aircraft Co., Inc.
George D. Ellis & Sons, Inc.
Eubanks Industries, Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.

Folstrom Co.
Farwell Metal Fabricating
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
Gatewood Products, Inc.
General American Transportation Corp.
General Box Co.
General Electric Co., Missile & Space Vehicle Dept. Pa.
Goldsman
Harco Containers Div.-Harbor Boat Building Co.
Harvey Aluminum
Ludwig Honold Mfg. Co.
Hydroforming Co. of America Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
International Steel Co.
Jeta, Inc.
Jet-Heet, Inc.
Kellett Aircraft Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kirk & Blum Mfg. Co., The
H. Koch & Sons
Lockheed Aircraft Corp., Missiles & Space Div.
Lofstrand Co., The
Lunn Laminates, Inc.
Lycoming Div., Avco Corp.
Norrich Plastics Corp.
Northeast Metals Industries, Inc.
Northrop Corp.
Olin Mathieson Chemical Corp., N.Y.
Parsons Corp., Special Products Div.
Pastushin Industries, Inc.
Penn-Michigan Mfg. Corp.
Piasecki Aircraft Corp.
Pressed Steel Tank Co.
Protectoseal Co., The
Pry Welding & Mfg., Inc.
REF Mfg. Corp.
Republic Steel Corp.
Rimak, Inc.
Roberts Industries Inc.
Royal Jet, Div.-Royal Industries, Inc.
Sillcocks-Miller Co.
Skydyne, Inc.
Southwest Research Institute
Spincraft, Inc.
Superior Air Products Co.
Texstar Plastics, Div.-The Texstar Corp.
Trailmobile Inc.
Twix Mfg. Co., Inc.
Vendorlator Mfg. Co.
Waco Aircraft Co.
Weber Aircraft Corp.
Young Development Div., Hercules Powder Co.
Zenith Electric Co.

CONTROLS

a. Audio Recording
b. Automatic Approach
c. Broadcasting Input
d. Camera
e. Camera, Remote
f. Capacitance Operated
g. Chemical
h. Combustion
i. Computer
j. Conductivity
k. Counting & Sorting
l. Density
m. Dimension
n. Dynamometer
o. Electronic AC Motor Speed
p. Engine
q. Film Thickness
r. Fire
s. Flame Failure
t. Fluid Conductivity
u. Fluid Flow
v. Fuel
w. Gas
x. Heat Treating
y. Humidity
z. Illumination
a-1. Inspection
b-1. Liquid Level
c-1. Loop Regulation
d-1. Machine Safety
e-1. Master
f-1. Materials Thickness
g-1. Mechanical Overload
h-1. Mechanical Switch
i-1. Motor & Generator
j-1. Motor & Generator Communications
k-1. Motor & Generator, Industrial
l-1. Oxygen
m-1. Ph
n-1. Photoelectric
o-1. Photographic Exposure
p-1. Positioning
q-1. Power Level
r-1. Pressure
s-1. Push-Pull
t-1. Radio Remote
u-1. Reactor, Nuclear
v-1. Register
w-1. Register Cutter
x-1. Remote, Antenna
y-1. Servo
z-1. Signal
a-2. Smoke Density
b-2. Sound System
c-2. Specific Gravity
d-2. Speed
e-2. Strain
f-2. Tension
g-2. Timing
h-2. Torque, Electronic
i-2. Turbidity
j-2. Vacuum
k-2. Ventilating Control System
l-2. Voltage Regulator
m-2. Volume
n-2. Volume & Tone

o-2. Weight
p-2. Welding
q-2. X-Ray

ACF Electronics Div., ACF Industries Inc., **k**, i-1, **o-2**.
ACF Industries Inc., **i**, r-1, **y-1**, **j-2**.
***ABRAMS INSTRUMENT CORP.**, **d**, o-1, **g-2**.
Accessory Products Co., Div.-Textron Inc., **u**, **v**, **w**, b-1, **l-1**, r-1, **j-2**.
Acme Industrial Co., **u**.
Acoustica Associates, Inc., **u**, **b-1**.
Actuation Research Corp., **u**, **c-1**, u-1.
Adel Precision Products of Calif., Div.-General Metals Corp., **u**.
Advance Industries, Inc., **u**, **x-1**, **y-1**.
Advance Instrument Corp., **y-1**.
Advanced Electronics, Inc., **a-1**.
Aero Instrument Co., **r-1**, **j-2**.
Aero Supply Mfg. Inc., **p**, **u**, **v**.
Aeroflex Labs. Div., Aeroflex Corp., **e**, **f-1**, **p-1**, **x-1**, **y-1**.
***AEROJET-GENERAL CORP.**, u, u-1.
Aeronca Mfg. Corp.-Aerospace Div., **i**, **k**, **a-1**, **y-1**, **d-2**.
Aeroscience, Inc., **k**, **m**, **u**, **e-2**, **f-2**, **h-2**, **o-2**.
Aerotec Industries Inc., Aircraft Equipment Div., **u**, **v**, **w**, **b-1**, **h-1**, **l-1**, r-1, **j-2**, **k-2**, **m-2**.
Agastat Timing Instruments-Elastic Stop Nut Corp. of America, **g-2**.
Agriculture Aviation Engineering Co. Inc., **u**.
Air Products, Inc., **l-1**, **p-2**.,
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **p-2**.
Airborne Accessories Corp., **d**, **p**, **v**.,
Aircraft Accessory Turbine Dept.-General Electric Co., **p**, **u**, **v**, **w**, **i-1**, **p-1**, r-1, **y-1**, **d-2**.
***AiRESEARCH MFG. OF ARIZONA**, **u**, **v**, **w**, **y**, **l-1**, r-1, **y-1**, **d-2**, **j-2**.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**, **t thru w**, **i-1**, **p-1**, **q-1**, r-1, **y-1**, **d-2**, **k-2**.
Airpax Electronics Inc., Cambridge div., **i**, **d-1**, **d-2**.
Airpax Electronics Inc., Seminole Div., **i**, **d-1**, **d-2**.
Alco Valve Co., **b-2**, **r-2**.
Alfred Electronics, **j-2**.
Allegany Instrument Co., Inc., **d**, **r-2**, **e-2**, **f-2**.,
Allied Chemical Corp., General Chemical Div., **g**.
Allis- Chalmers, **i-1**, **k-1**, **p-1**, **d-2**, **l-2**.
Allison Div., General Motors Corp., **h**, **p**.
American Electronics, Inc., **i-1**, **k-1**, **p-1**, **q-1**, **y-1**, **h-2**.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., **k**, **o-2**.
American Instrument Co., Inc., **q**, **y**, **f-1**, **m-1**, r-1.
American Machine & Foundry Co., **y-1**.
American Machine & Foundry Co., Government Products, N.Y., **k**, **p**, **v**, r-1, **u-1**, **x-1**, **c-2**.
American Machine & Foundry Co., Greenwich Engrg Div., **x-1**, **y-1**.
American Measurement & Control, Inc., **y-1**..
American Optical Co., **o-1**.,
American Potash & Chemical Corp., National Northern Div., **g**.
American Rectifier Corp., **d-1**, **i-1**.
American Research & Mfg. Corp., **o**, **a-1**, **n-1**, r-1, **y-1**, **l-2**.
Amglo Corp., **g-2**.,
Ampex Data Products Co., **i**.,
Andersen Labs., Inc., **x**.
Antlab Inc., **p-1**, **x-1**, **y-1**.
Applied Design Co., **d**, **i**, **p**.
Applied Dynamics Corp., r-1.
Applied Electronics Corp. of N. J., **d-2**, **e-2**, **g-2**.
Arens Controls, Inc., **s-1**.
Armament Div.-Universal Match Corp., **y-1**.
Arnoux Corp
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., r-1.
Arrow-Hart & Hegeman Electric Co., The, **i-1**, **k-1**.
Assembly Products, Inc., **g-1**, **m-1**, r-1, **d-2**, **l-2**, **m-2**.
Associated Co., Inc., **p**.
Raymond Atchley, Inc., **y-1**.,
Automatic Switch Co., **u**, **i-1**, **j-1**, **k-1**, u-1.,
Automatic Timing & Controls, Inc., **k**, **m**, **q**, **b-1**, **p-1**, r-1, **u-1**, **x-1**, **y-1**, **z-1**, **e-2**, **f-2**, **g-2**, **o-2**, **p-2**, **q-2**.
Automation Products, Inc., **l**, **b-1**, **c-2**, **i-2**.,
Autometric Corp., **p-1**, **y-1**.,
Automotive & Aircraft Div.-American Chain & Cable Co., Inc., **s-1**.
Autotron, Inc., **z**, **a-1 thru d-1**, **n-1**, **v-1**, **a-2**.
Autotronics Inc., **d-2**.
Avco Corp., Crosley Div., **t-1**, **d-2**, **g-2**.
Avien, Inc., **u**, **v**, **x**, **b-1**, **y-1**.
Babcock Radio Engrg., Inc., **t-1**.
Barber-Colman Co., **p-1**, **y-1**, **k-2**.
Beckman Instruments, Inc., Berkeley Div., **d-2**, **g-2**.
Bell & Gossett Co., **i**, **z-1**.
Belock Instrument Corp., **d**, **e**, **i**, x-1, **y-1**, **g-2**.
Bendix Aviation Corp., **b**, **i**, **k**, **p**, **u**, **v**, **w**, **y**, **z**, **b-1**, **f-1**, **i-1**, **l-1**, **p-1**, r-1, **t-1**, **u-1**, **x-1**, **y-1**, **z-1**, **d-2**, **k-2**, **l-2**.
Bendix Aviation Corp., Cincinnati Div., **i**, **t-1**, **u-1**, **z-1**, **g-2**, **l-2**.
***BENDIX AVIATION CORP., HAMILTON DIV.**, **p**, **u**, **v**, **y-1**.
Bendix Aviation Corp.-Montrose Div., **p-1**, r-1, **y-1**.
Bendix Aviation Corp., Pioneer-Central Div., **b-1**, **l-1**.
Bendix Corp., The, Eclipse-Pioneer Div., **b**.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**, **h**, **p**, **u**, **v**, **p-1**, **y-1**.
Bendix Utica Div., Bendix Aviation Corp., **p**, **u**, r-1, **y-1**, **g-2**.
Bendix -Pacific Div., Bendix Aviation Corp., **p-1**, **y-1**, **g-2**.
Benson-Lehner Corp., **d**, **e**, **i**, o-1, **y-1**.
Bergen Labs., Inc., **h-2**, **l-2**.
Bergen Wire Rope Co., **s-1**.
Bernco Engrg. Corp., **p**, **h-1**, **i-1**, **g-2**.
A. Biederman, Inc., **l-1**, **y-1**.
Blaco Mfg. Co., **s-1**.
Blonder-Tongue Labs., Inc., **a**.
Bogue Electric Mfg. Co., **b-1**, **i-1**, **k-1**, **y-1**.
Bowmar Instrument Corp., **g-1**, **p-1**, **y-1**, **d-2**.
Brach Mfg. Corp., **o**, **z**, **c-1**, **q-1**, **y-1**, **d-2**, **l-2**.
Branson Corp., **g-2**.,
Branson Instruments, Inc., **m**, **q**, **a-1**, **f-1**, **p-2**.
Breeze Corporations, Inc., **b-1**.
Briggs Associates, Inc., **g**, **i**, **p-2**.
***BRISTOL CO., THE.**, **x**, **y**, **b-1**, m-1, r-1, **g-2**, **j-2**.
Broadview Research Corp., **b**, **y-1**, **z-1**.
Brooks Rotameter Co., **u**, **v**, **w**, **b-1**, **c-2**.
Bruno-New York Industries Corp., **i**, **t-1**.
Budd Co., The, **a-1**, **f-1**, **g-1**, **e-2**, **f-2**, **p-2**.
Bulova Research & Development Labs., Inc., **i**, **g-2**.
Burroughs Corp., Electrodata Div., **i**.
Burton-Rodgers, Inc., **i**, **o**, **l-2**.
A.M. Byers Co., **u-1**.
Bytrex Corp., **n**, **u**, **e-2**, **f-2**, **o-2**.
CBS Laboratories, Div.-Columbia Broadcasting System, **a**, **d**, **e**, **q**, **n-1**.
Cadillac Gage Co., **u**, **p-1**, r-1, **y-1**.
California Plasteck Inc., **z**.
California Stamping & Mfg. Co., **p-2**.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **a**, **d**, **e**.
Captive Seal Corp., **v**, **w**.
Carleton Aviation Co., Inc., **s**, **u**, **w**, **l-1**, r-1, **g-2**, **j-2**, **m-2**.
Carling Electric, Inc., **o**, **z**, **h-1**, **s-1**.
Carson Mach & Supply Co., **w**, **i-1**, **k-1**.
Cedar Engrg. Div.-Control Data Corp., **i-1**, **j-1**, **y-1**.
Centralab Div.-Globe-Union Inc., **m-2**, **n-2**.
Chalco Engrg. Corp., **w**, **b-1**, **c-1**, **p-1**, r-1, **y-1**, **g-2**.
Chance Vought Aircraft, Inc., **p**, **p-1**, **y-1**.
Clark Controller Co., The, **n**, **o**, **c-1**, **d-1**, **g-1**, **h-1**, **i-1**, **k-1**, **n-1**, **p-1**, **y-1**, **a-2**.
i-1, **k-1**, **n-1**, **p-1**, **y-1**, **a-2**, **d-2**, **f-2**, **g-2**, **h-2**, **l-2**.
Clarostat Mfg. Co., Inc., **m-2**, **n-2**.
Cleveland Instrument Co., **m**, **a-1**.
Clevite Ordance, Div.-Clevite Corp., **p-1**, **t-1**, **y-1**.
Coleman Electronics, Inc., **p-1**.
Collins Radio Co., **a**, **c**.
Colorado Research Corp., **i**, **y-1**, **k-2**.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**, **p-2**.
Communications Research Co., **t-1**.
Components Corp., **u**.
Compudyne Corp., **u**, **v**, **p-1**, r-1, **U-1**, **e-2**, **f-2**.
Computer Control Co., Inc., **i**.,
Computer Control Co., Inc., Western Div., **i**.
Conoflow Corp., **u**, **v**, **w**, **b-1**, r-1, **j-2**.
Consolidated Airborne Systems, Inc., **f**, **l**, **q**, **u**, **v**, **a-1**, **b-1**, **y-1**, **d-2**.
Consolidated Controls Corp., **m**, **o**, **p**, **u**, **v**, **w**, **b-1**, j-1, **p-1**, r-1, **u-1**, **y-1**, **z-1**, **d-2**, **j-2**.
Continental-Wirt Electronics Corp., **m-2**, **n-2**.
Control Electronics Co., Inc., **y-1**.
Control Technology Co., **d**, **e**, **g-2**.
Convair Instruments, Convair Div.-General Dynamics Corp., **b-1**.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **u**, **v**, **w**, **l-1**, r-1.
Cramer Controls Corp., **g-2**
Crescent Engrg. & Research Co., **p-1**, r-1, **y-1**, **d-2**.
Croname Inc., **t-1**.
Curtiss-Wright Corp., Princeton Div., **l**, **q**, **a-1**, **u-1**, **l-2**, **q-2**.
Custom Component Switches Inc., **p**, **r**, **u**, **v**, **w**, **b-1**, **d-1**, **g-1**, **l-1**, r-1, **d-2**, **k-2**.
DBM Research Corp., **d**, **e**, **g-2**.
Dage Television Div., Thompson Ramo Wooldridge, Inc., **c**.
George W. Dahl Co., Inc., **w**.
Dale Products, Inc., **o**.
Dalmo Victor Co., Div.-Textron, Inc., **u**, **p-1**, **y-1**.
Data-Control Systems, Inc., **t-1**.
Datex Corp., **p-1**, r-1, **u-1**, **x-1**, **y-1**, **g-2**.
Daven Co., The, **a**, **c**, **b-2**, **m-2**, **n-2**.
Davenport Mfg. Co., **l-2**.
Joe Davidson & Associates., **n**, **o**, **r**, **i-1**, **j-1**, **k-1**, **p-1**, r-1, **s-1**, **x-1**, **y-1**, **d-2**, **g-2**, **h-2**.
Daystrom Inc., Control Systems Div., **p-1**, **u-1**, **y-1**.
Daystrom Inc., Military Electronics Div., **u-1**.
Daystrom Inc., Pacific Div., **i**, r-1.
Daystrom Inc., Weston Instrument Div., **q**, **y**, **n-1**, **o-1**, r-1.
Daytronic Corp., **k**, **m**, **d-1**, **f-1**, **p-1**, **e-2**, **f-2**.
Decker Corp., The, **b**, **f**, **l**, **m**, **q**, **u**, **y**, **a-1**, **b-1**, **f-1**, **p-1**, r-1, **y-1**, **c-2 thru g-2**, **j-2**.
Dejur-Amsco Corp., Electronic Sales Div., **d**, **n-1**.
Delco Radio Div.-General Motors Corp., **i**, **c-1**, **q-1**, **y-1**, **z-1**, **g-2**, **l-2**.
Delta Corp., **p-2**, **q-2**.
Deltron Inc., **j**, **k**, **b-1**, **l-2**.
Designers For Industry, Inc., **y-1**, **g-2**.
Destron Co., **g-2**.
Dial Products Co., **f-2**.
J.W. Dice Co., **k**, **m**, **q**, **f-1**.
Diehl Mfg. Co., **o**, **i-1**, **p-1**, **y-1**.
Henry G. Dietz Co., Inc., **b-1**, r-1, **g-2**, **j-2**, **k-2**.
Digital Sensors Inc., **p-1**, r-1, **g-2**.
W.C. Dillon & Co., Inc., **n**.
Djeco, Div.-Djordjevic Engrg. Co., **i**, **q**, **f-1**, **l-2**.
Don-Lan Electronics Inc., **h-1**, **x-1**.
Donner Scientific Co., **d-2**.
Douglas Aircraft Co., Inc., **y-1**.
Drayer Hanson Div.-Crane Co., **k-2**.
Driaire, Inc., **y**.
Du Kane Corp., **p-1**, **b-2**.
Durant Mfg. Co., **n-1**.
Dynamic Controls Co., **i**.
Dynamic Controls Corp., **p**, **u**, **v**, **b-1**, r-1, **g-2**, **l-2**.
Dynatronics, Inc., **e**, **o-1**, **x-1**, **y-1**, **g-2**.
Eagle Signale Co., **k**, **h-1**, **g-2**.
Eastern Industries Inc., **p**, **u**, **v**, **y**, **p-1**, r-1, **y-1**, **d-2**.
Eastman Kodak Co., **a-1**.
Eclipse Fuel Engrg. Co., **h**, **w**, **x**, r-1.
Eclipse-Pioneer Div., Bendix Aviation Corp., **y-1**.
Edcliff Instruments, **p-1**, r-1.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **s**, **i-1**, r-1, **y-1**.
Edmund Scientific Co., **a-1**.
Edwards High Vacuum Ltd., **u**, r-1, **j-2**.
Eisler Engrg. Co., Inc., **p-2**.
Electric Autolite Co., The, **l-2**.
Electric Indicator Co., Inc., **i-1**, **j-1**, **k-1**.
Electric Machinery Mfg. Co., **i-1**, **k-1**.
Electro Products Labs. Inc., **k**, **d-1**, **p-1**, **d-2**, **g-2**.
Electrol Inc., **u**, **y-1**.,
Electro-Mechanical Specialites Co., Inc., **o**, **g-2**.
Electronic Applications, Inc., **a**, **t-1**.
Electronic Control Corp., **h**, **j**, **k**, **l**, **t**, **b-1**, **d-1**, **n-1**, **q-1**, **a-2**, **g-2**, **h-2**.
Electronic Engrg. Co. of California, **d**, **e**, **g-2**.
Electronic Specialty Co., **g-2**.
Electron-Radar Products, **s**, **z**, **n-1**, **a-2**.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **g-2**.
Ellison Draft Gage Co., Inc., **h**, **u**, r-1, **z-1**, **j-2**.
Engelhard Industries, Inc., **l-2**.
***ENGIS EQUIPMENT CO.**, **a-1**, **n-1**, **o-1**.
***EQUIPMENT DIV., RAYTHEON CO.**, **b**.
Erie Resistor Corp., **k**, **l**, **u**, r-1, **c-2**, **g-2**.
Essex Mfg. Co., Inc., **b-1**.
Euclid Electric & Mfg. Co., The, **k-1**, **d-2**.
Ewald Instruments, **p-2**.
Exact Engrg. & Mfg. Inc., **g-2**.
Ex-Cell-O Corp., **p**, **v**, **p-1**, r-1, **u-1**, **y-1**.
FAE Instrument Corp., **y-1**, **d-2**, **g-2**.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **p**, **p-1**, **y-1**, **d-2**.
Fairchild Controls Corp., Components Div., **i**, **u**, **b-1**, **l-1**, **R-1**, **z-1**, **d-2**, **j-2**.
Fairfield Engrg. Corp., **o**, **c-1**, **h-1**, **i-1**, **k-1**, **p-1**, **s-1**, **x-1**, **y-1**, **d-2**, **e-2**, **f-2**, **l-2**.
Farmer Electric Products Co., Inc., **n-1**, **g-2**.
Fasco Industries Inc., **r-1**.
J.W. Fecker Div., American Optical Co., **d**, **e**, **n-1**, **y-1**.
Federal Electronics Products Inc., **p-1**.
Federal Products Corp., **m**, **a-1**, **p-1**.
Feedback Controls, Inc., **p-1**, **y-1**, **l-2**.
Fenwal Inc., **h**, r, **s**, **x**, **b-1**, **y-1**, **k-2**.
Fischer & Porter Co., **l**, **u**, **b-1**, r-1.
Fisher Governor Co., **f**, **w**, **b-1**, **q-1**.
Fla. Aircraft Radio & Marine, **t-1**.
Flight Refueling, Inc., **k**, **l**, **u**, **v**, **b-1**, **p-1**, **u-1**, **y-1**, **k-2**.
Flight Research, Inc., **d**, **e**, **o-1**.
Flight Support, Inc., **i**, **n**, **e-1**, **i-1**, **j-1**, **k-1**, r-1, **h-2**, **l-2**.
Fluid Power Inc., **l-1**.
Ford Instrument Co., Div.-Sperry Rand Corp., **b**, **e**, **i-1**, **j-1**, **k-1**, **p-1**, **u-1**, **y-1**, **g-2**, **h-2**, **l-2**.
Foto-Video Labs., Inc., **d**.
Frick Co., **b-1**.
Friez Instrument Div., Bendix Aviation Corp., **y**, **b-1**, **p-1**, r-1.
Furnas Electric Co., **b-1**, **e-1**, **k-1**, r-1.
GPL Div.-General Precision, Inc., **e**.
GAP Instrument Corp., **y-1**.
Gardner Laboratory, Inc., **q**, **f-1**, **m-1**.
General Aniline & Film Corp., Ansco Div., **y-1**.
General Communication Co., **l**, **x-1**, **c-2**.
General Controls Co., **h**, **k**, **s**, **u**, **v**, **w**, **y**, **b-1**, **k-1**, r-1, **x-1**, **g-2**, **j-2**, **k-2**.
General Devices, Inc., **i**, **k**, **h-1**, **p-1**.
General Electric Co., **i-1**, **k-1**, **p-1**, **v-1**, **a-2**, **d-2**, **l-2**.
General Electric Co., Apparatus Sales Div., **n**, **o**, **q**, **u**, **x**, **b-1**, **e-1**, **f-1**, **i-1**, **j-1**, **k-1**, **n-1**, **p-1**, **q-1**, r-1, **v-1**, **y-1**, **a-2**, **d-2 thru g-2**, **i-2**, **j-2**, **l-2**, **p-2**.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept., **b**.
General Electric Co., Computer Dept., **i**.

General Electric Co., Instrument Dept., h-2.
General Electric Co., Light Military Electronics Dept., b.
General Electric Co., Missile & Space Vehicle Dept., k-1.
General Electric Co., Missile & Space Vehicle Dept., Pa., d, o-1.
General Electric Co., X-Ray Dept., q-2.
General Electro-Mechanical Corp., n, y-1, f-2, h-2.
General Instrument Corp., Defense & Engrg. Products Group, t-1.
General Radio Co., o, z, l-2.
Paul E. Gerst & Co., o, i-1, k-1, d-2, l-2.
Gilfillan Bros. Inc., i, y-1.
Gilmore Industries, Inc., l, n, u, v, b-1, r-1, d-2, e-2, f-2, h-2, o-2.
Glassco Instrument Co., r-1, j-2.
Good Electronic Corp., e-2.
Gordon Enterprises, d, o-1, g-2.
Grove Valve & Regulator Co., r-1.
Guidance Controls Corp., i, k, d-1, g-1, p-1, y-1, d-2, e-2, f-2, h-2.
Guided Missile Div., The Firestone Tire & Rubber Co., n-1, t-1, x-1, y-1.
Gulton Industries, Inc., i, u, l-2.
a, w, i-1, j-1.
B. H. Hadley, Inc., h, l, p, u, v, w, b-1, g-1, h-1, l-1, p-1, q-1, r-1, y-1, g-2, j-2, k-2, m-2.
Hagan Chemicals & Controls Inc., h, j, b-1, m-1, p-1, r-1, c-2.
Hagen Mfg. Co., k, h-1, g-2.
Haledy Electronics Co., u, b-1, n-1, j-2.
Hallamore Electronics Co., Div.-Siegler Corp., d, e, p, i-1, k-1, r-1, y-1, g-2, l-2.
Hallikainen Instruments, l, i-2.
Hamilton Standard, Div.-United Aircraft Corp., p, v, k-2.
Hamilton Watch Co., Military Products Div., g-2.
Hammarlund Mfg. Co., The, t-1.
Hammett-Mercury-Rex Div., k-1, y-1.
George E. Harris & Co., Inc., o, r, z, i-1, y-1, j-2, l-2.
Haskel Engrg. & Supply Co., t, u, r-1.
Hass Instrument Corp., The, n-1, r-1, j-2.
Hathaway Instruments, Inc., e-2.
A. W. Haydon Co., The, k, o, g-2.
Hays Corp., The, u, b-1, m-1, r-1.
Heinemann Electric Co., d-1, i-1, k-1, g-2.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., j-2.
E. Vernon Hill & Co., l-2.
Hobbs Mfg. Co., d-2, f-2, h-2.
Hoefner Corp., u, v, w, l-1, r-1, y-1.
Hofman Labs., Inc., l-1.
Hoke Inc., u, v, w, l-1, j-2.
Hoover Electric Co., o, y, g-1, i-1, j-1, y-1, h-2.
Howe Scale Co., The, o-2.
Hughes Tool Co., Aircraft Div., u, v, b-1, l-1, p-1, d-2, e-2, f-2, j-2.
Hughey & Phillips, Inc., n-1.
Humidial Co., y.
Huyck Systems Co., i, u, v.
Hydra-Power Corp., p, t thru w, c-1, p-1, q-1, r-1, x-1, y-1.
Hydraulic Research & Mfg. Co., u, p-1, r-1, y-1.
Hydraulics, Inc., d-2.
Hydromatics, Inc., u, v, w.
I-L-S Instrument Div., The Meriam Instrument Co., k, u, v, b-1, n-1, y-1, d-2, g-2, h-2.
ITT Federal Div., International Telephone & Telegraph Corp., t-1.
Image Instruments, Inc., a-1, n-1.
Industrial Control Co., e, i, o, c-1, p-1, r-1, x-1, z-1, d-2, e-2.
Industrial Engrg. Corp., u.
Industrial Instruments Inc., t, b-1.
Industrial Timer Corp., o-1, g-2.
Ingraham Co., The, g-2.
Insco Co., Div.-Barry Controls Inc., d-2.
Instrument Div., The Budd Co., e-2, f-2.
Intercontinental Dynamics Corp., n-1, r-1, j-2.
*INTERELECTRONICS CORP.
International Electronic Research Corp., u-1.
International Instruments Inc., b.
Iron Fireman Mfg. Co., Aircraft Div., p, v.
Isotopes Specialties Co., Div.-Nuclear Corp. of America, l, q, a-1, b-1, f-1.
JEM Electronics Corp., n-1.
Jack & Heintz, Inc., i-1, y-1, l-2.
Jan Hardware Mfg. Co., Inc., y-1.
Janitrol Aircraft Div.-Midland-Ross Corp., v, w, l-1, r-1, j-2.
Jordan Electronics, Div.-Victoreen Instrument Co., g-2.
Kahn & Co., Inc., d-2.
*KEARFOTT DIV., GENERAL PRECISION, INC., e, i, u, b-1, f-1, i-1, k-1, p-1, y-1.
Keithley Instruments, Inc., u-1.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., a, d, e, k, r, z, e-1, h-1, p-1, s-1, t-1, v-1, b-2, g-2.
Kelsey-Hayes Co., y-1.
Kemp Aero Products, u, v, w, l-1, r-1, y-1.
Wayne Kerr Corp., f-1.
Kidde Aero-Space Div., Walter Kidde & Co., Inc., l-1, r-1, y-1.
Kieley & Mueller, Inc., l, u, v, w, b-1, l-1, m-1, p-1, r-1, u-1, y-1, c-2, i-2, j-2.
Kingston Electronics-Div.-Kingston Industries Inc., k-1.
Kollmorgen Optical Corp., d, e, p-1, t-1, y-1, h-2.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., i, p, n-1, r-1, y-1, j-2.
Lab. for Electronics, Inc., i, u, c-1, i-1, y-1, d-2, h-2.
Lane Electronics Mfg. Corp., a, c, n-1, t-1.
Leach Corp., o, g-1, k-1, k-1.
Lear, Inc., b, f thru i, k, m thru p, r, u thru z, b-1, c-1, e-1, g-1 thru j-1, n-1, p-1 thru u-1, x-1, y-1, z-1, d-2, h-2, j-2, k-2, l-2.
Leece-Neville Co., The, o, i-1, k-1, l-2.
Leeds & Northrup Co., g thru j, t thru z, l-1, m-1, u-1, y-1, a-2, d-2, e-2, f-2, o-2.
Le Fiell Mfg. Co., f-1, s-1.
Legris Resistor Corp., a, c, l-2, m-2, n-2.
Leland Airborne Products, Div.-American Machine & Foundry Co., i-1, q-1, d-2, h-2, l-2.
*WALLACE O. LEONARD, INC., p, v, w, b-1, l-1, y-1, z-2, d-2.
Leslie Co., u, b-1, r-1, j-2.
Librascope Div., General Precision, Inc., d, e, i, o-1, y-1.
Lincoln Electric Co., The, p-2.
Linde Co., Div.-Union Carbide Corp., l-1, p-2.
Link-Belt Co., g, d-2.
Liquidometer Corp., The, f, l, v, b-1, y-1, c-2.
Livingston Electronic Corp., p-2.
Lumen, Inc., n, u, n-1, q-1, u-1, y-1, e-2.
Lundy Mfg. Corp., v, g-2, k-2.
MB Electronics, i-1, y-1.
M. C. Mfg. Co., u.
Madigan Corp., b, i, e-1, p-1, u-1, x-1, y-1.
Magnaflux Corp., Sub.-General Mills, Inc., j, a-1, f-1.
Magnasync Corp., a, m, b-2, n-2.
Magnetic Circuit Elements, Inc., o, l-2.
Magnetic Controls Co., i, l-2.
Magnetic Instrument Co. Inc., b-1.
Magnetico, Inc., y-1.
Magtrol, Inc., n, o, p-1, y-1, h-2.
Maico Electronics, Inc., k, p-1, v-1.
P. R. Mallory & Co. Inc., s-1, g-2, m-2, n-2.
*MARTIN CO., THE, DENVER DIV., m thru p, r, u, a-1, b-1, i-1, k-1, p-1, q-1, r-1, z-1, g-2, k-2, l-2.
Mason-Neilan, u, b-1, r-1, j-2.
W. L. Maxson Corp., The, u, b-1, z-1.
Mead Specialties Co., Inc., u, r-1, d-2.
Meletron Corp., r-1.
Metron Instrument Co., d-2, h-2.
Micro Balancing, Inc., n-1.
Micro Gee Products, Inc., u, r-1, y-1.
Midwestern Instruments, Inc., a.
Milgo Electronic Corp., i, y-1.
Minatron Corp., m, p-1.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., b, v, w, b-1.
Minneapolis-Honeywell Regulator Co., Industrial Div., j, l, t, u, x, y, b-1, m-1, r-1, u-1, c-2, d-2, j-2.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., u-1.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., b, f, i, k, n, o, t thru w, y, a-1, b-1, c-1, e-1, l-1, m-1, p-1, r-1, y-1, c-2 thru g-2, i-2, j-2.
Mira Corp., The, l-1.
J. J. Monaghan Co., Inc., j, l-1.
Morse Instrument Co., The, p.
Motorola, Inc., a, b, c, i, r, y, n-1, t-1, x-1, y-1, b-2, g-2.
Muirhead Instruments Inc., y-1.
Mullenbach Div.-Electric Machinery Mfg. Co., l, d-1, e-1, g-1, i-1, j-1, k-1, d-2, g-2, p-2.
NUMEC-Nuclear Materials & Equipment Corp., u-1.
George L. Nankervis Co., n, u, i-1, k-1, c-2, d-2, e-2, l-2.
National Cylinder Gas, Div.-Chemetron Corp., w, l-1, p-2.
National Electronics, i-1, k-1, q-1, r-1, d-2, l-2.
National Instrument Laboratories, Inc., u, w.
National Welding Equipment Co., l-1, p-2.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc., p, u, r-1.
Navigation Computer Corp., i.
Networks Electronic Corp., l-2.
New England Scientific Instruments Co., y, b-1, m-1, q-1.
Newark Controls Co., l, w, b-1, r-1, d-2, j-2.
Newton Co., The, p-1, y-1.
Norden Div., United Aircraft Corp., p-1, y-1.
Ernest Norrman Laboratories, g-2.
Northrop Corp., p-1, y-1.
Nuclear Corp. of America, b-1, u-1.
Nuclear Development Corp. of America, u-1.
OPW-Jordan, b-1, r-1, k-2.
Ohmart Corp., The, g, k, l, u, b-1.
Oil-Dyne, Inc., t, u.
Opad Electric Co., d-2, l-2.
Optimized Devices, Inc., k.
Optomechanisms Inc., d, e, k, o-1.
John Oster Mfg. Co., Avionic Div., y-1.
Otis Elevator Co., Defense & Industrial Div., o, i-1, j-1, k-1, p-1, y-1, d-2, h-2, l-2.
Overload Control Co., g-1.
Oxygen Equipment & Service Co., l-1.
Pacific Scientific Co., f-2.
Packard Bell Computer Corp., i, k.
Panish Controls, p, v, w, g-1, h-1, p-1, s-1, y-1, d-2.
Paraplegics Mfg. Co., Inc., e-1, y-1.
Parker-Hannifin Corp., u, v, w, y-1.
Parkway Specialties Co., m-2, n-2.
Patterson Moos Research, Div.-Leesona Corp., g-2.
Pegasus Labs., Inc., m, p, q, u, f-1, p-1, q-1, r-1, u-1, x-1, y-1, d-2, e-2, f-2.
Performance Measurements Co., i, u, v, n-1, y-1.
Pesco Products Div.-Borg-Warner Corp., u.
Pesco Products Div., Borg-Warner Corp., Calif., i-1, l-2.
Philco Corp.-Govt. & Industrial Group, b thru e, i, y-1, z-1, g-2.
Philips Electronic Instruments, q-2.
Photobell Co., Inc., f, k, l, m, q, r, z, a-1 thru d-1, f-1, n-1, b-2, f-2, i-2.
Photovolt Corp., m-1, n-1, o-1.
Pimex, Inc., y, m-1.
Pioneer Industries Div., Almar-York Co. Inc., w, x, y, p-1, e-2, f-2, k-2, p-2, q-2.
Pitometer Log Corp., d-2, h-2.
Pneu-Hydro Valve Corp., r-1, j-2.
Potter Aeronautical Corp., k, l, u, v, w, c-2, d-2.
Power Supplies Inc., o, p, i-1, k-1, y-1, d-2, l-2.
Powers Regulator Co., The, y.
Precision Equipment Co., Inc., u-1.
Precision Thermometer & Instrument Co., b-1, c-2.
Presin Co., k, n-1, w-1.
Process & Instruments, g, m-1, j-2.
RBM Controls Div.-Essex Wire Corp., i-1.
REF Mfg. Corp., u, r-1.
Radiaphone Co. Inc., b, t-1.
Radiation Instrument Development Lab., Inc., u-1.
Radio Condenser Co., f.
*RADIO CORP. OF AMERICA, a thru g, i, k, l, m, q, r, y, a-1, e-1, f-1, g-1, n-1, q-1, s-1 thru v-1, x-1, y-1, z-1, b-2, g-2, j-2, l-2, m-2, n-2, q-2.
Radio Development & Research Corp., o, i-1, j-1, k-1, p-1, q-1, d-2, l-2.
Radio Receptor Co., Inc., Sub.-General Instrument Corp., t-1.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., i.
Reeves Instrument Corp., i, y-1.
Republic Aviation Corp., Missile Systems Div., y-1.
Research Controls, p, u, v, w, y, l-1, m-1, p-1, r-1.
Research, Inc., i, n, u, x, b-1, m-1, p-1, q-1, r-1, y-1, d-2, e-2, f-2, h-2, o-2, p-2.
Research Indsl. Lab. of Electronics, f, q, j-2.
Resitron Labs., Inc., q-.
Revere Corp. of America, Sub., Neptune Meter Co., u, b-1, o-2.
J. R. Robbins Co., o, u.
Robertshaw-Fulton Controls Co., A & I Div., f, u, w, b-1, l-1, r-1.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div., u, b-1, p-1, r-1, j-2.
Robot Industries Inc., x-1.
Rockwood Sprinkler Co., Div.-The Gamewell Co., r.
Ronson Hydraulic Units Corp., u, p-1, r-1, y-1.
Milton Roy Co., b-1, m-1, p-1.
Safety Electrical Equipment Corp., i-1, k-1, l-2.
Sangamo Electric Co., g-2.
Santa Barbara Research Center, r, s, n-1.
Sargent Engrg. Corp., p-1, y-1.
Schaevitz Engrg., l, m, n, q, u, v, w, b-1, f-1, r-1, y-1, f-2, g-2, h-2, o-2.
Sciaky Brothers, Inc., c-1, g-2, l-2, p-2.
Scientific-Atlanta, Inc., p-1, x-1, y-1.
Scott Aviation Corp., l-1, r-1.
Secode Corp., o, e-1, h-1 thru k-1, p-1, t-1, z-1, d-2, k-2.
Serdex, Inc., y.
Servomechanisms, Inc., h, i, l, p, u, v, b-1, c-1, h-1, i-1, k-1, p-1, r-1, y-1, d-2, h-2.
Servo-Tek Products Co., o, i-1, p-1, y-1, d-2.
Servwell Products Co., s-1.
Shallcross Mfg. Co., h-1.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., m, q, a-1, f-1, g-2.
Sierra Engrg. Co., u, w, l-1, r-1.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., u, v, w, r-1.
Sigma Instruments, Inc., n-1.
Simmonds Aerocessories, Inc., u, v, w, b-1, r-1, s-1.
Singer Military Products Div.-The Singer Mfg. Co., k-1, y-1.
Sirvalco Systems Corp., u.
Skyvalve, Inc., u, v, w, r-1.
A. O. Smith Corp., Smith-Erie Div., u, v.
Solar Aircraft Co., r-1.
Sonex, Inc., b-1.

Soroban Engrg., Inc., **i.**
South Wind Div., Stewart Warner Corp., **u, v, w.**
Southwest Products Co., **p, v, p-1, s-1.**
Southwest Research Institute, **g, h, j, l, n, p, q, r, t thru w, y, b-1, f-1, l-1, m-1, p-1, r-1, y-1, a-2, b-2, d-2, e-2, j-2.**
Southwestern Industrial Electronics Co., **i, p, u, b-1, c-1, e-1, g-1 thru k-1, p-1, q-1, r-1, t-1, y-1, d-2, g-2, k-2, m-2.**
Southwestern Valve Corp., **u, v, w.**
Special Products Dept., Melpar, Inc., **n-1, y-1.**
Specialties, Inc., **n-1.**
Specialty Electronics Development Corp., **l-2.**
Spectra Electronics Corp., **h, l, n-1, a-2.**
Spectrol Electronics Corp., **p-1, r-1, y-1.**
Sperry Piedmont Co., Div.-Sperry Rand Corp., **e-1, p-1, y-1.**
Stackpole Carbon Co., **m-2.**
State Testing Laboratory Inc., **a-1, q-2.**
Statham Development Corp., **y-1.**
Statham Instruments, Inc., **r-1, e-2.**
A. U. Stone & Co., Inc., **u, v, w.**
Stow Mfg. Co., **u-1.**
Strand Engrg. Co., **k, n-1.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **u, v, l-1, y-1, k-2.**
Stromberg-Carlson Div.-General Dynamics Corp., **i, u-1, g-2.**
Sun Electric Corp., Aeronautical Div., **v, b-1, l-1, n-1, p-1, r-1, y-1, g-2, j-2.**
Sunshine Scientific Instrument, **f, k, q, x, a-1, f-1, d-2, g-2, h-2, p-2.**
Superior Electric Co., The, **z, d-2, l-2.**
Tabet Mfg. Co., Inc., **n-1.**
Taft-Peirce Mfg. Co., The, **m, a-1.**
Talley Corp., The, **o, i-1, j-1, p-1, x-1, h-2.**
Tamar Electronics, Inc., **t-1, x-1.**
Tapco Group, Thompson Ramo Wooldridge Inc., **d, e, p, u, v, b-1, c-1, e-1, i-1, p-1, r-1, u-1, x-1, y-1, d-2, g-2, l-2.**
W. A. Taylor & Co., **m-1.**
Taylor-Winfield Corp., **p-2.**
Technical Materiel Corp., The, **t-1, x-1.**
Technical Products Co., **a, c.**
Telechrome Mfg. Corp., **c, d, e, i, k, n, u, y-1, e-2, f-2.**
Teleflex Inc., **p, s-1, u-1.**
Telex, Inc., **i, o-2.**
Tel-Instrument Electronics Corp., **l-2.**
Temco Aircraft Corp., **y-1.**
Temperature Engrg. Corp., **x, y, j-2.**
Tempo Instrument Inc., **k, g-2.**
Texas Instruments Inc., **d, v, s-1.**
Thayer Scale Corp., **f-1, o-2.**
Thermo Electric Co., Inc., **j, l, u, y, b-1, m-1, r-1, y-1, a-2, e-2.**
Thompson Ramo Wooldridge Inc., **d, e, p, u, v, b-1, c-1, e-1, i-1, p-1, r-1, u-1, x-1, y-1, d-2, g-2, l-2.**
Tork Time Controls, Inc., **g-2.**
Tracerlab Inc., **l, q, u, w, b-1, f-1, p-1, q-2.**
Traid Corp., **d, e, o-1.**
Trepac Corp. of America, **c-1, j-1.**
Trimount Instrument Co., **f, b-1.**
Trio Laboratories, Inc., **p-1, y-1, g-2.**
Twix Mfg. Co., Inc., **m, a-1, r-1, s-1, f-2, g-2.**
Uehling Instrument Co., **b-1.**
United Aircraft Products, Inc., **u, r-1.**
United Control Corp., **e, b-1, p-1, y-1.**
United Electric Controls Co., **p, x, y, b-1, i-1 thru l-1, r-1, j-2, k-2.**
U. S. Industries, Inc., **o, p, i-1.**
U. S. Science Corp., Div.-Topp Industries, Inc., **d, i, p-1, y-1, g-2.**
Universal Dynamics Corp., **y.**
Vacuum Specialties Co., Inc., **j-2.**
Vacuum Tube Products, Div.-Hughes Aircraft Co., **j-2, p-2.**
Valcor Engrg. Corp., **u, v, w, l-1, r-1, s-1, j-2.**
Vap-Air Aeronautical Products Div., Vapor Heating Corp., **p-1, y-1.**
Varo Mfg. Co., Inc., **f, i, k, o, p, u, v, w, c-1, e-1, g-1 thru k-1, p-1 thru t-1, x-1, y-1, z-1, d-2 thru h-2, l-2.**
Veeco Vacuum Corp., **j-2.**
Vemaline Products Co., **g-2.**
Vickers Inc., **u, r-1, y-1, m-2.**
Vickers Inc., Div.-Sperry Rand, **u, r-1, y-1.**
Vickers Inc., Electric Products Div., **u, z, b-1, c-1, n-1, r-1, u-1, y-1, z-1, d-2, e-2, f-2, l-2, p-2.**
Vickers, Inc., Mich., **p, u, v, i-1, r-1, y-1, d-2.**
Viewlex, Inc., **d, e.**
Vinson Mfg. Co. Inc., **b-1, y-1.**
Virginia Electronics Co., Inc., **t-1.**
Voi-Shan Electronics, **y-1, g-2, l-2.**
Wacline, Inc., **o, i-1, j-1, k-1, d-2.**
Wang Labs., Inc., **i, p-1, g-2.**
Warren Components, Div.-El-Tronics, Inc., **y.**
Waterman Hydraulics Corp., **u.**
Waugh Engrg. Co., **u, v, w, g-2.**
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., **l, n-1, o-1.**
Weldmatic Div., Unitek Corp., **p-2.**
Wells Industries Corp., **t-1, v-1, w-1, a-2, c-2, d-2, g-2, i-2, o-2, h, k, l, m, r thru u, x, y, z, a-1, b-1, d-1, f-1, n-1, p-1.**
Weltronic Co., **o, i-1, k-1, p-1, g-2, l-2, p-2.**
Western Control Corp., **p, s-1.**
Western Gear Corp.-Precision Products Div., **y-1.**
Westgate Lab., Inc., **y-1.**
Westinghouse Electric Corp., **n, o, p, e-1, i-1, j-1, k-1, n-1, p-1, t-1, u-1, x-1, d-2, f-2, k-2, l-2, p-2.**
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., **p, t thru w, r-1, y-1.**
Wheelock Signals Inc., **z-1.**
Wiancko Engrg. Co., **r-1.**
Wickes Engrg. & Construction Co., **i-1, j-1, k-1, t-1, l-2.**
G. C. Wilson & Co., **g-2.**
Winder Aircraft Corp. of Florida, **a-1, s-1.**
Wollensak Optical Co., **o-1.**
Wolverine Diesel Power Co., **p, l-2.**
Woolf Aircraft Products, Inc., **p-2.**
Worthington Corp., **p, u, v, w, i-1, k-1, r-1, j-2.**
Zenith Electric Co., **k-1, g-2.**
Zep Aero, **a-1, l-1.**
Zoomar Inc., **e, o-1.**

CONTROLS, ALARM SYSTEM

ASCOP Div., Electro-Mechanical Research, Inc.
All American Engrg. Co.
American District Telegraph Co.
American Instrument Co., Inc.
Assembly Products, Inc.
Bell & Gossett Co.
Briggs Associates, Inc.
***BRISTOL CO., THE**
CG Electronics Corp.
Clark Controller Co., The
Colorado Research Corp.
Conax Corp.
Joe Davidson & Associates
Daystrom, Inc., Control Systems Div.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
Electronic Control Corp.
Ellison Draft Gage Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fenwal Inc.
General Instrument Corp., Defense & Engrg. Products Group
Hammarlund Mfg. Co., The
Infrared Industries, Inc.
International Electronic Research Corp.
International Instruments Inc.
Interstate Electronics Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Leeds & Northrup Co.
Leslie Co.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
Mullenbach Div.-Electric Machinery Mfg. Co.
National Electronics
Photobell Co., Inc.
Production Research Corp., Sub.-Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Secode Corp.
Southwestern Industrial Electronics Co.
Special Products Dept., Melpar, Inc.
Spectra Electronics Corp.
Statham Development Corp.
Thermo Electric Co., Inc.
United Electric Controls Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Wells Industries Corp.
Wheelock Signals Inc.
Whittaker Controls, Div.-Telecomputing Corp.

CONTROLS, SURFACE FINISH

Branson Instruments, Inc.
Cleveland Instrument Co.
***ENGIS EQUIPMENT CO.**
General Electric Co., Apparatus Sales Div.
Pegasus Labs., Inc.
Photobell Co., Inc.
Southwest Research Institute
Unit Process Assemblies, Inc.

CONVERTERS

a. AC-DC
b. Analog Digital
c. DC-AC
d. Field Sequential
e. FM Communications
f. Frequency, Measurement & Test
g. Frequency, Power Supplies
h. Liquid Oxygen
i. Microwave
j. RF
k. Rotary
l. Voltage
m. Waveform

ACF Electronics Div., ACF Industries Inc., **b.**
ACF Industries Inc., **b.**
***ABRAMS INSTRUMENT CORP.**, **c.**
Acme Electric Corp., **a, c, l.**
Acoustica Associates, Inc., **b.**
Adage, Inc., **b.**
Advance Industries, Inc., **b.**
Aeronca Mfg. Corp.-Aerospace Div., **b.**
Air Logistics Corp., **a, c, l.**
Air Products, Inc., **h.**
Aircom Inc., **i.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**, **g, h, l.**
Airflyte Electronics Co., **b.**
Airpax Electronics Inc., Cambridge Div., **a, c, f.**
Airpax Electronics Inc., Seminole Div., **a, c, f.**
Allen Electric & Equipment Co., **a.**
Allied International Corp., **a, c.**
Allis-Chalmers, **a.**
American Electronics, Inc., **a, b, c, g, k.**
American Instrument Co., Inc., **a, c.**
American Rectifier Corp., **a.**
American Research & Mfg. Corp., **a, c, g, l.**
American Speedlight Corp., **c.**
Applied Electronics Corp. of N. J., **b, e.**
Applied Research Inc., **e, i, j.**
Arnold Magnetics Corp., **c.**
Arnoux Corp., **b, f.**
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., **h.**
Avco Corp., Crosley Div., **d.**
Avien, Inc., **a, c.**
B & H Instrument Co., Inc., **b, f.**
Barker & Williamson Inc., **a, c.**
Beckman Instruments, Inc., Berkeley Div., **f.**
Beckman-Systems Div., **b.**
Behlman Engrg. Co., **c, g.**
Bendix Aviation Corp., **a, b, c, i, k.**
Bendix Aviation Corp., Cincinnati Div., **b, f, l.**
Bendix Aviation Corp., Montrose Div., **k.**
Bendix Aviation Corp., Pioneer-Central Div., **h.**
Bendix Aviation Corp., York Div., **b.**
Bendix Corp., The, Eclipse-Pioneer Div., **b.**
Benson-Lehner Corp., **b, k.**
Bergen Labs., Inc., **c, l.**
Blonder-Tongue Labs., Inc., **j.**
Blonder-Tongue Labs. Inc., Special Products Div., **j.**
Bogue Electric Mfg. Co., **a, c, g, i, k, l.**
Briggs Associates, Inc., **b.**
***BRISTOL CO., THE, b, c.**
Broadview Research Corp., **b, d, e.**
Brunswick Instruments, **c.**
Budd Lewyt Electronics, inc., **a, b, c, e, g, i, j.**
Burroughs Corp., **b.**
CG Electronics Corp., **a, b.**
CGS Labs., Inc., **b.**
Carter Motor Co., **c, k.**
Chalco Engrg. Corp., **a, c.**
Chatham Electronics Div.-Tung-Sol Electric Inc., **a, c, g, l.**
Coleman Electronics, Inc., **b.**
Collins Radio Co., **c, i.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., g.**
Communication Accessories Co., **c, g, l, m.**
Computer Control Co., Inc., **b.**
Computer Control Co., Inc., Western Div., **b.**
Consolidated Airborne Systems, Inc., **f, g, h.**
Consolidated Controls Corp., **b.**
Consolidated Diesel Electric Corp., **a, c.**
***CONSOLIDATED ELECTRODYNAMICS CORP.**, **b.**
Control Data Corp., **b.**
Control Electronics Co., Inc., **f, g, i.**
Cornell-Dubilier Electric Corp., **a.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **b.**
Cox Instruments Div., George L. Nankervis Co., **b.**
Crescent Engrg. & Research Co., **a, c.**
Crosby-Teletronics Corp., **e.**
Cubic Corp., **a, b.**
D K Mfg. Co., **h.**
Datascan Inc., **a, c, g.**
Datex Corp., **b.**
Daven Co., The, **a, c.**
Davenport Mfg. Co., **a, c.**
Joe Davidson & Associates, **a, c, g, k, l, m.**
Daystrom, Inc., Control Systems Div., **a, b, c.**
Daystrom, Inc., Military Electronics Div., **a, b, c.**
Daystrom Inc., Transicoil Div., **b.**
Daystrom Inc., Weston Instruments Div., **a, b.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **c.**
Delco Radio Div.-General Motors Corp., **a, b, c, g, l, m.**
Deltron Inc., **a, c.**
Designers for Industry, Inc., **e, f, g, j.**
Digitran Co., The, **b.**
Djeco, Div.-Djordjevic Engrg. Co., **a, b, c, l.**
Dorsett Electronic Labs., Inc., **a, b, c, l.**
Douglas Aircraft Co., Inc., **b.**

Dynamic Controls Co., **a, c.**
Dynatronics, Inc., **b, j.**
Eicor Div.-Scranton, **a, c, g, k, l.**
Electro Instruments, Inc., **a, b, f.**
Electro Precision Corp., **b.**
Electromation Co., Div.-Del Mar Engrg. Labs., **a, b, c, g, l, m.**
Electronic Computer Co., Inc., **a, b.**
Electronic Specialty Co., **a.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **a, c.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **i.**
Epsco Inc., **a thru g.**
***EQUIPMENT DIV., RAYTHEON CO., a thru e, g, i, j.**
Erie Resistor Corp., **b.**
Fairfield Engrg. Corp., **a, c.**
Ferrotran Electronics Co., Inc., **a, c, j.**
Fischer & Porter Co., **b.**
Flight Support, Inc., **a, c.**
Ford Instrument Co., Div.-Sperry Rand Corp., **b, c, l.**
Franklin Electronics Inc., **b.**
Freed Transformer Co., Inc., **c.**
GPL Div.-General Precision, Inc., **g.**
Gates Electronic Co., **a.**
General Aniline & Film Corp., Ansco Div., **i, k.**
General Devices, Inc., **a, b, c, e, k.**
General Electric Co., **a, c.**
General Electric Co., Apparatus Sales Div., **a, c, d, g, k, l.**
General Electric Co., Heavy Military Electronics Dept., **b.**
General Instrument Corp., Defense & Engrg. Products Group, **e, i, j.**
General Magnetics, Inc., **c.**
General Mills, Inc., **b.**
Gerator Corp., **c, f, g, k.**
Paul E. Gerst & Co., **a, c, k, l.**
Gilfillan Bros. Inc., **a, b, c, i, j, l, m.**
John Gombos Co., Inc., **i.**
Gordon Enterprises, **k.**
Grimes Mfg. Co., **a, c.**
Guidance Controls Corp., **b.**
Gulton Industries, Inc., **a, b, f, g, l.**
W. & L. E. Gurley, **b.**
Gyrex Corp., The, **c.**
Hagan Chemicals & Controls Inc., **b.**
Hallamore Electronics Co., Div.-Siegler Corp., **a, b, c.**
Hamilton Standard, Div.-United Aircraft Corp., **a, c.**
Hammett-Mercury-Rex Div., **a, b, c, i, l.**
George E. Harris & Co., Inc., **a, c, l.**
Hathaway Instruments, Inc., **a, b, c, l.**
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co., **b.**
Hofman Labs., Inc., **h.**
Hol-Gar Mfg. Corp., **a, c, k.**
Hoover Electric Co., **a, c, k.**
Hoover Electronics Co., **b, e.**
William I. Horlick Co., Inc., **a, f, g, k, l.**
Houston Fearless Corp., **b.**
I-L-S Instrument Div., The Meriam Instrument Co., **a, c, f, g.**
ITT Federal Div., International Telephone & Telegraph Corp., **b.**
Image Instruments, Inc., **d.**
Induction Heating Corp., **g, j.**
Industrial Test Equipment Co., **c, g.**
Instrument Development Labs., Inc., **b.**
***INTERELECTRONICS CORP., a, c, f, g, l, m.**
Jack & Heintz, Inc., **a, c, k, l.**
James Electronics Inc., **a, c.**
Johnson Electronics Inc., **a, g.**
Jordan Electronics, Div.-Victoreen Instrument Co., **a, c, l.**
Katolight Corp., **k.**
***KEARFOTT DIV., GENERAL PRECISION, INC., b, i.**
Kepco, Inc., **a.**
Kin Tel Div.-Cohu Electronics, Inc., **b.**
James Knights Co., The, **f.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **b.**
Lab. for Electronics, Inc., **i.**
Lear, Inc., **a, b, c, g, j, k, l.**
Leece-Neville Co., The, **a, c, l.**
Lel, Inc., **j.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **a, c, g, k, l.**
Lepel High Frequency Labs. Inc., **j.**
Librascope Div., General Precision, Inc., **b.**
Linde Co., Div.-Union Carbide Corp., **h.**
Litton Industries, Inc., **b.**
Litton Industries, Maryland Div., **b.**
Lockheed Aircraft Corp., Missiles & Space Div., **a, b.**
Lumen, Inc., **a, c.**
MEG Products, Div.-Mandrel Industries, Inc., **a, c.**
Madigan Corp., **b.**
Magnetic Circuit Elements, Inc., **a, c, l.**
Magnetic Controls Co., **a, c.**
Magnetic Research Corp., **a, c.**
Magnetico, Inc., **c.**
Maico Electronics, Inc., **b.**
***MARTIN CO., THE, DENVER DIV., a, l, m.**
Micro Gee Products, Inc., **a, c.**
Milgo Electronic Corp., **b.**
Milro Controls Co., Inc., **a, c.**
Minneapolis-Honeywell Regulator Co., Boston Div., **a.**
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., **b.**
Mira Corp., The, **a.**
Model Rectifier Corp., **a, l.**
Modern Design Div.-H. C. Schloer, Inc., **c.**
Motor Generator Corp., **a, c, g, k.**
Motoresearch Co., **a.**
Motorola, Inc., **b, e, i, j.**
Heinz Mueller Eng. Co. Inc., **a, c, k.**
Mullenbach Div.-Electric Machinery Mfg. Co., **a.**
George L. Nankervis Co., **b.**
National Co., Inc., **e, i, j.**
National Cylinder Gas, Div.-Chemetron Corp., **h.**
National Instrument Laboratories, Inc., **f.**
Networks Electronic Corp., **a, c, f, g, l.**
Newton Co., The, **b.**
Non-Linear Systems, Inc., **a, b.**
Norden Div., United Aircraft Corp., **b.**
Ernest Norrman Laboratories, **f, g.**
Northeastern Engrg. Inc., **b, f.**
Northrop Corp., **a, b, c.**
Opad Electric Co., **a, c, g.**
Orbitron Co., Inc., **b.**
Packard Bell Computer Corp., **b.**
Paraplegics Mfg. Co., Inc., **g.**
Patterson Moos Research, Div.-Leesona Corp., **c.**
Performance Measurements Co., **b, g.**
Perkin Engrg. Corp., **a, c.**
Permoflux Products Co., **a, c, g.**
Pesco Products Div., Borg-Warner Corp., **a, c.**
Pesco Products Div., Borg-Warner Corp., Calif., **a, c, g, k.**
Potter Aeronautical Corp., **a, b, f.**
Potter Instrument Co., Inc., **b.**
Power Supplies Inc., **a, c.**
RS Electronics Corp., **a.**
Radiation, Inc., **b.**
Radiation Instrument Development Lab., Inc., **b.**
***RADIO CORP. OF AMERICA, b, d thru g, i, j, l, m.**
Radio Development & Research Corp., **a, b, c, g thru m.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **e, i, j.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **a, b, c.**
Redmond Co., Inc., Sub.-Controls Co. of America, **a, c.**
Resdel Engrg. Corp., **j.**
Ronan & Kunzl, Inc., **h.**
Safety Electrical Equipment Corp., **c, k, l.**
Sangamo Electric Co., **a, c, g, k.**
Scientific-Atlanta, Inc., **i, j.**
Servomechanisms, Inc., **b.**
Signal Equipment Co., Inc., **g.**
Skiatron Electronics & Television Corp., **b.**
Sonotone Corp., **a, c, l.**
Southwest Research Institute, **b.**
Southwestern Industrial Electronics Co., **a, b, c, e, g, k, l.**
Specialty Electronics Development Corp., **i.**
Spectralab Instruments, **j.**
Spectrol Electronics Corp., **a, c.**
Spencer-Kennedy Labs., Inc., **j**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **f, i.**
Standard Electric Time Co., The, **c.**
Standard Steel Corp., Cambridge Div., **h.**
Stewart & Stevenson Services, Inc., **a.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, b, c, f.**
Sun Electric Corp., Aeronautical Div., **a, b, c, f, g.**
Sunair Electronics, Inc., **a, c.**
Superior Air Products Co., **h.**
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., **g, i.**
System Labs., Div.-Electronic Specialty Co., **b.**
Systron Corp., **a, b, f.**
TRG, Inc., **i.**
Talley Corp., The, **a, c, k, l.**
Tally Register Corp., **b.**
Tamar Electronics, Inc., **i, j, m.**
Tapco Group, Thompson Ramo Wooldridge Inc., **b, c, l.**
Technical Materiel Corp., The, **e, f, g.**
Technitrol Engrg. Co., **b.**
Telechrome Mfg. Corp., **b, d.**
Tel-Instrument Electronics Corp., **g.**
Telkor, Inc., **a, c, f, g.**
Terado Co., **c.**
Thompson Ramo Wooldridge Inc., **b, c, l.**
Traid Corp., **a.**
Trans Electronics, Inc., **a, c.**
Transistor Electronics Corp., **a, c.**
Trans-Sil Corp., **a.**
Universal Toroid Coil Winding, Inc., **a, c.**
Universal Transistor Products Corp., **a, c, e, f, g, l, m.**
Valor Instruments, Inc., **a, l.**
Varo Mfg. Co., Inc., **a, b, c, f, g, k, l, m.**
Wacline, Inc., **f.**
Wang Labs., Inc., **b.**
Waugh Engrg. Co., **a, f.**
Wayne-George Corp., **b.**
Weltronic Co., **a, c.**
Wesrep Corp., **a, c, f, g, j.**
Western Gear Corp.-Precision Products Div., **a, c, k, l.**
Westinghouse Electric Corp., **a, b, c, f, g, k, l.**
Wickes Engrg. & Construction Co., **a, c.**
Wincharger Corp., Sub.-Zenith Radio Corp., **c, k.**
Winder Aircraft Corp. of Florida, **a, c.**
Worthington Corp., **a, c, g.**

CONVEYORS

Aeroil Products Co., Inc.
American Monorail Co., The
Beacon Steel Corp.
E. W. Buschman Co., The
A. M. Byers Co.
Albert H. Cayne Equipment Corp.
Columbia Research & Development Corp.
Dudwallen Mfg. Co., Inc., The
General American Transportation Corp.
Hanson-Van Winkle-Munning Co.
Howe Scale Co., The
International Steel Co.
Jeffrey Mfg. Co., The
Joy Mfg. Co.
Lamson Corp., The
Link-Belt Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Lone Star Plastics Co. Inc.
Magline Inc.
***MARTIN CO., THE, DENVER DIV.**
Mechanical Handling Systems Inc.
Oliver Corp., The-A. B. Farquhar Div.
Rapids-Standard Co., Inc., The
Edw. Renneburg & Sons Co.
Richards-Wilcox Mfg. Co.
Robot Industries Inc.
Roto Finish-Ransohoff
Sage Equipment Co. Inc.
Sandvik Steel, Inc.
***SEALMASTER BEARING DIV., STEPHENS-ADAMSON MFG. CO.**
A. T. Stevens Co.
Thermoid Div.-H. K. Porter Co., Inc.
Welded Construction Inc.

COOKERS, ELECTRONIC

***EQUIPMENT DIV., RAYTHEON CO.**
Hammett-Mercury-Rex Div.
Edw. Renneburg & Sons Co.
Temperature Engrg. Corp.
Thermal Dynamic Products Div.-Waltham Precision Instrument Co.

COOLANTS

Anderson Oil & Chemical Co., Inc.
Armour Industrial Chemical Co.
Cincinnati Milling Machine Co., The
E. I. Du Pont de Nemours & Co. Inc.
Fluoro-Chem Corp.
Halocarbon Products Corp.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Silicone Products Dept., General Electric Co., Dept. C.
Southwest Research Institute
White & Bagley Co., The
York Div., Borg-Warner Corp.

COOLERS, OIL

***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Auto-Control Labs. Inc.
B. H. Aircraft Co., Inc.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Budd Lewyt Electronics, Inc.
California Stamping & Mfg. Co.
Dunham-Bush Inc.
Ellis & Watts Products, Inc.
Griscom-Russell Co., The
Highland Engrg. Co.
Janitrol Aircraft Div.-Midland-Ross Corp.
Manning & Lewis Eng. Co.
Marlo Coil Co.
Modine Mfg. Co.
Portland Copper & Tank Works Inc.
Edw. Renneburg & Sons Co.
Schutte & Koerting Co.
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.

United Aircraft Products, Inc.
Vilter Mfg. Co., The
Whitlock Mfg. Co., The
Woolf Aircraft Products, Inc.

COOLING SYSTEMS, ELECTRONIC

Aeroquip Corp., Jackson Div.
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
Amco Engrg. Co.
American Standard Industrial Div.
*BENDIX AVIATION CORP., HAMILTON DIV.
Bendix Utica Div., Bendix Aviation Corp.
Benson Mfg. Co.
Birtcher Corp., The
Budd Lewyt Electronics, Inc.
Dean & Benson Research, Div.-Benson Mfg. Co.
Dunham-Bush Inc.
Eastern Industries Inc.
Ellis & Watts Products, Inc.
C. G. Kokanson Co., Inc.
Induction Heating Corp.
Janitrol Aircraft Div.-Midland-Ross Corp.
Kentucky Metal Products Co.
Lear, Inc.
Modine Mfg. Co.
Northrop Corp.
On Mark Couplings, Inc.
Pesco Products Div.-Borg-Warner Corp.
Pioneer Industries Div., Almar-York Co., Inc.
Pneumafil Corp.
*RADIO CORP. OF AMERICA
Santa Barbara Research Center
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
A. U. Stone & Co., Inc.
United Aircraft Products, Inc.
United Mfg. Co., Div., The W. L. Maxson Corp.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Wenzlau Engrg. Co.
Western Div., Aeroquip Corp.
Westinghouse Electric Corp.
Worthington Corp.
York Div., Borg-Warner Corp.

COPPER

Allied Research Products, Inc.
Alloys Unlimited Inc.
American Brass Co., The
American Brazing Alloys Corp.
American Silver Co., Inc.
American Smelting & Refining Co.
Ampco Metal, Inc.
Bond Metal Surplus Co.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Bristol Brass Corp., The
Chase Brass & Copper Co., Inc.
Custom Tool & Mfg. Co.
Electronic Parts Mfg. Co., Inc.
Gibson Electric Co.
C. G. Hussey & Co., Div.-Copper Range Co.
National Copper & Smelting Co.
Nippert Electric Products Co., The
Olin Mathieson Chemical Corp.-Metals Div
Olin Mathieson Chemical Corp., N. Y.
Phelps Dodge Copper Products Corp.
Revere Copper & Brass Inc.
Roovers-Lotsch Corp.
Southwire Co.
Springfield Brass Co., Inc.
Udylite Corp., The
Utility Brass & Copper Corp

COPPER LAMINATES, PRINTED CIRCUIT

Adept Industries Inc.
Allied Plastics Supply Corp.
American Printed Circuits Co., Inc.
Bo Myte Co., Inc., The
Bridgeport Brass Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
California Plasteck Inc
Cordo Chemical Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Formica Corp.
Franklin Fibre-Lamitex Corp.
Garlock Packing Co., The-Electronic Products
General Plastics Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Thomas J. Long, Inc.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
*MINNESOTA MINING & MFG. CO.
Mycalex Corp. of America
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
*RADIO CORP. OF AMERICA
Raybestos-Manhattan, Inc.
St. Regis Paper Co., Panelyte Div.
Spaulding Fibre Co., Inc.
Synthane Corp.
Taylor Fibre Co.
Tingstol Co.
Westinghouse Electric Corp., Micarta Div.

CORD SETS

Alden Products Co.
Belden Mfg. Co.
Bernco Engrg. Corp.
Birnbach Radio Co., Inc.
Cable Electric Products Inc.
Carol Cable Div.
Joe Davidson & Associates
Eagle Electric Mfg. Co. Inc.
Electric Cords & Supply Corp.
Empire Electronics Co., Inc.
Essex Wire Corp.
General Cable Corp.
Holyoke Wire & Cable Corp.
ITI Electronics, Inc.
International Electric Industries, Inc.
Kings Electronics Co., Inc.
Lab-Tronics, Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Molded Insulation Co.
Chester Morton Electronics Corp.
Paraplegics Mfg. Co., Inc.
Permoflux Products Co.
Phelps Dodge Copper Products Corp.
Projects Unlimited, Inc.
Milton Ross Metals Co., The
Royal Electric Corp.
Seeger-Williams, Inc.
Spectra-Strip Wire & Cable Corp.
Telex, Inc.
Victor Electric Wire & Cable Corp
Whitaker Cable Corp.
Edwin L. Wiegand Co.
Winder Aircraft Corp. of Florida

CORDS

a. Attachment
b. Dial
c. Dial Cords & Cables
d. Lacing
e. Line
f. Line Resistance
g. Patch
h. Retractile
i. Shock

ADC Inc., **g.**
AMP Inc., **g.**
Aerolite Electronics Corp., **g.**
Alden Products Co., **a, e, g.**
Alpha Wire Corp., **d, e.**
American Super-Temperature Wires, Inc., **d.**
Associated Engrg. Corp., **e, g.**
Associated Suppliers Co., **d, i.**
Aviation Textile Associates, **a, d, e, i.**
Belden Mfg. Co., **a, h.**
Bernco Engrg. Corp., **a, e.**
Birnbach Radio Co., Inc., **a thru h.**
Cable Electric Products Inc., **a, e, f.**
Carol Cable Div.
Columbian Rope Co., **d.**
C. R. Daniels, Inc., **i.**
Eagle Electric Mfg. Co. Inc., **a, e.**
Electric Cords & Supply Corp., **a, e thru h.**
Empire Electronics Co., Inc., **g.**
Essex Wire Corp., **a, e, h.**
G-C Electronics Co., **c.**
Gates Radio Co., **g.**
General Cable Corp.
General Logistics Div., Aeroquip Corp., **i.**
General Radio Co., **g.**
Gudebrod Bros. Silk Co., Inc., **b, c, d.**
Holyoke Wire & Cable Corp., **f.**
International Electric Industries, Inc., **a, e thru h.**
JFD Electronics Corp., **c, f.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **c, e, g, h, i.**
Lab-Tronics, Inc., **a, g.**
Leviton Mfg. Co., Inc., **a.**
*MARTIN CO., THE, DENVER DIV., **c, e, g, h.**
Milgo Electronic Corp., **g.**
Nameplates Inc., **b.**
New England Electrical Works, Inc., **c.**
M. M. Newman Corp., **d.**
Paul Nurches Co., **g.**
Paraplegics Mfg. Co., Inc., **c.**
Permoflux Products Co.
Piasecki Aircraft Corp., **a, g.**
Pomona Electronics Co., Inc., **g.**
Fred T. Roberts & Co., **h.**
Robins Industries Corp., **g.**
Royal Electric Corp., **a.**
Russell Mfg. Co., **i.**
Spectra-Strip Wire & Cable Corp., **h.**
Standard Electric Time Co., The, **g.**
F. M. Stevenson Co., Inc., **i.**
Stromberg-Carlson Div.-General Dynamics Corp., **g.**
Telex, Inc., **g.**
Texstar Plastics, Div.-The Texstar Corp., **i.**
Victor Electric Wire & Cable Corp., **a, e, f.**

CORES & CORE MATERIALS

a. Ceramic
b. Ferrite
c. Laminated
d. Powdered
e. Tape Wound
f. Toroidal

Alden Products Co., **f.**
American Feldmuehle Corp., **a.**
American Lava Corp., **a.**
American Potash & Chemical Corp., National Northern Div., **d.**
American Rectifier Corp., **f.**
Antara Chemicals, Div.-General Aniline & Film Corp., **b.**
Armco Steel Corp., **c, e.**
Arnold Engrg. Co., The, **c thru f.**
Barker Sales Co., **e, f.**
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., **a, d.**
Bergen Carbide Co., **a.**
Bridgeport Brass Co., **c.**
Brunswick Balke Collender Co., The, Defense Products Div., **c.**
Brush Beryllium Co., The, **a.**
Carborundum Co., The, **a.**
Carborundum Co., Latrobe Plant, Refractories Div., **a.**
Carborundum Co., Refractories Div., **a.**
Centralab, Div.-Globe-Union, Inc., **a.**
Corning Glass Works, **a.**
Crane Co., Special Products Div., **d.**
Custom Tool & Mfg. Co., **f.**
Diamonite Products Mfg. Co., **a.**
Double E Products Co., **a, b, d, f.**
Du-Co Ceramics Co., **a.**
Dynacor, Inc., **e, f.**
Electrical Refractories Co., The, **a.**
Erie Resistor Corp., **b.**
Ex-Cell-O Corp., **b.**
Ferroxcube Corp. of America, **a thru f.**
Food Machinery & Chemical Corp.-Dapon Dept., **c, d.**
Food Machinery & Chemical Corp.-Epoxy Dept., **c, d.**
Frenchtown Porcelain Co., **a.**
G-L Electronics Co., Inc., **c, e, f.**
General Ceramics Div., Indiana General Corp., **a, b.**
General Electric Co., Heavy Military Electronics Dept., **a, b.**
Gladding, McBean & Co., **a.**
Hastings Plastics, Inc., **a, d.**
Honeycomb Co. of America, Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Industrial Equipment Div., Baldwin Lima Hamilton Corp., **c.**
Isolantite Mfg. Corp.
Kaiser Aluminum & Chemical Sales, Inc., **d.**
Keystone Carbon Co., **d.**
M. Kirchberger & Co., Inc., **a.**
Lear, Inc., **a, b, d.**
Librascope Div., General Precision, Inc., **b.**
Lockheed Aircraft Corp., Missiles & Space Div., **b.**
Magnetic Core Corp., **b, d, f.**
Magnetic Metals Co., **c, d, e.**
*MICROWAVE & POWER TUBE DIV., RAYTHEON CO., **a, b.**
James Millen Mfg. Co. Inc., **a.**
*MINNESOTA MINING & MFG. CO., **a, f.**
Motorola, Inc., **a, b, d, f.**
NUMEC-Nuclear Materials & Equipment Corp., **a, d.**
National Beryllia Corp., **a.**
National Ceramic Co., **a.**
National Moldite Co., **b, d, f.**
Nopco Chemical Co., Plastics Div.
Norrich Plastics Corp., **a.**
Norton Co., New Products Dept., **a.**
Olin Mathieson Chemical Corp., N.Y., **d.**
Plastic Age Sales, Inc., **c, e.**
Polymer Corp., The, **d, f.**
Pyroferric Co. Inc., **d, f.**
Quality Components, Inc., **d.**
Quartzite Processing Inc., **b.**
Radio Cores, Inc., **d, f.**
*RADIO CORP. OF AMERICA **a, b, c, e, f.**
Sangamo Electric Co., **f.**
Saxonburg Ceramics, Inc., **a.**
H.M. Scott Co., The, **c.**
Servomechanisms, Inc., **a.**
Servo-Tek Products Co., **f.**
Sillcocks-Miller Co., **c.**
Sprague Electric Co., **e, f.**
Stackpole Carbon Co., **b.**

Standard Electronics Div.-Reeves Instrument Corp., **e, f.**
Superex Electronics Corp., **b.**
Superior Steatite & Ceramic Corp., **a.**
Telcon, Inc., **c, f.**
Texas Instruments Inc., **c.**
Texstar Plastics, Div.-The Texstar Corp., **c.**
H. I. Thompson Fiber Glass Co., **c.**
Thor Ceramics, Inc., **a.**
United Mineral & Chemical Corp., **b.**
Van Der Horst Corp. of America., **b.**
Waters Mfg., Inc., **b.**
Wesrep Corp., **b, d, f.**
Western Gold & Platinum Co., **a.**
Westinghouse Electric Corp., **a thru f.**

CORK

Armstrong Cork Co.
Auburn Mfg. Co., The
General Gasket Inc.
Mechanical Rubber Products Co.
A. T. Stevens Co.

COUNTERMEASURES, ELECTRONIC

ACF Industries Inc.
A.R.F. Products, Inc.
Advance Industries, Inc.
***AEROJET-GENERAL CORP.**
Aeronca Mfg. Corp.-Aerospace Div.
Alfred Electronics
American Electronic Labs., Inc.
American Research & Mfg. Corp.
Applied Research Inc.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bjorksten Research Labs. For Industry, Inc.
Budd Lewyt Electronics, Inc.
CGS Labs., Inc.
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Daystrom, Inc., Military Electronics Div.
De Havilland Aircraft Of Canada, Ltd., Special Products Div.
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
Allen B. Du Mont Labs., Inc.
Dynatronics, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Epsco Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
Gabriel Co., The, Gabriel Electronics Div.
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept. Pa.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hallicrafters Co., The
ITT Federal Div., International Telephone & Telegraph Corp.
Instruments For Industry, Inc.
Kollmorgen Optical Corp.
Lab. for Electronics, Inc.
Lear, Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lockheed Electronics Co., Stavid Div.
Loral Electronics Corp.
Lundy Mfg. Corp.
Madigan Corp.
Maico Electronics, Inc.
National Co., Inc.
National Scientific Labs., Inc.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Philco Corp.-Govt. & Industrial Group
Polarad Electronics Corp.
Production Research Corp., Sub.-Radio Condenser Co.
Radalab Inc.
Radiation, Inc.
Radio City Products Co. Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Republic Aviation Corp., Missile Systems Div.
Sanders Associates, Inc.
Santa Barbara Research Center
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Spectra Electronics Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Tamar Electronics, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Texas Instruments Inc.
Textran Corp.
Thompson Ramo Wooldridge Inc.
Westinghouse Electric Corp.

COUNTERS

a. Computer
b. Electro-Magnetic
c. Electronic
d. Footage
e. Frequency
f. Geiger
g. Impulse
h. Mechanical
i. Preset
j. Proportional
k. Radiation
l. Revolution
m. Scintillation

ACF Industries Inc., **c.**
***ABRAMS INSTRUMENT CORP., b, i.**
Actuator Products Div., Geartronics Corp., **b, d, h, l.**
Adage, Inc., **c.**
Aeronca Mfg. Corp.-Aerospace Div., **a, c.**
Allegany Instrument Co., Inc., **i.**
Alwac Computer, Div.-El-Tronics Inc., **a.**
Amerac Inc., **e, h.**
American Electronics, Inc., **k, m.**
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., **a, h, i, l.**
American Machine & Foundry Co., Government Products Group, **e, g.**
American Tradair Corp., **f, k, m.**
Automatic Timing & Controls, Inc., **b, g, l.**
Avien, Inc., **c.**
Baird-Automic, Inc., **f, h thru k, m.**
Ball Brothers Research Corp., **f, m.**
E. Bauches S. A., Freeport Engrg. Co., **e.**
Beckman Instruments, Inc., Berkely Div., **c, e, g, i, l.**
Beckman-Systems Div., **c.**
Bell & Gossett Co., **k.**
Bendix Aviation Corp., **a, c, k, l, m.**
Bendix Aviation Corp., Cincinnati Div., **a, c, e, f, g, i, k, m.**
Benson-Lehner Corp., **c, g, i, l.**
James G. Biddle Co., **e.**
Blonder-Tongue Labs. Inc., Special Products Div., **i.**
Bowmar Instruments Corp., **b, c, g, h, i, j, l.**
Bowser, Inc., **h.**
Briggs Associates, Inc., **b, j.**
Broadview Research Corp., **a.**
Brown & Sharpe Mfg. Co., **h.**
Bruno-New York Industries Corp., **c, e.**
Budd Lewyt Electronics, Inc., **a.**
Bulova Research & Development Labs., Inc., **c, g.**
Burroughs Corp., **a, b, c, e, i, l.**
Burroughs Corp., Electronic Tube Div., **c, e, g, i.**
CG Electronics Corp., **b, c.**
C&K Components, Inc., **c, i.**
California Computer Products, Inc., **a.**
Central Electronics Mfrs., Div.-Nuclear Corp. of America, **k.**
Coleman Electronics, Inc., **b, l.**
Computer Control Co., Inc., **a.**
Computer Control Co., Inc., Western Div., **a.**
Consolidated Airborne Systems, Inc., **e, l.**
DBM Research Corp., **c.**
Data Instruments Div.-Telecomputing Corp., **b, h, i, l.**
Datex Corp., **c.**
Daystrom, Inc., Control Systems Div., **a.**
Daystrom, Inc., Military Electronics Div., **c.**
Decker Corp., The, **c, l.**
Dejur-Amsco Corp., Electronic Sales Div., **f.**
Delco Radio Div.-General Motors Corp., **a, c.**
Designers for Industry, Inc., **d, e.**
Digitran Co., The, **h, l.**
Durant Mfg. Co., **d, g, h, i, l.**
Dynatronics, Inc., **a, c.**
Eagle Signal Co., **b, g, i, l.**
Eclipse-Pioneer Div., Bendix Aviation Corp., **h.**
Electro Instruments, Inc., **a, c, e, g, i thru l.**
Electro Precision Corp., **a, e, i.**
Electronic Applications, Inc., **e.**
Electonic Computer Co., Inc., **a, c, g.**
Electronic Engrg. Co. of California, **c.**
Electro-Pulse, Inc., **c, e, i.**
Epsco Inc., **a.**
Erie Instrumation, Div.-Erie Resistor Corp., **a, b, c, e, g, i, j, l.**
Erie Resistor Corp., **c, e, g, i, l.**
Exact Engrg. & Mfg. Inc., **h.**
FAE Instrument Corp., **b, h, l.**
Freed Transformer Co., Inc., **c, g, i, l.**
Gates Radio Co., **h.**
General Controls Co., **b, c, d, g thru j, l.**
General Devices, Inc., **a, b, c, h.**
General Electric Co., X-Ray Dept., **m.**
General Electro-Mechanical Corp., **b, h.**
Gordon Enterprises, **d, h, l.**
Hagen Mfg. Co., **b, g, i.**
Hamilton Watch Co., Military Products Div., **h.**
Hammett-Mercury-Rex Div., **a.**
A. W. Haydon Co., The
Hewlett -Packard Co., **c, e, i, l.**
E. Vernon Hill & Co., **l.**
Hillburn Electronic Prod. Co., **b, g.**
Huyck Systems Co., **a, b, c.**
I-1-S Instrument Div., The Meriam Instrument Co., **c, d, e, g, i, j, l.**
Iconix Inc., **c, d, e, g, i thru m.**
International Electronic Research Corp., **k.**
Interstate Electronics Corp., **f, j, k, m.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **k, m.**
***KEARFOTT DIV., GENERAL PRECISION, INC., h.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **c, g, h.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **a, h, l.**
Lab. for Electronics, Inc., **a, c, e, i.**
Landis & Cyr, Inc., **b, c, g, i.**
Lovoie Labs., Inc., **c, e.**
Lear, Inc., **h, l.**
Leetronics, Inc., **b.**
Levinthal Electronic Products, Inc., **m.**
Librascope Div., General Precision, Inc., **a, h, i, j.**
MB Electronics., **e.**
Madigan Corp., **a, c.**
Magnasync Corp., **d.**
Milgo Electric Corp., **a, c.**
James Millen Mfg. Co. Inc., **h.**
Modern Design Div.-H.C. Schloer, Inc., **c.**
Motorola, Inc., **a, b, c, g.**
National Scientific Labs., Inc., **c.**
Navigation Computer Corp., **a, c.**
Networks Electronic Corp., **g.**
Northeastern Engrg. Inc., **c, e, i.**
Nuclear Corp. of America, **k, m.**
Nuclear Development Lab., **f, k.**
Nuclear Measurements Corp., **f, j, k, m.**
Nuclear-Chicago Corp., **f, i, j, k, m.**
Ohmart Corp., The, **f, m.**
Optomechanisms Inc., **c.**
Packard Bell Computer Corp., **a.**
Patterson Moos Research, Div.-Leesona Corp., **c.**
Performance Measurements Co., **c, g, h, l.**
Pesco Products Div., Borg-Warner Corp., Calif., **e.**
Philips Electronic Instruments, **f, j, m.**
Photocon Research Products, **b, h, i, l.**
Piasecki Aircraft Corp., **f, k, m.**
Potter Aeronautical Corp., **a thru e, g, i, j, l.**
Precision Radiation Instruments, Inc., **f, k, m.**
Presin Co., **b, d, g, h, i, l.**
Production Research Corp., Sub.-Radio Condenser Co., **a, c.**
Radalab Inc., **e.**
Radiation Instrument Development Lab., Inc., **f, j, k, m.**
***RADIO CORP. OF AMERICA, a, c, d, e, h, m.**
Rapids-Standard Co., Inc., The, **h.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., f.**
Resdel Engrg. Corp., **c.**
Revere Corp. of America, Sub., Neptune Meter Co., **g.**
Sigma Instruments, Inc., **b.**
Singer Military Products Div.-The Singer Mfg. Co., **b.**
A. O. Smith Corp., Smith-Erie Div., **h, i.**
Southwestern Industrial Electronics Co., **a, c, g.**
Standard Electric Time Co., The., **c, e.**
Geo. Stevens Mfg. Co., Inc., **h.**
Herman H. Sticht Co., Inc., **l.**
Strand Engrg. Co., **c, i, k.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, c, e.**
Sun Electric Corp., Aeronautical Div., **c, h.**
Systron Corp., **a, c, d, e, g, l.**
TRG, Inc., **c, k.**
Talley Corp., The., **b, h.**
Telechrome Mfg. Corp., **a thru e, g thru j, l.**
Telex, Inc., **a, b, c.**
Tracerlab Inc., **c, f, j, k, m.**
U. S. Science Corp., Div.-Topp Industries, Inc., **b.**
United States Instrument Corp., **b.**
Universal Toroid Coil Winding, Inc., **c.**
Universal Transistor Products Corp., **f, k, m.**
Veeder-Root Inc., **c, d, e, g, h, i, k, l.**
Victoreen Instrument Co., **f, j, k, m.**
Voi-Shan Electronics., **b, g, h.**
Wocline, Inc., **e.**
Walkirt c o., **a, c, e, g, i.**
Wang Labs., Inc., **a.**
Wells Industries Corp., **b, c, g, i, l.**
Weltronic Co., **c.**
Westinghouse Electric Corp., **k.**
Wickes Engrg. & Construction Co., **c, h.**
N. Wood Counter Lab., **f, j, k, m.**

COUPLERS, DIRECTIONAL, MICROWAVE

Aircom Inc
Airtron, Div.-Litton Industries.
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Bendix Aviation Corp.
Bogart Mfg. Corp.
Budd Lewyt Electronics, Inc
Chance Vought Aircraft, Inc.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Dalmo Victor Co., Div.-Textron, Inc
Joe Davidson & Associates
Daystrom, Inc., Military Electronics Div
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Don-Lan Electronics Inc.
Douglas Microwave Co., Inc
Electronic Applications, Inc.
Empire Products Sales Corp.
FXR, Inc
Gabriel Co., The, Gabriel Electronics Div.
General Bronze Electronics Corp.
General Electric Co., Light Military Electronics Dept
General Instrument Corp., Defense & Engrg. Products Croup.
Gilfillan Bros. Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
George E. Harris & Co., Inc.
Hewlett-Packard Co.
ITT Federal Div., International Telephone & Telegraph Corp.
J-V-M Microwave Co.
Kearfott Div., General Precision, Inc.
Kearfott Div., General Precision, Inc., Microwave Products.
Lab. For Electronics, Inc.
Lieco, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The.
Meridian Metalcraft, Inc.
Microphase Corp.
Microwave Associates, Inc.
Motorola, Inc.
Narda Microwave Corp., The.
Omega Labs., Inc.
Polytechnic Research & Development Co., Inc.
Radalab Inc.
Radar Design Corp.
*RADIO CORP. OF AMERICA
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Rantec Corp.
Sage Labs., Inc.
Sanders Associates, Inc.
Sierra Electronic Corp., Div.-Philco Corp
Special Products Dept., Melpar, Inc.
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
TRG, Inc
Tamar Electronics, Inc.
Technicraft, Div.-Electronic Specialty Co.
Telerad Mfg. Corp.
Telkor, Inc.
Tober Electronic Corp.
Transco Products, Inc.
Victor R. F. & Microwave Co.
Waveline, Inc.

COUPLERS, TRANSMITTER

Airtron, Div.-Litton Industries
Chance Vought Aircraft, Inc.
Daystrom, Inc., Military Electronics Div.
Gabriel Co., The, Gabriel Electronics Div.
Gorham Electronics-Div.-Gorham Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Corp.
E. F. Johnson Co.
Litton Industries, Maryland Div.
*MARTIN CO., THE, DENVER DIV.
Microphase Corp.
*RADIO CORP. OF AMERICA
Republic Aviation Corp., Missile Systems Div.
Tamar Electronics, Inc.
Technical Materiel Corp., The
Westinghouse Electric Corp.

COUPLING & PHASING UNITS

Airtron, Div.-Litton Industries
Beech Aircraft Corp.
Bendix Aviation Corp.
CGS Labs., Inc.
Chance Vought Aircraft, Inc.
Diamond Antenna & Microwave Corp
Gabriel Co., The, Gabriel Electronics Div.
ITT Federal Div., International Telephone & Telegraph Corp.
Litton Industries, Maryland Div.
*MARTIN CO., THE, DENVER DIV.
Motorola, Inc.
*RADIO CORP. OF AMERICA.
Republic Aviation Corp., Missile Systems Div.
Tamar Electronics, Inc.
Tober Electronic Corp.
Weatherhead Co., The

COUPLINGS

a. Flexible
b. Hydraulic
c. Microwave
d. Quick Disconnect
e. Rigid
f. Shaft
g. Shaft, Reducers & Extensions
h. Shaft, Rigid & Flexible
i. Tube

ACF Electronics Div., ACF Industries Inc., **c.**
Accessory Products Co., Div.-Textron Inc., **d.**
Accurate Electronics Corp., **h.**
Acme Industrial Co., **f, g, h.**
Actuator Products Div., Geortronics Corp., **a.**
Aero Spares, Inc., **b.**
Aeroquip Corp., Jackson Div., **b, d, e, i.**
Aeroscience, Inc., **a.**
Aerotec Industries Inc., Aircraft Equipment Div., **d.**
Agricultural Aviation Engineering Co. Inc., **d.**
Airaterra., **a, b, d.**
Airborne Research & Development Corp., **b, d.**
Aircom Inc., **c.**
Aircraft Armaments, Inc., **c, d.**
Airdrome Parts Co., **b.**
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., **d.**
Airtron, Div.-Litton Industries, **a, c, d, e.**
All Specs Corp., **a, b, d, e.**
Allen Aircraft Products, Inc., **d.**
Amatom Electronic Hardware Co., Inc., **a, e thru h.**
American Brass Co., The, **a, b.**
American Instrument Co., Inc., **b, i.**
Anaconda Metal Hose Div., The American Brass Co., **a, b.**
Anchor Coupling Co. Inc., **b.**
Ardmore Products Div., Amco-Corp. **d, e.**
Arkwin Industries, Inc., **b, d.**
Arnav Aircraft Associates, Inc., **b.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **a, i.**
Associated Co., Inc., **e, i.**
Belmar Wheel & Machine Co., Inc., **e.**
Bendix Aviation Corp., **a, c, f.**
Bendix Utica Div., Bendix Aviation Corp., **a, d.**
Best Aircraft Corp., **b, e, i.**
Birnbach Radio Co., Inc., **e thru h.**
Boston Gear Works, **a.**
Breeze Corporations, Inc., **a.**
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., **a.**
Bruning Co., The, **a, b, d, e, i.**
Buckeye Iron & Brass Works, **d.**
Bud Radio, Inc., **a, f, g.**
Bushings, Inc., **a, f.**
A. M. Byers Co., **b, g.**
Cal Connector Co., **d.**
California Stamping & Mfg. Co., **a.**
Capewell Mfg. Co., **d.**
Carson Mach & Supply Co., **a.**
Chance Vought Aircraft, Inc., **c.**
Chase Brass & Copper Co., Inc., **i.**
Chiksan Co., Sub.-Food Machinery & Chemical Corp., **a.**
Cleco Air Tools, Div.-Reed Roller Bit Co., **d.**
Cobra Metal Hose Div. DK Mfg. Co., **a, i.**
Collins Mfg. Corp., **b.**
Custom Products Corp., **f, g.**
D. S. D. Mfg. Co., The, **d, i.**
George W. Dahl Co., Inc., **i.**
Dalmo Victor Co., Div.-Textron, Inc., **c.**
Joe Davidson & Associates, **c, e.**
Demornay-Bonardi, **c.**
Deutsch Co., The, Electronic Components Div., **d.**
Dial Products Co., **a, f, h.**
Diamond Antenna & Microwave Corp., **c, e.**
Dill Mfg. Co., The, **d.**
Dodge Mfg. Corp., **a, e, f, h.**
Don-Lan Electronics Inc., **c, d, e.**
Dorne & Margolin, Inc., **c.**
Dumont Engrg. Co., **b, e, i.**
Eastern Industries Inc., **b, d.**
Eco Engrg. Co., **a.**
Edwards High Vacuum Ltd., **a.**
Essex Mfg., Co., Inc., **b, d.**
Ex-Cell-O Corp., **b.**
FAE Instrument Corp., **a, e, f, h.**
Falcon Machine & Tool Co., **a, d thru h.**
Federal Screw Products Inc., **f, g.**
Flexonics Corp., **a.**
Flight Refueling, Inc., **a, b, d, i.**
Futurecraft Corp., **d.**
Gabriel Co., The, Gabriel Electronics Div., **c.**
Gabriel Co., Rocket Power-Talco, **d.**
General Aniline & Film Corp., Ansco Div., **c.**
General Bronze Electronics Corp., **c.**
Gilfillan Bros. Inc., **c.**
Gleason Works, **e, f.**
John Gombos Co., Inc., **c.**
B. F. Goodrich Aviation Products, **a.**
Gorham Electronics-Div.-Gorham Mfg. Co., **c, e.**
Graphite Metallizing Corp., **c.**
Guidance Controls Corp., **a, f, g, h.**
Gustin-Bacon Mfg. Co., **a, e.,**
B. H. Hadley, Inc., **a, b, d, e, i.**
Hallett Mfg. Co., **d.**
Hammett-Mercury-Rex Div., **c.**
George E. Harris & Co., Inc., **b, d.**
Haskel Engrg. & Supply Co., **b.**
Herlo Corp., **d, f, g.,**
Hewlett-Packard Co., **c.**
Walter J. Hyatt Co., The, **b, d.**
Hydra-Power Corp., **b, d.**
ITE Circuit Breaker Co., Special Products Div., **c.**
Integral Corp., **b, d.**
Jan Hardware Mfg. Co., Inc., **a, e thru i.**
Janitrol Aircraft Div.-Midland-Ross Corp., **a, b, d, e, i.**
Jeffrey Mfg. Co., The, **a, f, h.**
E. F. Johnson Co., **a, f, h.**
Kahn & Co., Inc., **d.**
KEARFOTT DIV., GENERAL PRECISION, INC., c.
Kemp Aero Products, **b, d.**
Kerns Mfg. Corp., **a, e, f, h.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **d.**
H. Koch & Sons, **d.**
Koppers Co., Inc., Metal Products Div., **a, h.**
Kwikset Powdered Metal Products, **d.**
Ladish Co., **b, d, e.**
Lieco, Inc., **c.**
Link-Belt Co., **a, b, d thru h.**
Lithium Corp. of America Inc., The Fulton-Irgon Di **d.**
Litton Industries, Maryland Div., **c.**
Lord Mfg. Co., **h.**
Lovejoy Flexible Coupling Co., **f.**
Marman Div., Aeroquip Corp., **a, b, c, e, i.**
*MARTIN CO., THE, DENVER DIV., **a thru d, g.**
W. L. Maxson Corp., The., **c.**
Meridian Metalcraft, Inc., **c.**
Metron Instrument Co., **a.**
Microwave Associates, Inc., **c.**
James Millen Mfg. Co. Inc., **a, e, f, g.**
Motorola, Inc., **c.**
Narda Microwave Corp., The, **c.**
Naugler Engrg., Inc., **a, f, h.**
Nilsen Mfg. Co., **a, h.**
Norrich Screw Machine Products, **e, f, i.**
OPW-Jordan, **d.**
Ohlson Empire Inc., **b, i.**
Omega Labs., Inc., **c.**
On Mark Couplings, Inc., **a thru e, i.**
Ozone Metal Products Corp., **b, d.**
Pacific Scientific Co., **d.**
Parker Fittings & Hose Div., Parker-Hannifin Corp., **e, i.**
Parts Engrg. Co., Inc., **a, e.**
Paul & Beekman, Inc., **i.**
Polytechnic Research & Development Co., Inc., **c.**
Prodelin Inc., **c.**
Pyles Industries, Inc., **b, d, e.**
Rantec Corp., **c.**
Reeves Instrument Corp., **a, c.**
Renbrandt, Inc., **a.**
Edw. Renneburg & Sons Co., **d, e.**
Resistoflex Corp., **a.**
J. R. Robbins Co., **b.**
Robertshaw-Fulton Controls Co., A & I Div., **d.**
Robertshaw-Fulton Controls Co., Fulton Sylphon Di **a.**
Ronan & Kunzl, Inc., **d.**
Ronson Hydraulic Units Corp., **b, d.**
Roylyn Inc., **d, d.**
Sage Labs., Inc., **c.**
Scientific-Atlanta, Inc., **c.**
Scovill Mfg. Co., **i.**
Sedco, **a, b, d, e.**
Sier-Bath Gear & Pump Co., Inc., **a, d, e.**
*SNAP-TITE, INC., **b, d.**
Southwest Products Co., **a.**
Specialty Electronics Development Corp., **c.**
Specialty Products Corp., **d.**
Stewart-Warner Corp., Alemite Div., **a, d, e.**
Stow Mfg. Co., **a.**
*STRATOFLEX, INC., **b, d.**
TRG, Inc., **c.**
Tapco Group, Thompson Ramo Wooldridge Inc., **c.**
Technicraft, Div.-Electronic Specialty Co., **d.**
Technology Instrument Corp., **f, h.**
Telerad Mfg. Corp., **c.**
Thomas Flexible Coupling Co., **a, f, h.**
Thompson Ramo Wooldridge Inc., **d.**
Titeflex, Inc., **d.**

Tober Electronic Corp., **c, d, e.**
Transco Products, Inc., **c.**
Tube-Turns Div., Chemetron Corp., **f.**
Uni-Flex Mfg. & Engrg. Inc., **d.**
United States Rubber Co., **a.**
Veeco Vacuum Corp., **d.**
Vemaline Products Co., **a, f, h.**
Vibration Isolation Products, **a.**
Vickers, Inc., Mich., **b, f.**
Waldrick Engrg. Co., **d.**
Wasley Products, Inc., **a, b, e.**
Waveline, Inc., **c.**
Weatherhead Co., The, **a, b, d, e, i.**
Weba, Inc., **b, d.**
Wesrep Corp., **a.**
Western Div., Aeroquip Corp., **b, d, e, i.**
Zippertubing Co., The, **a, i.**
Zurn Industries, Inc., **a, f, g, h.**

CRANES

American Monorail Co., The
Austin-Western, Constr. Equip. Div.-Baldwin-Lima-Hamilton Corp.
Baker Industrial Trucks, Div.-Otis Elevator Co.
A. M. Byers Co.
Albert H. Cayne Equipment Corp.
Chisholm-Moore Hoist Div., Columbus McKinnon Chain Corp.
Clark Equipment Co.
Elwell-Parker Electric Co., The
Flight Refueling, Inc.
Gar Wood Industries Inc.
McDowell Wellman Companies, The
Pacific Coast Engrg. Co.
Pitman Mfg. Co.
Regent Jack Mfg. Co., Inc.
Richards-Wilcox Mfg. Co.
Robbins & Meyers, Inc., Hoist & Crane Div.
Safway Steel Products, Inc.
Silent Hoist & Crane Co.
Unit Crane & Shovel Corp.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Whiting Corp.
Wright Hoist Div., American Chain & Cable Co., Inc.

CRYOGENICS

Acoustica Associates, Inc.
***AEROJET-GENERAL CORP.**
Aeroquip Corp., Jackson Div.
Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Airborne Research & Development Corp.
***AiRESEARCH MFG. OF ARIZONA**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Aluminum Co. of America
American Instrument Co., Inc.
American Latex Products Corp.
Arkwin Industries, Inc.
Beech Aircraft Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
A. M. Byers Co.
Chicago Bridge & Iron Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Consolidated Controls Corp.
Cryogenerators, Inc.
Cryogenic Engrg. Co.
Dean Products, Inc.
Flight Refueling, Inc.
Futurecraft Corp.
General American Transportation Corp.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Ordnance Dept.
Goodyear Aircraft Corp.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
B. H. Hadley, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hofman Labs., Inc.
Hughes Tool Co., Aircraft Div.
Walter J. Hyatt Co., The
Infrared Industries, Inc.
Interstate Electronics Corp.
Interstate Engrg. Corp.
Kaiser Aluminum & Chemical Sales, Inc.
Keystone Carbon Co.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Langley Corp.
Lear, Inc.
***WALLACE O. LEONARD, INC.**
Librascope Div., General Precision, Inc.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
Arthur D. Little, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Marman Div., Aeroquip Corp.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Missimers Inc.
Northrop Corp.
On Mark Couplings, Inc.
Peacock Engrg. & Mfg. Co.
Pesco Products Div.-Borg-Warner Corp.
Research Controls
Ronan & Kunzl, Inc.
Ronan & Kunzl, Inc., Cryogenic Div.
Ronson Hydraulic Units Corp.
Rosemount Engrg. Co.
Milton Roy Co.
Ryan Industries, Inc., Dept. M.
Santa Barbara Research Center
Sargent Engrg. Corp.
Sedco
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Spaceatomics Div., The Budd Co.
Standard Steel Corp.
Standard Steel Corp., Cambridge Div.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Struthers Wells Corp.
Sundstrand Turbo
Superior Air Products Co.
TRG, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thermon Mfg. Co.
Thompson Ramo Wooldridge Inc.
Trimount Instrument Co.
Uni-Flex Mfg. & Engrg. Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Western Div., Aeroquip Corp.
Westinghouse Electric Corp.
Whittaker Controls, Div.-Telecomputing Corp.
Worthington Corp.
Wyle Labs.

CRYSTALS, RADIO FREQUENCY

a. Analysis Equipment
b. Assemblies
c. Mounts
d. Ovens
e. Sockets

Accurate Electronics Corp., **b, c, e.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **a.**
Allied International Corp.
Augat Brothers, Inc., **c, e.**
Rex Bassett, Inc., **b, d.**
Birtcher Corp., The, **c.**
Bulova Watch Co., Electronics Div., **b thru e.**
Clark Crystal Co., **d.**
L. L. Constantin & Co., **c.**
Joe Davidson & Associates, **c.**
***DEL MAR ENGRG. LABS., b.**
Diamond Antenna & Microwave Corp., **b, c.**
Dorne & Margolin, Inc., **a.**
Eidson Electronic Co., **b.**
Electronic Applications, Inc., **a.**
Garlock Packing Co., The-Electronic Products, **e.**
Hammett-Mercury-Rex Div., **b, c.**
Hermetic Seal Corp., **c.**
P. R. Hoffman Co.
Hunt Corp., The, **d.**
Javex Electronics, **e.**
E. F. Johnson Co., **e.**
Keystone Electronics Co., The, **a, b, d.**
James Knights Co., The, **d.**
Lavoie Labs., Inc., **d.**
Lear, Inc.
Livingston Electronic Corp., **e.**
Manson Labs., Inc., **d.**
Master Mobile Mounts, Inc.
Mc Coy Electronics Co., **b, d.**
James Millen Mfg. Co. Inc., **e.**
Motorola, Inc., **a, b, c, e.**
Narda Microwave Corp., The, **c.**
Northern Engrg. Laboratories, Inc., **b, c, d.**
Palmer Instruments, **b, d.**
Premier Research Laboratories, Inc., **b, d.**
Probescope Co. Inc., **a.**
Radalab Inc.
***RADIO CORP. OF AMERICA, a, b, c.**
Reeves-Hoffman Div., **b thru e.**
Robertshaw-Fulton Controls Co., A & I Div., **d.**
Sage Labs., Inc., **c.**
Scientific Radio Products, Inc., **a, b.**
Scientific Radio Service
F. J. Stokes Corp., **d.**
TRG, Inc., **a.**
Valpey Crystal Corp., **b, d.**
Victor R. F. & Microwave Co., **c.**
Waltham Electronics Corp., **d.**
Warren Components, Div.-El-Tronics, Inc., **c.**
Waveline, Inc., **c.**
Wright Electronics Inc., **b, d.**

CRYSTALS, RAW

Acoustica Associates, Inc.
Allegheny Electronic Chemicals Co.
Alloys Unlimited Inc.
Delta Chemical Works, Inc.
Diamond Drill Carbon Co., The
Dow Corning Corp.
***ENGIS EQUIPMENT CO.**
P. R. Hoffman Co.
Linde Co., Div.-Union Carbide Corp.
Motorola, Inc.
Norton Co., New Products Dept.
Reeves-Hoffman Div.
Semi-Elements, Inc.
Valpey Crystal Corp.
Var-Lac-Oid Chemical Co.

CRYSTALS, SAPPHIRE

Hammett-Mercury-Rex Div.
Hugo P. Keller, Jr.
Lear, Inc.
Linde Co., Div.-Union Carbide Corp.
Semi-Elements, Inc.
TRG, Inc.

CUTTERS

Aerojet-General Corp., Downey Plant
Bergen Carbide Co.
Brown & Sharpe Mfg. Co.
Carborundum Co., The
Cherry Rivet Div.-Townsend Co.
Eisler Engrg. Co., Inc.
Handicraft Tools, Inc., Div.-X-Acto, Inc.
Martindale Electric Co.
Norwalk Cutter Sharpening Co.
Onsrud Cutter Mfg. Co., Inc.
H. P. Preis Engraving Machine Co.

CYLINDERS

a. Air
b. Compressed Gas
c. Hydraulic
d. Rocket Engine

ACF Industries Inc., **d.**
Accessory Products Co., Div.-Textron Inc., **a, b.**
Acme Industrial Co., **c.**
Adel Precision Products of Calif., Div.-General Metals Corp., **c.**
***AEROJET-GENERAL CORP., d.**
Aerojet-General Corp., Downey Plant, **a, b, d.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **b.**
Allenair Corp., **a, c.**
Aluminum Co. of America, **d.**
American Car & Foundry Div., ACF Industries, Inc., **d.**
American Instrument Co., Inc., **a, b, c.**
American Tubing Co., Inc.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp., **a, b, c.**
Arkwin Industries, Inc., **c.**
Armour Industrial Chemical Co., **b.**
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., **a, b.**
Cyril Bath Co., The, **d.**
Beacon Steel Corp., **d.**
Bellows-Valvair Divs., **a, c.**
Benbow Mfg. Corp., **a, c.**
Bendix Aviation Corp., **c, d.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c, d.**
Bendix-Pacific Div., Bendix Aviation Corp., **a thru d.**
Benson Mfg. Co., **b.**
Benton Harbor Engrg. Works, Inc., **c.**
Bethlehem Steel Co., **a, b, c.**
S. Blickman, Inc., **a, b, d.**
E. W. Bliss Co., **c, d.**
Brooks & Perkins, Inc., **a thru d.**
Bruning Co., The, **a, c.**
Burklyn Co., **a.**
A. M. Byers Co., d.
Cadillac Gage Co., **c.**
Calcor Corp., **d.**
Capital City Mfg. Co., Inc., **c.**
Carson Mach & Supply Co., b.
Caterpillar Tractor Co., Defense Products Dept., **c.**
Chance Vought Aircraft, Inc., **c, d.**
Commercial Shearing & Stamping Co., **c.**
Conoflow Corp., **a.**
Cornelius Co., The, Aero Div., **a, b.**
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **a, b.**
Cromer Mfg. & Engrg., Inc., **a, b, d.**
Delta Corp., **d.**
Dukes Co., Inc., **c.**
Electrol Inc., **a, c.**
Ex-Cell-O Corp., **c, d.**
Freeman Co., The, **c.**
Gabriel Co., Rocket Power-Talco, **d.**
Galland-Henning Mfg. Co., Nopak Div., **a, c.**

Gar Wood Industries Inc., **c.**
General American Transportation Corp., **a, b.**
Great Lakes Mfg. Corp., **a, c.**
B. H. Hadley, Inc., **a, c.**
Hagan Chemicals & Controls Inc., **a.**
Hahn & Clay, **a thru d.**
Haskel Engrg. & Supply Co., **a, b, c.**
Hein-Werner Corp., **c.**
Hoke Inc., **a, b.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., a thru d.**
Hughes Tool Co., Aircraft Div., **c.**
Hydra-Power Corp., **a, b, c.**
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., **a, c.**
Ingersoll Kalamazoo Div., Borg-Warner Corp., **d.**
Integral Corp., **c.**
Interstate Engrg. Corp., **a, c.**
Kahn & Co., Inc., **a, b.**
Kaiser Fleetwings, Inc., **d.**
Kemp Aero Products, **a, c.**
Kidco Inc., **c.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **a, b.**
Lamtex Industries Inc., **a thru d.**
Langley Corp., **a, c.**
Ledeen Inc., **a, c.**
Le Fiell Mfg. Co., **a, b, d.**
Linde Co., Div.-Union Carbide Corp., **b.**
Liquid Carbonic Div.-General Dynamics Corp., **b.**
Lithium Corp. of America Inc., The Fulton-Irgon Div., **d.**
Lockheed Aircraft Corp., Missiles & Space Div., **d.**
Lofstrand Co., The, **d.**
Lukens Steel Co., **a, b, d.**
Lycoming Div., Avco Corp., **d.**
McDowell-Wellman Companies, The, **a, c.**
McGregor Mfg. Corp., **a thru d.**
Mead Specialties Co., Inc., **a, c.**
Menasco Mfg. Co., **a thru d.**
***MINNESOTA MINING & MFG. CO., b, d.**
National Forge Co., **c.**
National Tube Div.-United States Steel Corp., **a, b.**
Newton Hydraulic Tooling Co., **c.**
Norris-Thermador Corp., **a thru d.**
Northrop Corp., **b, c.**
Ortman-Miller Machine Co., Inc., **a, c.**
Owatonna Tool Co. Precision Hydraulic Div., **c.**
Oxygen Equipment & Service Co., **b.**
Ozone Metal Products Corp., **c.**
Parker-Hannifin Corp., **a, b, c.**
Peacock Engrg. & Mfg. Co., **c.**
Pegasus Labs., Inc., **c.**
Petch Mfg. Co., **a, c.**
Richard Philip Co., **a, c.**
Pitman Mfg. Co., **c.**
Pressed Steel Tank Co., **a thru d.**
Redco Corp., **c, d.**
Republic Mfg. Co., **c.**
Research, Inc., **c.**
Rivett Lathe & Grinder Inc., **a, c.**
J. R. Robbins Co., **a, c.**
Ronson Hydraulic Units Corp., **a thru d.**
Rotary Lift Co., Div.-Dover Corp., **a, c.**
Rotex Punch Co., Inc., **a, c.**
S-P Mfg. Corp., The, **a, c.**
Sancor Corp., **c.**
Sargent Engrg. Corp., **a, b, c.**
Simmonds Aerocessories, Inc., **a, c.**
A. O. Smith Corp., Smith-Erie Div., **a, b, d.**
Spaceatomics Div., The Budd Co., **d.**
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp., **d.**
Struthers Wells Corp., **b, c.**
Sweetland Engrg. Co., **a, c.**
Talley Corp., The, **a.**
Tapco Group, Thompson Ramo Wooldridge Inc., **c.**
Taylor-Winfield Corp., **a.**
Thompson Ramo Wooldridge Inc., **c.**
U. S. Pipe & Foundry Co., Steel & Tubes Div., **d.**
United States Chemical Milling Corp., **d.**
Van der Horst Corp. of America
Vickers Inc., **c.**
Vickers, Inc., Mich., **b, c.**
Vinson Mfg. Co. Inc., **a, c.**
Weatherhead Co., The, **a thru d.**
Weaver Mfg. Co., Div.-Dura Corp., **c.**
Weba, Inc., **c.**
Wells Industries Corp., **a, b, c.**
Western Design, Div.-U. S. Industries, Inc., **c.**
Western Pneumatic Tube Co.
Westinghouse Air Brake Co., Industrial Products Div., **a.**
Westinghouse Electric Corp., **d.**
Whiton Machine Co., The, **a, c.**
Wickfield, Inc., **a, c.**
Worcester Pressed Steel Co., **b.**
Young Development Div., Hercules Powder Co., **a thru d.**
Zero Aero, **a, b.**

DAMPERS, CONTROL

Bendix Aviation Corp.
Cadillac Gage Co.
Delco Products Div.-General Motors Corp.
Hagan Chemicals & Controls Inc.
Haskel Engrg. & Supply Co.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Hydra-Power Corp
Kemp Aero Products
Kieley & Mueller, Inc.
Lear, Inc
***MARTIN CO., THE, DENVER DIV.**
Ozone Metal Products Corp.
Edw. Renneburg & Sons Co.
Ronson Hydraulic Units Corp.
Simmonds Aerocessories, Inc.
Southwest Research Institute
Vickers, Inc., Mich.

DAMPERS, PULSATION

Auto-Control Labs. Inc.
Consolidated Controls Corp.
Delco Products Div.-General Motors Corp.
Emhart Mfg. Co., Maxim Div.
Industrial Acoustics Co., Inc.
Kemp Aero Products
Lear, Inc.
National Engrg. Products, Inc.
Ozone Metal Products Corp.
Parts Engrg. Co., Inc.
Southwest Research Institute
A. U. Stone & Co., Inc.
Sun Electric Corp., Aeronautical Div.
Vickers, Inc., Mich.
Western Design, Div.-U. S. Industries, Inc.

DAMPERS, VIBRATION & SHIMMY

Anaconda Metal Hose Div., The American Brass Co.
Armstrong Cork Co.
Barry Controls Inc.
Bendix Aviation Corp.
Cordo Chemical Corp.
Delco Products Div.-General Motors Corp.
Dow-Elco, Inc.
Electrol Inc.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
General Logistics Div., Aeroquip Corp.
Haskel Engrg. & Supply Co.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Hydra-Power Corp.
K. W. Johnson & Co., Inc.
Kemp Aero Products
Lear, Inc.
Lord Mfg. Co.
MB Electronics
Menasco Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
Northrop Corp.
Ozone Metal Products Corp.
Parts Engrg. Co., Inc.
Raybestos-Manhattan, Inc.
Rimak, Inc.
Robins Industries Corp.
Ronson Hydraulic Units Corp.
Rubbercraft Corp. of California
Sargent Engrg. Corp.
Southwest Research Institute
Taylor Devices, Inc.
Vibration Isolation Products
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

DATA ACQUISITION & HANDLING SYSTEMS

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
ASCOP Div., Electro-Mechanical Research, Inc.
Acoustica Associates, Inc.
Advance Industries, Inc.
***AEROJET-GENERAL CORP.**
Aeronca Mfg. Corp.-Aerospace Div.
American Machine & Foundry Co., Government Products Group, N. Y.
Applied Electronics Corp. of N. J.
Arnoux Corp.
Autonetics, Div.-North American Aviation, Inc.
Avco Corp., Crosley Div.
Baird-Atomic, Inc.
Barker Sales Co
Beckman-Systems Div.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Benson-Lehner Corp.
Ernest E. Blanche & Associates, Inc.
Briggs Associates, Inc.
Broadview Research Corp.
Brush Instruments, Div.-Clevite Corp.
Budd Lewyt Electronics, Inc.
CG Electronics Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chalco Engrg. Corp.
Chance Vought Aircraft, Inc.
Computer Control Co., Inc.
Computer Control Co., Inc., Western Div.
Computer Engrg. Associates, Inc.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Control Data Corp.
Cubic Corp.
Curtiss-Wright Corp., Electronics Div.
Data Instruments Div.-Telecomputing Corp.
Daystrom, Inc., Control Systems Div.
Daystrom, Inc., Military Electronics Div.
Daystrom Inc., Pacific Div.
Designers for Industry, Inc.
Donner Scientific Co.
Dynametrics Corp.
Dynatronics, Inc.
Eastman Kodak Co.
Eldorado Electronics
Electro Instruments, Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
Electronic Engrg. Co. of California
Electronics Div.-The National Cash Register Co.
Epsco Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
J. W. Fecker Div., American Optical Co.
Fenske, Fedrick & Miller Inc.
Flight Support, Inc.
GPL Div.-General Precision, Inc.
General Devices, Inc.
General Electric Co., Computer Dept.
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Light Military Electronics Dept.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
Gilmore Industries, Inc.
Gulton Industries, Inc.
HRB-Singer, Inc., Sub.-Singer Mfg. Co
Hagan Chemicals & Controls Inc.
Hallamore Electronics Co., Div.-Siegler Corp.
Hallicrafters Co., The
Hammarlund Mfg. Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co.
Hughes Tool Co., Aircraft Div.
ITT Federal Div., International Telephone & Telegraph Corp.
Kin Tel Div.-Cohu Electronics, Inc.
Lab. for Electronics, Inc.
Leach Corp.
Lear, Inc.
Leeds & Northrup Co.
***WALLACE O. LEONARD, INC.**
Librascope Div., General Precision, Inc.
Litton Industries, Inc
Lockheed Aircraft Corp., Missiles & Space Div.
Lundy Mfg. Corp.
Madigan Corp.
***MAGNAVOX CO., THE**
Maico Electronics, Inc.
Midwestern Instruments, Inc.
Milgo Electronic Corp.
Mincom Div., Minnesota Mining & Mfg. Co
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Mitchell Camera Corp.
Motorola, Inc.
National Co., Inc.
Navigation Computer Corp.
Packard Bell Computer Corp.
Philco Corp.-Govt. & Industrial Group
Potter Instrument Co., Inc.
Radiaphone Co. Inc.
Radiation, Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Remington Rand Univac Div.-Sperry Rand Corp.
Republic Aviation Corp., Missile Systems Div.
Singer Military Products Div.-The Singer Mfg. Co.
Skiatron Electronics & Television Corp.
Solar Aircraft Co.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Stromberg-Carlson Div.-General Dynamics Corp.

Stromberg-Carlson, San Diego, General Dynamics Corp.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
Talley Register Corp.
Texas Instruments Inc.
Thompson Ramo Wooldridge Inc.
Wayne-George Corp.
Western Union Telegraph Co., The
Westinghouse Electric Corp.
Westronics Inc.
Wiancko Engrg. Co.

DATA REDUCTION SYSTEMS

ACF Industries Inc.
ASCOP Div., Electro-Mechanical Research, Inc.
Advance Industries, Inc.
***AEROJET-GENERAL CORP.**
Aeronca Mfg. Corp.-Aerospace Div.
Alwac Computer, Div.-El-Tronics Inc.
Applied Electronics Corp. of N. J.
Arnoux Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Benson-Lehner Corp.
Ernest E. Blanche & Associates, Inc.
Briggs Associates, Inc.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
CG Electronics Corp.
Chance Vought Aircraft, Inc.
Computer Control Co., Inc.
Computer Control Co., Inc., Western Div.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Control Data Corp.
Cubic Corp.
Data Instruments Div.-Telecomputing Corp.
Joe Davidson & Associates
Daystrom, Inc., Control Systems Div.
Designers for Industry, Inc.
Donner Scientific Co.
Allen B. Du Mont Labs., Inc.
Dynatronics, Inc.
Electro Instruments, Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
Electronic Computer Co., Inc.
Electronics Div.-The National Cash Register Co.
Epsco Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
Fenske, Fedrick & Miller Inc.
Fischer & Porter Co.
Flight Support, Inc.
Franklin Electronics Inc.
General Devices, Inc.
General Electric Co., Computer Dept.
General Electric Co., Heavy Military Electronics Dept.
General Mills, Inc.
Gilfillan Bros. Inc.
Gulton Industries, Inc.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Hammett-Mercury-Rex Div.
Hewlett-Packard Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Leeds & Northrup Co.
Librascope Div., General Precision, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Madigan Corp.
Mincom Div., Minnesota Mining & Mfg. Co.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div.
Mitchell Camera Corp.
Moran Instrument Corp.
Motorola, Inc.
Navigation Computer Corp.
Northrop Corp.
Optomechanisms Inc.
Pacific Automation Products, Inc.
Packard Bell Computer Corp.
Parabam, Inc.
Philco Corp.-Govt. & Industrial Group
Potter Instrument Co., Inc.
Radiaphone Co. Inc.
Radiation, Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Remington Rand Univac Div.-Sperry Rand Corp.
Republic Aviation Corp., Missile Systems Div.
Soroban Engrg., Inc.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Special Products Dept., Melpar, Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Systron Corp.
Tally Register Corp.
Westronics Inc.

DECADE BOXES

Associated Engineers, Inc.
Barnes Development Co.
Clarostat Mfg. Co., Inc.
Cornell-Dubilier Electric Corp.
Daven Co., The
Dmeter Mfg. Co.
Electro Scientific Industries
Electronic Applications, Inc.
Epic, Inc.
Epsco Inc.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Fisher Scientific Co., Maryland
Freed Transformer Co., Inc.
General Radio Co.
Gray Instrument Co.
Industrial Instruments Inc.
Kirk & Blum Mfg. Co., The
Lear, Inc.
Leeds & Northrup Co.
***MARTIN CO., THE, DENVER DIV.**
Muirhead Instruments Inc.
New England Scientific Instruments Co.
Nuclear-Chicago Corp.
Pacific Automation Products, Inc.
Pimex, Inc.
Precise Development Corp.
***RADIO CORP. OF AMERICA**
Rimak, Inc.
Universal Mfg. Co., Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

DECALCOMANIAS

Adept Industries Inc.
Allied Decals, Inc.
W. H. Brady Co.
California Plasteck Inc.
Croname Inc.
Duralith Corp.
Walter J. Hyatt Co., The
Meyercord Co., The
Meyercord Co., The, AMC Div.
***MINNESOTA MINING & MFG. CO.**
New England Etching Co. Inc.
Norsid Mfg. Co., Inc., The
Regal Air Corp.
Scioto Sign Co.
Sillcocks-Miller Co.
Stanpat Co.
Swift Textile Metalizing & Laminating Corp.
E. F. Twomey Co., Inc.

DECODERS

Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Bendix Aviation Corp., Cincinnati Div.
Blonder-Tongue Labs. Inc., Special Products Div.
Bruno-New York Industries Corp.
CG Electronics Corp.
Dynatronics, Inc.
Electronic Computer Co., Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
Fenske, Fedrick & Miller Inc.
Gilfillan Bros. Inc.
Lear, Inc.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
Molded Insulation Co.
Motorola, Inc.
National Co., Inc.
Navigation Computer Corp.
Philco Corp.-Govt. & Industrial Group
Radiaphone Co. Inc.
Radiation, Inc.
***RADIO CORP. OF AMERICA**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Secode Corp.
Southwestern Industrial Electronics Co.
Tally Register Corp.
Transistor Electronics Corp.
Wickes Engrg. & Construction Co.

DEHUMIDIFIERS

Accessory Controls & Equipment Corp.
Advance Industries, Inc.
American Instrument Co., Inc.
Atlantic Research Corp.
Barium & Chemicals, Inc.
Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
Carrier Corp.
Dampp-Chaser, Inc.
Joe Davidson & Associates
Desomatic Products, Inc.-Anders-Driline
Drayer Hanson Div.-Crane Co.
Driaire, Inc.
Dryomatic Corp.
Eastern Industries Inc
Ellis & Watts Products, Inc.
Frick Co.
Great Lakes Mfg. Corp.
Gremco, Inc.
Hammett-Mercury-Rex Div.
C. G. Hokanson Co., Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Kahn & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear, Inc.
Merix Chemical Co.
Murphy & Miller Inc.
Pioneer Industries Div., Almar-York Co. Inc.
Pittsburgh Lectrodryer Div.-Mc Graw-Edison Co.
J. F. Pritchard & Co. of California
Robbins Aviation, Inc.
Southwest Research Institute
Trinity Equipment Corp.
Universal Dynamics Corp.
Wells Industries Corp.
Wenzlau Engrg. Co.
Westinghouse Electric Corp.

DEHYDRATING AGENTS

Barium & Chemicals, Inc.
Budd Lewyt Electronics, Inc.
Driaire, Inc.
Kahn & Co., Inc.
Monsanto Chemical Co.
Robbins Aviation, Inc.
Southwest Research Institute
Universal Dynamics Corp.
Wells Industries Corp.

DEHYDRATOR PLUGS

Driaire, Inc.
Robbins Aviation, Inc.
Universal Dynamics Corp.
Wells Industries Corp.

DEHYDRATORS, AUTOMATIC

Advance Industries, Inc.
American Instrument Co., Inc.
Applied Dynamics Corp.
Budd Lewyt Electronics, Inc.
Cornelius Co., The, Aero Div.
Crane Co., Special Products Div.
Dalmo Victor Co., Div.-Textron, Inc.
Desomatic Products, Inc.-Anders-Driline
Dryomatic Corp.
Eastern Industries Inc.
Frick Co.
Great Lakes Mfg. Corp.
Harris Refrigeration Co.
Kahn & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear, Inc.
Olympic Plastics Co., Inc.
Pittsburgh Lectrodryer Div.-Mc Graw-Edison Co.
J. F. Pritchard & Co. of California
Robbins Aviation, Inc.
S & G Mfg. Corp.
Selas Corp. of America
Southwest Research Institute
Trinity Equipment Corp.
Universal Dynamics Corp.
Wells Industries Corp.

DEHYDRATORS, OXYGEN EQUIPMENT

Advance Industries, Inc.
Air Products, Inc.
Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
Desomatic Products, Inc.-Anders-Driline
Driaire, Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Pittsburgh Lectrodryer Div.-Mc Graw-Edison Co.
Robbins Aviation, Inc.
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Universal Dynamics Corp.
Wells Industries Corp.
Zep Aero

DELAY LINES

a. Computer

b. Decade
c. Distributed-Constant Fixed
d. Distributed-Constant Variable
e. Lumped-Constant Fixed
f. Lumped-Constant Variable
g. Printed Circuit

ACDC Electronics, Inc., **a, b, c, e, g.**
AMP Inc., **c thru f.**
Admiral Corp., **e, f.**
Advance Industries, Inc., **a.**
Alden Products Co.
American Tube Bending Co., Inc.
Andersen Labs., Inc., **a thru f.**
Bel Fuse Inc., **a, c.**
Bendix Aviation Corp., **a.**
Bendix Aviation Corp., Cincinnati Div., **a.**
Richard D. Brew & Co., Inc., **a thru g.**
Burnell & Co., Inc., **e, f.**
Burton-Rodgers, Inc., **a, g.**
Chance Vought Aircraft, Inc., **e.**
Columbia Technical Corp., **a thru g.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., c, e.**
Communication Accessories Co., **e, f, g.**
Computer Control Co., Inc., **a.**
Computer Control Co., Inc., Western Div., **a.**
Control Electronics Co., Inc., **a thru g.**
Corning Glass Works
Curtiss-Wright Corp., Electronics Div.
Daven Co., The, **e.**
Double E Products Co., **a thru g.**
ESC Corp., **a thru g.**
Electrical & Physical Instrument Corp., **d.**
Electro-Winders Co. Inc., **a thru g.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **a, d.**
Filtron Co., Inc., **a thru g.**
Forbes & Wagner, Inc., **a, c, e.**
General Electric Co., Heavy Military Electronics Dept., **c, d.**
General Radio Co., **d.**
Gilfillan Bros. Inc.
Gudeman Co., The, **c, e.**
Hallamore Electronics Co., Div.-Siegler Corp., **c.**
Hammett-Mercury-Rex Div., **a.**
George E. Harris & Co., Inc.
Helipot Div.-Beckman Instruments, Inc., **d.**
IMC Magnetics Corp., **c thru f.**
Industrial Test Equipment Co., **f.**
JFD Electronics Corp., **c thru g.**
Lab. for Electronics, Inc., **a, c thru f.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **g.**
La Pointe Industries Inc., **g.**
Lear, Inc., **a, c, g.**
Librascope Div., General Precision, Inc., **a, c, g.**
Litton Industries, Inc.
Meridian Metalcraft, Inc. **c.**
Micamold Electronics Mfg. Corp., **e.**
James Millen Mfg. Co. Inc., **a, c, e.**
Mitronics Inc., **g.**
Motorola, Inc., **a, c, thru g.**
Nytronics, Inc., Essex Electronics Div., **a, c, e, g.**
Orbitran Co., Inc., **e.**
Ralph M. Parsons Co., The, Electronics Div., **e, f.**
Philco Corp.-Govt. & Industrial Group, **a, e, f, g.**
Polyphase Instrument Co., **e.**
Precision Lapping Co. Inc.
Q-Circuits, Div.-Etching Co. of Calif., **g.**
Radio Condenser Co., **f.**
***RADIO CORP. OF AMERICA, a thru g.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **c thru f.**
Redman Electronics Corp., **a, e.**
Rytron Co., Inc., **e.**
Sangamo Electric Co., **e.**
Shallcross Mfg. Co., **a thru g.**
Southwestern Industrial Electronics Co., **a, d.**
Sprague Electric Co., **e.**
Stanpat Co., **g.**
Stewart-Warner Electronics Div., **c, e.**
Superior Electric Co., The
Taffet Electronics, Inc., **b, d.**
Technitrol Engrg. Co., **a, c, e.**
Thompson Ramo Wooldridge Inc., **e, f.**
Transco Products, Inc., **c.**
Transistor Electronics Corp., **a.**
U. S. Sonics Corp., **a.**
Valor Instruments, Inc., **a thru g.**
Vanguard Electronics Co., **c, e, f.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **e, f, g.**

DELAY NETWORKS

ACDC Electronics, Inc.
Advance Industries, Inc.
American Potash & Chemical Corp., National Northern Div.
Andersen Labs., Inc.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Richard D. Brew & Co., Inc.
Burnell & Co., Inc.
Chance Vought Aircraft, Inc.
Columbia Technical Corp.
Control Electronics Co., Inc.
Daven Co., The
Double E Products Co.
ESC Corp.
Electro-Winders Co. Inc.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Forbes & Wagner, Inc.
General Radio Co.
Gilfillan Bros. Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
***MARTIN CO., THE, DENVER DIV.**
Microphase Corp.
James Millen Mfg. Co. Inc.
Motorola, Inc.
National Co., Inc.
Nytronics, Inc., Essex Electronics Div.
Orbitran Co., Inc.
Philco Corp.-Govt. & Industrial Group
Polyphase Instrument Co.
***RADIO CORP. OF AMERICA**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Stewart-Warner Electronics Div.
Taffet Electronics, Inc.
Tamar Electronics, Inc.
Telectro Industries Corp.
Valor Instruments, Inc.
Vanguard Electronics Co.
Varo Mfg. Co., Inc.
Voi-Shan Electronics
Western Union Telegraph Co., The
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

DEMAGNETIZERS

R. B. Annis Co.
Bearing Inspection, Inc.
Caltron Products Co.
Electronic Brazing Co.
Ideal Industries, Inc.
Kahn & Co., Inc.
L & R Mfg. Co.
Librascope Div., General Precision, Inc.
Magnaflux Corp., Sub.-General Mills, Inc.
Magnetic Circuit Elements, Inc.
Merix Chemical Co.
Microtran Co. Inc.
Robins Industries Corp.
Southwestern Industrial Electronics Co.
Taft-Peirce Mfg. Co., The
Telectro Industries Corp.

DEMODULATORS, COMPUTER

Advance Industries, Inc.
Arnoux Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Lear, Inc.
Librascope Div., General Precision, Inc.
Micro Gee Products, Inc.
Motorola, Inc.
National Co., Inc.
Otis Elevator Co., Defense & Industrial Div.
Polyphase Instrument Co.
***RADIO CORP. OF AMERICA**
Servomechanisms, Inc.
Solar Mfg. Corp.
Summers Gyroscope Co.
Sun Electric Corp., Aeronautical Div.
Telectro Industries Corp.
Varo Mfg. Co., Inc.

DEMODULATORS, CURRENT

***R. C. ALLEN AIRCRAFT INSTRUMENT DIV., R. C. ALLEN BUSINESS MACHINES, INC.**

DENSITOMETERS, ELECTRONIC

Applied Research Labs., Inc.
Automation Products, Inc.
Bendix Aviation Corp., Cincinnati Div.
Empire Products Sales Corp.
***ENGIS EQUIPMENT CO.**
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Gordon Enterprises
Jarrell-Ash Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Photovolt Corp.
Potter Aeronautical Corp.
Revere Corp. of America, Sub., Neptune Meter Co.
Servomechanisms, Inc.
Spectra Electronics Corp.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

DESTRUCTORS

***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
American Machine & Foundry Co.
American Potash & Chemical Corp., National Northern Div.
Armament Div.-Universal Match Corp.
Avco Corp., Crosley Div.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Bulova Research & Development Labs., Inc.
Joe Davidson & Associates
Daystrom Inc., Weston Instruments Div.
Gabriel Co., Rocket Power-Talco
Hercules Powder Co., Chemical Propulsion Div.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Librascope Div., General Precision, Inc.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Litton Industries, Maryland Div.
Mc Cormick Selph Associates
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Young Development Div., Hercules Powder Co.

DESTRUCTORS & ASSOCIATED MECHANISMS

***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
American Machine & Foundry Co.
American Potash & Chemical Corp., National Northern Div.
Armament Div.-Universal Match Corp.
Avco Corp., Crosley Div.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Bulova Research & Development Labs., Inc.
E. I. Du Pont de Nemours & Co., Inc.
Gabriel Co., Rocket Power-Talco
Hercules Powder Co., Chemical Propulsion Div.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Librascope Div., General Precision, Inc.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.

DETECTION SYSTEMS

ACF Industries Inc.
Advanced Electronics, Inc.
American District Telegraph Co.
American Research & Mfg. Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Chance Vought Aircraft, Inc.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom Inc., Weston Instruments Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Designers for Industry, Inc.
Eastman Kodak Co.
Thomas A. Edison Ind. Instrument Div., Mc Graw Edison Co.
***EQUIPMENT DIV., RAYTHEON CO.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Fenwal Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense & Engrg. Products Group.
Hughes Tool Co., Aircraft Div.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear, Inc.
Litton Industries, Maryland Div.
Magnaflux Corp., Sub.-General Mills, Inc.
Motorola, Inc.
National Co., Inc.
Nuclear Measurements Corp.
Radio City Products Co. Inc.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Special Products Dept., Melpar, Inc
Spectra Electronics Corp.
Sun Electric Corp., Aeronautical Div.
Tapco Group, Thompson Ramo Wooldridge Inc.
Texas Instruments Inc.
Thompson Ramo Wooldridge Inc.
U.S. Industries, Inc.

Wells Industries Corp.
Western Union Telegraph Co., The

DETECTORS

- a. Crack
- b. Crystal
- c. Detonation
- d. Explosive Gas
- e. Flaw & Defect, Electronic
- f. Impedance
- g. Leak
- h. Magnetic
- i. Metal, Electronic
- j. Monoxide
- k. Null
- l. Null, RF
- m. Radiation
- n. Radiation, Nuclear
- o. Resistance
- p. Scintillation
- q. Smoke
- r. Standing Wave
- s. Vibration
- t. Voltage
- u. Water Leak

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Acoustica Associates, Inc., g, u.
Advanced Electronics, Inc., s.
Aerolux Light Corp., t.
Aircom Inc., r.
Airpax Electronics Inc., Cambridge Div., h.
Airpax Electronics Inc., Seminole Div., h.
Allen Electric & Equipment Co., g, u.
American District Telegraph Co., q.
American Electronics, Inc., g, m, n, p.
American Machine & Foundry Co., a, e.
American Potash & Chemical Corp., National Northern Div., m.
American Research & Mfg. Corp., h, i, s, t.
American Tradair Corp., n, p.
Arnoux Corp., o.
Aviation Textile Associates, h.
Avien, Inc., t.
Baird-Atomic, Inc., m, n, p.
Ball Brothers Research Corp., p.
Barber-Colman Co., k.
Barnes Development Co., k, o.
Bendix Aviation Corp., b, k thru n.
Bendix Aviation Corp., Cincinnati Div., m thru p.
Boonton Electronics Corp., k, l, t.
Branson Instruments, Inc., a, e.
E. W. Brilmayer Labs., Inc., i.
Calvert Electronics Inc., o.
Chatham Electronics Div.-Tung-Sol Electric Inc., m.
Circo Equipment Co., e.
Circo Ultrasonic Corp., e.
Clevite Transistor Products, Div.-Clevite Corp., b.
Consolidated Controls Corp., o.
*CONSOLIDATED ELECTRODYNAMICS CORP., g, s.
Consolidated Vacuum Corp., g.
Continental Electric Co., d.
Convair Instruments, Convair Div.-General Dynamics Corp. g.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., g.
Crosby-Teletronics Corp., g.
Dalmo Victor Co., Div.-Textron, Inc., h.
Davis Instruments, d.
Daystrom Inc., Weston Instruments Div., e.
Delsen Corp., e.
Demornay-Bonardi, r
Designers for Industry, Inc., e, h, i.
Diamond Antenna & Microwave Corp., b, r.
J. W. Dice Co., e, i.
Double E Products Co., l, m.
Douglas Microwave Co., Inc.. r.
Du Kane Corp., h.
Dytronics Co., g, k, u.
Eastman Kodak Co., m.
Eberline Instrument Corp., n, p.
Edwards High Vacuum Ltd., g.
Electro Scientific Industries, f, k, o.
Electronic Control Corp., q.
Electron-Radar Products, q.
Empire Products Sales Corp., m.
Epic, Inc., s.
*EQUIPMENT DIV., RAYTHEON CO.,
Erdco Engrg. Corp., d.
FXR, Inc., r.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., m.
Fenwal Inc., d, k.
Fisher Scientific Co., g.
Food Machinery & Chemical Corp., Ordnance Div., e.
Freed Transformer Co., Inc., k.
Fyr-Fyter Co., The, q.
Gardiner Electronics, i, m, p.
Gardner Laboratory, Inc., j.
General Electric Co., Apparatus Sales Div., d, g, i, m, q.
General Radio Co., f, k, l, o, r, s.
General Scientific Equipment Co., d, j, q.
Paul E. Gerst & Co., h.
John Gombos Co., Inc., r.
Grant-Lehr Corp., g, u.
Gulton Industries, Inc., s.
Hammett-Mercury-Rex Div., b, h, t.
Hewlett-Packard Co., b, r.
E. Vernon Hill & Co., g, s.
Hoffman Electronics Co., d.
Hoffman Electronics Corp., Semiconductor Div., d, q.
Houston Instrument Corp., d.
Hughes Tool Co., Aircraft Div., g.
Image Instruments, Inc., e.
Industrial Test Equipment Co., k, t.
Infrared Industries, Inc., m.
Instrument Div., The Budd Co., a, n.
International Electronic Research Corp., m, n.
Interstate Electronics Corp., b, f, g, m, n, p, q, u.
Isotopes Specialties Co., Div.-Nuclear Corp. of America, a, n, p.
Johnson-Williams, Inc., d.
Kahn & Co., Inc., s.
Kay Electric Co., t.
Keithley Instruments, Inc., f, k, o, t.
Wayne Kerr Corp., s.
Kin Tel Div.-Cohu Electronics, Inc., k.
Kistler Instrument Corp., s.
Land-Air Inc., Sub.-California Eastern Aviation, Inc., m, n, p.
Lear, Inc., e, g, k, l, o, t.
Leeds & Northrup Co., j, k, o, q.
Levinthal Electronic Products, Inc., p.
Lewis Engrg. Co., The, b.
Lieco, Inc., b.
Linde Co., Div.-Union Carbide Corp., g.
MB Electronics, s.
Magnaflux Corp., Sub.-General Mills, Inc., a, e, g, h, i.
Magnetic Circuit Elements, Inc., t.
*MARTIN CO., THE, DENVER DIV., a, e, g, k, q, s, t, u.
Mechanics Research Div., American Machine & Foundry Co., a.
Meridian Metalcraft, Inc., b.
Microphase Corp., b.
Microwave Associates, Inc., b, r.
James Millen Mfg. Co. Inc., r.
Mine Safety Appliances Co., g.
Motorola, Inc., b, i.
Muirhead Instruments Inc., k.
NUMEC-Nuclear Materials & Equipment Corp., m, n.
Narda Microwave Corp., The, b.
National Co., Inc., l, m.
Newark Controls Co., g, u.
Northrop Corp., a.
Notifier Corp.,
Nuclear Corp. of America, n, p.
Nuclear Development Lab., n.
Nuclear Measurements Corp., m, n, p.
Nuclear-Chicago Corp., m, n, p.
Ohio Chemical & Surgical Equip. Co., Div.-Air Reduction Co., Inc., g.
Omart Corp., The, n, p.
Olin Mathieson Chemical Corp., N.Y., a thru d, j.
Omega Labs., Inc., r.
Patterson Moos Research, Div.-Leesona Corp., c, d, m, n, p, q.
Penn Keystone Corp., h, t.
Performance Measurements Co., k.
Perkin-Elmer Corp., g.
Peschel Electronics, Inc., e, t.
Philco Corp.-Govt. & Industrial Group, b, p.
Philips Electronic Instruments, p.
Photobell Co., Inc., e, q.
Piasecki Aircraft Corp., m, n, p.
Pilot Chemicals, Inc., p.
Pioneer Industries Div., Almar-York Co. Inc., e, i, o.
Polarad Electronics Corp., m, r.
Polytechnic Research & Development Co., Inc., f, r.
Potter Aeronautical Corp., g, u.
Radiation Instrument Development Lab., Inc., n, p.
Radio Condenser Co., l.
*RADIO CORP. OF AMERICA, e thru h, k, l, p, r, t.
Rantec Corp., b.
Milton Roy Co., g.
Sage Labs., Inc., b, r.
Scientific & Process Instruments Div.-Beckman Instruments, Inc., g.
Scientific-Atlanta, Inc., b.
H. H. Scott, Inc., s.
*SEMICONDUCTOR DIV., RAYTHEON CO., b.
Simpson Electric Co., k.
Singer Military Products Div.-The Singer Mfg. Co., r.
Southwest Research Institute, a, d, e, g, h, i, r, s, u.
Southwestern Industrial Electronics Co., s.
Special Products Dept., Melpar, Inc., t.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., m, r.
Sperry Products Co., Div.-Howe Sound Co., a, e.
Strand Engrg. Co., n.
Sun Electric Corp., Aeronautical Div., s.
Sunshine Scientific Instrument, e, g, h, i.
Sylvania Semiconductor Div., Sylvania Electric Products Inc.,
TRG, Inc., b, n, r.
Tamar Electronics, Inc., l.
Telechrome Mfg. Corp., e, m, n, p.
Telonic Industries, Inc., b.
Theta Instrument Corp., k.
Tracerlab Inc., n, p.
Trio Laboratories, Inc., t.
Turco Products, Inc., a, g.
U. S. Industries, Inc., m, n, p.
U. S. Science Corp., Div.-Topp Industries, Inc., s.
Universal Transistor Products Corp., g, m, n, p.
Varo Mfg. Co., Inc., t.
Veeco Vacuum Corp., g.
Vickers Inc., Electric Products Div., t.
Victoreen Instrument Co., m, n, p.
Video Instruments Co., Inc., s.
Voi-Shan Electronics, t.
Waugh Engrg. Co., g.
Waveline, Inc., r.
Wells Industries Corp., q.
Westinghouse Electric Corp., n, p, s.
Wiancko Engrg. Co., g.
N. Wood Counter Lab., m, p.

DEVELOPERS, CHEMICAL

American Potash & Chemical Corp., National Northern Div.
Armour Industrial Chemical Co.
Gallery Chemical Co.
Delta Chemical Works, Inc.
E. I. Du Pont de Nemours & Co. Inc.
Eastman Kodak Co.
Gordon Enterprises
Merix Chemical Co.
Semi-Elements, Inc.

DIAGNOSTIC EQUIPMENT-COMPUTER

Bendix Aviation Corp.
Broadview Research Corp.
Computer Control Co., Inc.
Computer Control Co., Inc., Western Div.
Ensco, Inc.
Epsco Inc.
Gulton Industries, Inc.
Hammett-Mercury-Rex Div.
Iconix Inc.
Librascope Div., General Precision, Inc.
Motorola, Inc.
Navigation Computer Corp.
Northrop Corp.
Optomechanisms Inc.
Packard Bell Computer Corp.
Philco Corp.-Govt. & Industrial Group
*RADIO CORP. OF AMERICA

DIAL CRYSTALS

American Insulator Corp.
Connecticut Instrument Corp.
G-C Electronics Co.
Homalite Corp., The
Lancaster Glass Corp.
Semi-Elements, Inc.
Sillcocks-Miller Co.
Sterling Glass Corp.
Sun Electric Corp., Aeronautical Div.

DIALS

Ackerman Engravers, Inc.
Acromark Co., The
Adept Industries Inc.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
American Insulator Corp.
Apahouser Corp. of N. E.
A. Biederman, Inc.
Borg Equipment Div., Amphenol-Borg Electronics Corp.
W. H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Canadian Radium & Uranium Corp.
Chemical Micro Milling Co.
Connecticut Instrument Corp.
Cronome Inc.
Henry G. Dietz Co., Inc.
Dura Plastics of N. Y., Inc.
Duralith Corp.
Electric Autolite Co., The
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Fisher & Crome
Ford Instrument Co., Div.-Sperry Rand Corp.
Franklin Fibre-Lamitex Corp.
Garwin, Inc.

General Communication Co.
General Radio Co.
W. & L. E. Gurley
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div.
Homalite Corp., The
E. F. Johnson Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kerrco
Kilo Engrg. Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Kurtz-Kasch, Inc.
Librascope Div., General Precision, Inc.
Litho-Etch Metal Name Plate Co.
James Millen Mfg. Co. Inc.
Miller Dial & Nameplate Co.
Muirhead Instruments Inc.
New England Etching Co. Inc.
North Shore Nameplate, Div.-Anodyne, Inc.
Panel Engrg. Corp.
Phaostron Instrument & Electronic Co.
Q-Circuits, Div.-Etching Co. of Calif.
Rimak, Inc.
D. A. Schultz Co.
Sillcocks-Miller Co.
Spectrol Electronics Corp.
Sun Dial Corp.
Technology Instrument Corp.
United States Radium Corp.
Universal Unlimited, Inc.
Vemaline Products Co.
Virginia Plak Co.

DIALS, COMPLETE

Ackerman Engravers, Inc.
Adept Industries Inc.
Associated Engineers, Inc.
A. Biederman, Inc.
Borg Equipment Div., Amphenol-Borg
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Canadian Radium & Uranium Corp.
Chemical Micro Milling Co.
Electric Autolite Co., The
Garwin, Inc.
General Radio Co.
Hamilton Watch Co., Military Products Div
E. F. Johnson Co
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kilo Engrg. Co.
James Millen Mfg. Co. Inc.
Muirhead Instruments Inc.
Panel Engrg. Corp.
Reeves Instrument Corp.
D. A. Schultz Co.
Sillcocks-Miller Co.
Sun Dial Corp.
Theta Instrument Corp.
Vemaline Products Co.

DIALS, INSTRUMENT

Ackerman Engravers, Inc.
Acromark Co., The
Adept Industries Inc.
Allen Electric & Equipment Co.
Apahouser Corp. of N. E.
A. Biederman, Inc.
Borg Equipment Div., Amphenol-Borg Electronics Corp.
W. H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Calvert Electronics Inc.
Canadian Radium & Uranium Corp.
Chemical Micro Milling Co.
Connecticut Instrument Corp.
Croname Inc.
Dale Products, Inc.
Henry G. Dietz Co., Inc.
Dura Plastics of N. Y., Inc.
Duralith Corp.
Electric Autolite Co., The
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Fisher & Crome
Ford Instrument Co., Div.-Sperry Rand Corp.
Garwin, Inc.
General Communication Co.
General Radio Co.
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div.
Jan Hardware Mfg. Co., Inc
E. F. Johnson Co.
Kerrco
Kilo Engrg. Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
*MARTIN CO., THE, DENVER DIV.
James Millen Mfg. Co. Inc.
*MINNESOTA MINING & MFG. CO.
Muirhead Instruments Inc.
New England Etching Co. Inc.
North Shore Nameplate, Div.-Anodyne, Inc.
Panel Engrg. Corp.
Phaostron Instrument & Electronic Co.
Reeves Instrument Corp.
Rimak, Inc.
D. A. Schultz Co.
Sillcocks-Miller Co.
Simmonds Aerocessories, Inc.
Spectrol Electronics Corp.
Sterling Glass Corp.
Sun Dial Corp.
Sun Electric Corp., Aeronautical Div.
Technology Instrument Corp.
Unified Industries, Inc.
United States Radium Corp.
Universal Unlimited, Inc.
Vemaline Products Co.
Virginia Plak Co.

DIAPHRAGMS, JET ENGINE

ACF Industries Inc
Aero Gasket Corp.
Allison Div., General Motors Corp.
Auburn Mfg. Co. The
Bellofram Corp.
Falcon Machine & Tool Co.
B. F. Goodrich Aviation Products
ITE Circuit Breaker Co., Special Products Div.
Joclin Mfg. Co., The
Kerns Mfg. Corp.
Linear, Inc.
Lycoming Div., Avco Corp.
Mc Gregor Mfg. Corp.
Portland Copper & Tank Works Inc.
Reeves Brothers, Inc.
Solar Aircraft Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
United States Chemical Milling Corp.
United States Rubber Co.
Weatherhead Co., The

DIAPHRAGMS, JET ENGINE NOZZLE

ACF Industries Inc.
Aero Gasket Corp.
Allison Div., General Motors Corp.
Bellofram Corp.
Capital City Mfg. Co., Inc.
Falcon Machine & Tool Co.
ITE Circuit Breaker Co., Special Products Div.
Kerns Mfg. Corp.
Linear, Inc.
Lycoming Div., Avco Corp.
McGregor Mfg. Corp.
Portland Copper & Tank Works Inc.
Solar Aircraft Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc
United States Chemical Milling Corp.
United States Rubber Co
Weatherhead Co., The
Induction Heating Corp.
Radio Freqdency Co., Inc.
Reeve Electronics, Inc.
Resdel Engrg. Corp.
D. A. Schultz Co.
Scientific Electric Inc.
Sherman Indsl. Electronics Co., Div.-Electronic Development Inc.
Westinghouse Electric Corp.
Young Brothers Co.

DIE CASTINGS

ABA Tool & Die Co.
ACF Industries Inc.
Aluminum Co. of America
Collins Mfg. Corp.
Doehler-Jarvis Div., National Lead Co.
Dow Chemical Co., The
General Communication Co.
Gries Reproducer Corp.
Jan Hardware Mfg. Co., Inc.
Lear, Inc.
Magline Inc.
C. A. Morgren Co.
Richard Philip Co.
Milton Ross Metals Co., The
Weatherhead Co., The
Westinghouse Electric Corp.

DIELECTRIC HEATING EQUIPMENT

*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Djeco, Div.-Djordjevic Engrg. Co.
Erdco Engrg. Corp.

DIELECTRIC MATERIALS

Biwax Corp.
Bjorksten Research Labs. for Industry, Inc.
Carborundum Co., The
Carborundum Co., Latrobe Plant, Refractories Div.
Coors Porcelain Co.
Corning Glass Works
D & R Pilot Plants Inc.
Dilectrix Corp.
Dow Corning Corp.
E. I. Du Pont de Nemours & Co. Inc.
Emerson & Cuming, Inc.
Flexible Tubing Corp.
Food Machinery & Chemical Corp.-Dapon Dept.
Insulation Mfrs. Corp.
*INTERELECTRONICS CORP.
Joclin Mfg. Co., The
Lamtex Industries Inc.
Lear, Inc.
Mc Millan Companies, The
*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
Monsanto Chemical Co.
Motorola, Inc.
Mycalex Corp. of America
National Beryllia Corp.
National Ceramic Co.
Natvar Corp.
Norton Co., New Products Dept.
Penn Fibre & Specialty Co., Inc.
Polymer Corp., The
Rogers Corp.
Rubbercraft Corp., of California
Special Products Dept., Melpar, Inc.
A. S. Thomas, Inc.
Thor Ceramics, Inc.
Wilmington Fibre Specialty Co.
Zirconium Corp. of America

DIES

ABA Tool & Die Co.
ACF Industries Inc.
Acromark Co., The
Allied Products Corp.
Amatom Electronic Hardware Co. Inc.
American Feldmuehle Corp.
Basic Tool Industries, Inc.
Cyril Bath Co., The
Bergen Carbide Co.
E. W. Bliss Co.
California Stamping & Mfg. Co
Cincinnati Shaper Co., The
*EXCELCO DEVELOPMENTS INC.
Forsberg Mfg., Co., The
Gar Products Corp.
Gemex Corp., The, Indsl. Div.
Greenfield Tap & Die, Div.-United-Greenfield Corp.
Henry & Miller Industries, Inc.
Kerns Mfg. Corp.
E. Konigslow Stamping & Tool Co.
Lear, Inc.
Lindgren Foundry Co.
*MARTIN CO., THE, DENVER DIV.
Metal Carbides Corp.
J. I. Morris Co.
Pennsylvania Tool & Mfg. Co., The
Richard Philip Co.
Milton Ross Metals Co., The
Sheffield Corp., The, Sub.-Bendix Aviation Corp.
Sheridan-Gray, Inc.
Superior Industrial Machine Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Therm, Inc.
Thompson Ramo Wooldridge Inc.
Twix Mfg. Co., Inc.
Unified Industries, Inc.
Universal Mfg. Co., Inc.
Victor Tool & Mfg., Inc.
Wales Strippit Inc., Unit of Houdaille Industries, Inc.
Wayne Foundry & Stamping Co.
Whitehead Stamping Co.
Winder Aircraft Corp. of Florida

DIFFUSERS, GAS TURBINE ENGINE

Allison Div., General Motors Corp.
Beacon Steel Corp.
Douglas Aircraft Corp., Inc.
Dura Plastics of N. Y., Inc.
Herlo Corp.
ITE Circuit Breaker Co., Special Products Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Janke & Co. Inc.
Kelsey-Hayes Co.
Lycoming Div., Avco Corp.
Mc Gregor Mfg. Corp.
Portland Copper & Tank Inc.
Solar Aircraft Co.
Western Design, Div.-U.S. Industries, Inc.

DIODES

a. Crystal
b. Germanium
c. Selenium
d. Silicon
e. Tunnel
f. Zener

American Elite, Inc., **b.**
American Rectifier Corp., **c, d.**
Amperex Electronic Corp., **a, b, d, e, f.**
Associated Engineers, Inc., **f.**
Bendix Aviation Corp., **a, b, d.**
Bendix Aviation Corp.-Semiconductor Products, Red Bank Div., **d.**
Bogue Electric Mfg. Co., **c, f.**
Bradley Semiconductor Corp., **c, d.**
Bulova Watch Co., Electronics Div., **a.**
CBS Electronics, Div.-Columbia Broadcasting System, Inc., **b, d.**
CBS Laboratories, Div.-Columbia Broadcasting System, **a.**
Calvert Electronics Inc., **a thru f.**
Chatham Electronics Div.-Tung-Sol Electric Inc., **d.**
Clevite Transistor Products, Div.-Clevite Corp., **a, b, d, e.**
Columbus Electronics Corp., **d.**
Cornell-Dubilier Electric Corp., **b.**
Dallons Semiconductors, Div.-Dallons Labs. **d.**
Delco Radio Div.-General Motors Corp., **b, d.**
Eitel-Mc Cullough, Inc.
Erie Resistor Corp., **b, d.**
Fairchild Semiconductor Corp., **d.**
Fansteel Metallurgical Corp., **d.**
Finney Co., The, **a thru f.**
Gahagan Inc., **a, b.**
General Electric Co. Ltd. of England, **b, c, d, f.**
General Instrument Corp., Semiconductor Div., **a, b, d, f.**
General Transistor Corp., **b, e.**
George E. Harris & Co., Inc., **c, d.**
Hoffman Electronics Co., **d, e, f.**
Hoffman Electronics Corp., Semiconductor Div., **d, e, f.**
Hughes Semiconductor Div.-Hughes Aircraft Co., **b, d, f.**
ITT Components Div., International Telephone & Telegraph Corp., **c, d, f.**
International Electronics Corp., **a, b, d, f.**
International Rectifier Corp., **c, d, f.**
Interstate Electronics Inc., **a thru f.**
Lear, Inc., **a, b, d, f.**
Microwave Associates, Inc., **a, d.**
Motorola, Inc., **a, b, f.**
North American Electronics Inc., **d, f.**
Nucleonic Products Co., **b, d.**
Philco Corp.-Govt & Industrial Group., **a, b, d, e, f.**
Philco Corp., Lansdale Div., **a, b, d, e.**
***RADIO CORP. OF AMERICA, a thru e.**
Radio Development & Research Corp., **d.**
***SEMICONDUCTOR DIV., RAYTHEON CO., a, b, d, e.**
Semi-Elements, Inc., **a, b, d, e.**
Shockley Transistor Corp., **d.**
Silicon Transistor Corp., **d.**
Sperry Semiconductor Div., Sperry Rand Corp., **d, e.**
Sylvania Electric Products Inc., Sylvania Electronic Tubes Div., **a, b, d, e.**
Sylvania Semiconductor Div., Sylvania Electric Products Inc., **a, b, d, e.**
Technical Apparatus Builders, **b, c, d, f.**
Texas Instruments Inc., **d, e, f.**
Thompson Ramo Wooldridge Inc., **b, d.**
Transitron Electronic Corp., **a, b, d, e, f.**
Trans-Sil Corp., **a, d.**
Tung-Sol Electric, Inc., **a, c, d.**
Udylite Corp., The., **c, e.**
U. S. Semiconductor Products Div.-United Industrial Corp., **d, f.**
Vickers Inc., Electric Products Div., **c, d.**
Westinghouse Electric Corp., **b, c, d, f.**

DIRECTION FINDERS

Allied International Corp.
Anderson Labs., Inc.
Autonetics, Div.-North American Aviation Inc.
Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
Collins Radio Co.
Control Electronics Co., Inc.
Eastman Kodak Co.
Fla. Aircraft Radio & Marine
General Instrument Corp., Defense & Engrg. Products Group
Hoover Electronics Co.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Interstate Electronics Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co., Inc.
Lear, Inc.
Litton Industries, Maryland Div.
Madigan Corp.
***MAGNAVOX CO., THE**
W. L. Maxson Corp., The
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Packard-Bell Electronics Corp.
Philco Corp.-Govt. & Industrial Group
Precise Development Corp.
Production Research Corp., Sub.-Radio Condenser Co.
Radio City Products Co. Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Robot Industries Inc.,
Schaevitz Engrg.
Skiatron Electronics & Television Corp.
Southwest Research Institute
Specialty Electronics Development Corp.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Stromberg-Carlson Div. General Dynamics Corp.
Telectro Industries Corp.

DISCHARGE EQUIPMENT, LOW TEMPERATURE

Budd Lewyt Electronics, Inc.
A. M. Byers Co.
Cryogenerators, Inc.
Standard Steel Corp., Cambridge Div.
Thermon Mfg. Co.

DISCHARGERS, STATIC

Dayton Aircraft Products, Inc.
Lear, Inc.
Tober Electronic Corp.

DISCONNECTS, CONTROL SYSTEMS

Aerotec Industries Inc., Aircraft Equipment Div.
Arkwin Industries, Inc.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Burndy Corp., Omaton Div.
Cal Connector Co.
FAE Instrument Corp.
Gabriel Co., Rocket Power-Talco
General Electric Co., Apparatus Sales Div.
B. H. Hadley, Inc.
Hoefner Corp.
Walter J. Hyatt Co., The
Kahn & Co., Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
On Mark Couplings, Inc.
Pacific Scientific Co.
Peacock Engrg. & Mfg. Co.
Weatherhead Co., The

DISCONNECTS, IGNITION SYSTEMS

Airtron, Div.-Litton Industries
Burndy Corp., Omaton Div.
Gabriel Co., Rocket Power-Talco
Hallett Mfg. Co.
Olin Mathieson Chemical Corp., Winchester-Western Div.
On Mark Couplings, Inc.

DISCRIMINATORS

ASCOP Div., Electro-Mechanical Research, Inc.
American Missile Products Co., Inc.
Barker & Williamson Inc.
Bendix Aviation Corp., Cincinnati Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Beva Lab., Inc.
Data-Control Systems, Inc.
Gilfillan Bros. Inc.
Hammarlund Mfg. Co., The
Industrial Test Equipment Co.
Lear, Inc.
Lel, Inc.
Magnetic Circuit Elements, Inc.
W. L. Maxson Corp., The
Meridian Metalcraft, Inc.
Midwestern Instruments, Inc.
James Millen Mfg. Co. Inc.
Motorola, Inc.
National Co., Inc.
Northrop Corp.
Radiaphone Co. Inc.
Tamar Electronics, Inc.
Tracerlab Inc.
Unit Process Assemblies, Inc.
Varo Mfg. Co., Inc.
Voi-Shan Electronics
Wickes Engrg. & Construction Co.

DISCS, COMPUTER

Allied Plastics Supply Corp.
Bergen Carbide Co.
Emeloid Co., Inc., The
Guidance Controls Corp.
W. & L. E. Gurley
Lab. for Electronics, Inc.
Librascope Div., General Precision, Inc.
Lytle Corp.
***RADIO CORP. OF AMERICA**
Sillcocks-Miller Co.

DISSIPATORS, HEAT

Birtcher Corp., The
Budd Lewyt Electronics, Inc.
A. M. Byers Co.
California Stamping & Mfg Co.
Carborundum Co., The
Gar Products Corp.
Hanlon & Wilson Co., The
Haskel Engrg. & Supply Co.
IERC Div., International Electronic Research Corp.
International Electronic Research Corp.
Janitrol Aircraft Div.-Midland-Ross Corp.
Lear, Inc.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Modine Mfg. Co.
National Beryllia Corp.
Rimak, Inc.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Tober Electronic Corp.
Westinghouse Electric Corp.
Zippertubing Co., The

DISTANCE MEASURING EQUIPMENT

Aeronca Mfg. Corp.-Aerospace Div.
Bendix Aviation Corp.
A. Biederman, Inc.
***BRISTOL CO., THE**
Collins Radio Co.
Cubic Corp.
Joe Davidson & Associates
Allen B. Du Mont Labs., Inc.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Ford Instrument Co., Div.-Sperry Rand Corp.
GPL Div.-General Precision, Inc.
Gates Radio Co.
General Instrument Corp., Defense & Engrg. Products Group
Gordon Enterprises
Hamilton Watch Co., Military Products Div
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Integrated Dynamics Div., Globe Industries, Inc.
Interstate Electronics Corp.
Lab. for Electronics, Inc.
Lear, Inc.
Motorola, Inc.
Optomechanisms Inc.
Ralph M. Parsons Co., The, Electronics Div.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Sillcocks-Miller Co.
Spectra Electronics Corp.
Trio Laboratories, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.

DISTRIBUTORS, FUEL

***BENDIX AVIATION CORP., HAMILTON DIV.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Delavan Mfg. Co.
***DEL MAR ENGRG. LABS.**
Kemp Aero Products
MB Electronics

DISTRIBUTORS, IGNITION

Bendix Aviation Corp.
Electric Autolite Co., The
Hallett Mfg. Co.

DOLLIES

Aero-Test Equipment Co., Inc.
Air Logistics Corp.
American Car & Foundry Div., ACF Industries, Inc.
American Conveyor Co.
American Machine & Foundry Co., Greenwich Engrg. Div.
Arnolt Corp.
Artisan Metal Works Co.
Associated Co., Inc.
Beacon Steel Corp.
Beech Aircraft Corp.

Bennett-Feragen
Brooks & Perkins, Inc.
Calcor Corp.
California Stamping & Mfg. Co.
Colson Corp., The
Columbia Research & Development Corp.
Consolidated Diesel Electric Corp.
Craig Systems, Inc.
Cromer Mfg. & Engrg., Inc.
Doak Aircraft Co. Inc.
Dudwallen Mfg. Co., Inc., The
Eastern Rotorcraft Corp.
Electronic Tube Corp.
Elzee Metal Products Co., Inc.
FDW Corp.
Fairbanks Co., The
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
Fred S. Gichner Iron Works, Inc.
Gordon Enterprises
Harco Containers Div.-Harbor Boat Building Co.
George E. Harris & Co., Inc.
Henry & Miller Industries, Inc.
Highland Engrg. Co.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries Inc.
Kellett Aircraft Corp.
Machine Products Div., New Haven Trap Rock Co.
Magnesium Co. of America
*MARTIN CO., THE, DENVER DIV.
Mid-West Metal Products, Inc.
Northrop Corp.
Nutting Truck & Caster Co.
P. B. R. Mfg. Co.
Penn-Michigan Mfg. Corp.
Premier Metal Products Co.
Regent Jack Mfg. Co., Inc
Sancor Corp.
B. K. Sweeney Mfg. Co
Technical Service Corp
Trailmobile Inc
Twin Coach Co., Aircraft-Missiles
Twix Mfg. Co., Inc.
Waco Aircraft Co.
Weber Aircraft Corp.
Welded Construction Inc
Wells Industries Corp
Westholt Mfg. Inc
Wickfield, Inc.
Winder Aircraft Corp. of Florida

DOSIMETERS

Baird-Atomic, Inc.
Bausch & Lomb Optical Co
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Corning Glass Works
Edgerton, Germeshausen & Grier, Inc.
Empire Products Sales Corp.
Industrial Acoustics Co., Inc.
Instrument Div., The Budd Co.
Interstate Electronics Corp.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
*MINNESOTA MINING & MFG. CO.
Nuclear-Chicago Corp.
Ohmart Corp., The
Sillcocks-Miller Co.
Tracerlab Inc
Universal Transistor Products Corp
Victoreen Instrument Co.

DOWELS

Abbott Screw & Mfg. Co.
Acme Industrial Co.
Aero Spares, Inc.
Allmetal Screw Products Co., Inc.
Best Aircraft Corp.
*BRISTOL CO., THE
Capital City Mfg. Co., Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Hartford Machine Screw Co., Div.-Standard Screw Co.
Walter K. Jaros Aircrafters
*MARTIN CO., THE, DENVER DIV.
Mercury Air Ports Co., Inc.
Norrich Plastics Corp.
Ohlson Empire Inc
Sillcocks-Miller Co
Standard Pressed Steel Co
Stanley-Judd Div.-The Stanley Works
Torrington Co., The

DRAFTING EQUIPMENT

Eugene Dietzgen Co.
Emmert Mfg. Co.
Faber Pen & Pencil Co. Inc., Eberhard Fisher & Crome
Gordon Enterprises
John Griffin Co.
Corydon M. Johnson Co., Inc.
Koh-I-Noor Pencil Co., Inc.
L. A. B. Corp.
A. Lietz Co., The
Optical Gaging Products, Inc.
Sillcocks-Miller Co.
J. S. Staedtler, Inc.
Stanpat Co.
E. F. Twomey Co., Inc.
Universal Drafting Machine Corp.
Warren-Knight Co.
Wasley Products, Inc.

DRAFTING PAPER

Eugene Dietzgen Co.
A. Lietz Co., The
Stanpat Co.
Warren-Knight Co.

DRIFTMETERS

General Aniline & Film Corp., Ansco Div.
Gordon Enterprises
W. & L. E. Gurley
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Theta Instrument Corp.

DRILL PRESSES

Black & Decker Mfg. Co., The
Budd Co., The
Burg Tool Mfg. Co., Inc.
Burgmaster Corp.
Clausing Div.-Atlas Press Co.
High Speed Hammer Co., Inc., The
Milman Engrg. Co.
Joseph T. Ryerson & Son, Inc.
U. S. Industries, Inc.

DRILL PRESSES, PRECISION

Brown & Sharpe Mfg. Co.
Budd Co., The
Burg Tool Mfg. Co., Inc.
Burgmaster Corp.
Clausing Div.-Atlas Press Co.
High Speed Hammer Co., Inc., The
Lennox Tool & Machine Builders
Louis Levin & Son, Inc.
Mico Instrument Co.
Milman Engrg. Co.
U. S. Industries, Inc.

DRILLS, ELECTRIC

Air Speed Tool Co.
Albertson & Co., Inc.
Black & Decker Mfg. Co., The
Foredom Electric Co., Inc.
Hammett-Mercury-Rex Div.
High Speed Hammer Co., Inc., The
Miller Falls Co.
Joseph T. Ryerson & Son, Inc.
Snap-On-Tools Corp.
George A. Terry Co.
Thor Power Tool Co.
U. S. Electrical Tool Co.
United Supply Co.

DRILLS, HAND

Bendix Aviation Corp.
Chicago Expansion Bolt Co.
Gardner-Denver Co.
Greenfield Tap & Die, Div.-United-Greenfield Corp.
Handicraft Tools, Inc., Div.-X-Acto, Inc.
Miller Falls Co.
Proto Tool Co.
Joseph T. Ryerson & Son, Inc.
Superior Pneumatic & Mfg., Inc.
United Supply Co.

DRILLS, TWIST

Bendix Aviation Corp.
Bergen Carbide Co.
Brown & Sharpe Mfg. Co.
Fish-Schurman Corp.
Greenfield Tap & Die, Div.-United-Greenfield Corp.
Miller Falls Co.
New York Twist Drill Co., Inc.
Norwalk Cutter Sharpening Co.
Joseph T. Ryerson & Son, Inc.
Snap-On-Tools Corp.
United Supply Co.
Whitman & Barnes Drills & Reamers

DRIVES

a. Antenna
b. Hydraulic
c. Small Electric Drive Mechanisms
d. Tachometer
e. Torque Tube

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, d.
Acme Industrial Co., b.
Actuation Research Corp., c.
Actuator Products Div., Geartronics Corp., c, d.
Adel Precision Products of Calif., Div.-General Metals Corp., b.
Aeroflex Labs. Div., Aeroflex Corp., a, b, c.
Aeronca Mfg. Corp.-Aerospace Div., d.
Ainslie Corp., a.
Aircraft Accessory Turbine Dept.-General Electric Co., b.
*AiRESEARCH MFG. OF ARIZONA, b.
Allison Div., General Motors Corp., b, c.
American Brake Shoe Co., b.
American Machine & Foundry Co., Greenwich Engrg. Div., a, b.
Amglo Corp., c.
Bead Chain Mfg. Co., The, c.
Belock Instrument Corp., a, c.
Bendix Aviation Corp., a, b, c.
*BENDIX AVIATION CORP., HAMILTON DIV., b.
Bendix-Pacific Div., Bendix Aviation Corp., b.
E. W. Bliss Co., a, b.
Bowser, Inc., a, b, c.
Bowser Inc., Defense Div., a.
Breeze Corporations, Inc., c, e.
CG Electronics Corp., a.
Chance Vought Aircraft, Inc., a.
Clark Equipment Co., b.
Clevite Ordnance, Div.-Clevite Corp., c.
Conrad & Moser, a.
Consolidated Diesel Electric Corp., b, c.
Cornelius Co., The, Aero Div., b.
Custom Products Corp., c.
Dalmo Victor Co., Div.-Textron, Inc., a thru e.
Dano Corp., e.
Joe Davidson & Associates, c, d, e.
Daystrom, Inc., Control Systems Div., a.
Diamond Antenna & Microwave Corp., a.
Dorne & Margolin, Inc., a.
Eastern Industries Inc., b.
Electric Autolite Co., The, c.
*EQUIPMENT DIV., RAYTHEON CO., a, b, c.
FAE Instrument Corp., a, c.
Fairfield Engrg. Corp., a.
J. W. Fecker Div., American Optical Co., a, c.
Flight Support, Inc., a thru d.
General Bronze Electronics Corp., a.
General Electric Co., Apparatus Sales Div., c, d.
General Electric Co., Ordnance Dept., a, b, c.
General Electro-Mechanical Corp., c.
Genisco, Inc., c.
Gilfillan Bros. Inc., a, b, c.
Guidance Controls Corp., c.
Haskel Engrg. & Supply Co., b.
Hathaway Instruments, Inc., c.
A. W. Haydon Co., The, c, d.
Hoover Electric Co., a, c, e.
Walter J. Hyatt Co., The, b, c.
Hydra-Power Corp., b.
I-L-S Instrument Div., The Meriam Instrument C
ITE Circuit Breaker Co., Special Products Div., a e.
Industrial Control Co., a, c.
Insco Co., Div.-Barry Controls Inc., c.
Jan Hardware Mfg. Co., Inc., c, e.
*KEARFOTT DIV., GENERAL PRECISION, INC., d.
Kelsey-Hayes Co., a, b.
Kieley & Mueller, Inc., b.
La Pointe Industries Inc., a.
Lear, Inc., a thru e.
Leeds & Northrup Co., c.
Leetronics, Inc., c.
Le Fiell Mfg. Co., e.
Link-Belt Co., b, d.
Litton Industries, Maryland Div., a.
Lundy Mfg. Corp., c.
Madigan Corp., a.
Nevada Air Products Co., c.
New York Air Brake Co., The, Watertown D.
Northrop Corp., a, b.
Oil-Dyne, Inc., b.
Ozone Metal Products Corp., b.
Parabam, Inc., b, c.
Pegasus Labs., Inc., a, b.
Pesco Products Div.-Borg-Warner Corp., b.
Portland Copper & Tank Works Inc., a.
REF Mfg. Corp., b.
Radio Development & Research Corp., a thru d.
Rantec Corp., a.
Reeves Instrument Corp., a.
Reliance Electric & Engrg. Co., a, d.
Research, Inc., a thru e.
J. R. Robbins Co., b.
Robot Industries Inc., a, b, c.
Sargent Engrg. Corp., b.
Schaevitz Engrg., c.
Scientific-Atlanta, Inc., a, c.

Servo-Tek Products Co., **c, d.**
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., **b, c.**
Stainless Inc., **a.**
Statham Development Corp., **c.**
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co., **a, c.**
Sundstrand Turbo, **b.**
TRG, Inc., **a, c.**
Talley Corp., The, **a thru e.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, c.**
Technical Appliance Corp., **a.**
Thompson Ramo Wooldridge Inc., **a, b, c.**
U. S. Industries, Inc., **b, c.**
Vickers Inc., **a, b.**
Vickers, Inc., Mich., **a, b, c.**
Waste King Corp., Technical Products Div., **c.**
Wells Industries Corp., **b.**
Western Gear Corp.-Precision Products Div., **a, c.**
Westinghouse Electric Corp., **a, c.**
Wickfield, Inc., **b.**

DROP FORGINGS

Acton Laboratories Inc.
Aerial Machine & Tool Corp.
Aluminum Co. of America
American Brake Shoe Co.
American Car & Foundry Div., ACF Industries, Inc.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Bethlehem Steel Co.
Billings & Spencer Co., The
A. M. Byers Co.
California Stamping & Mfg. Co.
Capewell Mfg. Co.
Chase Brass & Copper Co., Inc.
Collins Mfg. Corp.
Crucible Steel Co. of America
Curtiss-Wright Corp., Metals Processing Div.
Custom Tool & Mfg. Co.
Dana Corp.
Deutsch Co., The, Electronic Components Div.
Endicott Forging & Mfg. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Kelsey-Hayes Co.
Ladish Co.
Ohlson Empire Inc.
Scovill Mfg. Co.
Solar Aircraft Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Transue & Williams Steel Forging Corp.
United Shoe Machinery Corp.
United States Steel Corp.
Vichek Tool Co.
Wilcox-Crittenden Div., North & Judd Mfg. Co.
Wyman-Gordon Co.

UCTS, EXHAUST

Aerocal Div., Aeronca Mfg. Corp.
American Agile Corp.
American Brass Co., The
Anaconda Metal Hose Div., The American Brass Co.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Associated Co., Inc.
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Cyril Bath Co., The
Beacon Steel Corp.
Benson Mfg. Co.
Bethlehem Steel Co.
Breeze Corporations, Inc.
A. M. Byers Co.
Calcor Corp.
California Aircraft Products
California Stamping & Mfg. Co.
Chance Vought Aircraft, Inc.
Cobra Metal Hose Div., DK Mfg. Co.
Colonial Aircraft Corp.
Crane Co., Special Products Div.
Cromer Mfg. & Engrg., Inc.
C. R. Daniels, Inc.
Delta Corp.
Doak Aircraft Co. Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Fibercraft, Inc.
Flexaust Co., The
Flexonics Corp.
Hanlon & Wilson Co., The
Heil Process Equipment Corp.
Herlo Corp.
ITE Circuit Breaker Co., Special Products Div.
Industrial Acoustics Co., Inc.
Janke & Co. Inc.
Kaiser Fleetwings, Inc.
Kelsey-Hayes Co.
Kerns Mfg. Corp.
Kirk & Blum Mfg. Co., The
Lamtex Industries Inc.
***LAVELLE AIRCRAFT CORP.**
McGregor Mfg. Corp.
Northeast Metals Industries, Inc.
Northrop Corp.
Parsons Corp., Special Products Div.
Portland Copper & Tank Works Inc.
Edw. Renneburg & Sons Co.
J. R. Robbins Co.
Solar Aircraft Co.
Stamping Div.-Rockwell Standard Corp.
F. M. Stevenson Co., Inc.
T. O. D. Mfg. Co. Inc.
Thermionic Aeronautical Div.
Thermoid Div.-H. K. Porter Co., Inc.
United Aircraft Products, Inc.
Westholt Mfg. Inc.
Winder Aircraft Corp. of Florida
Wiremold Co., The
Woolf Aircraft Products, Inc.
Zippertubing Co., The

DUCTS, FLEXIBLE & COMPRESSIBLE

Airaterra
Anaconda Metal Hose Div., The American Brass Co.
Arcair Co.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Bemis Bro. Bag Co.
Breeze Corporations, Inc.
Calcor Corp.
California Aircraft Products
California Stamping & Mfg. Co.
Cobra Metal Hose Div., DK Mfg. Co.
Continental Rubber Works
Cromer Mfg. & Engrg., Inc.
D K Mfg. Co.
Doak Aircraft Co. Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Flexaust Co., The
Flexible Metal Hose Mfg. Co.
Flexible Tubing Corp.
Flexonics Corp.
Flight Refueling, Inc.
Hanlon & Wilson Co., The
Herlo Corp.
Industrial Acoustics Co., Inc.
Kaiser Fleetwings, Inc.
Kelsey-Hayes Co.
Lone Star Plastics Co. Inc.
Marman Div., Aeroquip Corp.
***MINNESOTA MINING & MFG. CO.**
Parts Engrg. Co., Inc.
Reeves Bros. Inc., Vulcan Rubber Div.
Fred T. Roberts & Co.
Roylyn Inc.
Rubbercraft Corp. of California
Solar Aircraft Co.
Southwest Products Co.
F. M. Stevenson Co., Inc.
Texstar Plastics, Div.-The Texstar Corp.
Thermoid Div.-H. K. Porter Co., Inc.
United States Rubber Co.
Wiremold Co., The
Zippertubing Co., The

DUCTS, NON-FLEXIBLE

American Agile Corp.
American Tube Bending Co., Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings Inc.
Associated Co., Inc.
Atkins & Merrill, Inc.
B. H. Aircraft Co., Inc.
Bethlehem Steel Co.
Brooks & Perkins, Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Calcor Corp.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Chance Vought Aircraft, Inc.
Cobra Metal Hose Div., DK Mfg. Co.
Colonial Aircraft Corp.
Cromer Mfg. & Engrg., Inc.
D K Mfg. Co.
Doak Aircraft Co. Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Emerson Plastics Corp.
Falstrom Co.
Fibercraft, Inc.
Flexible Metal Hose Mfg. Co.
Flexible Tubing Corp.
Flexonics Corp.
Hanlon & Wilson Co., The
Heil Process Equipment Corp.
Herlo Corp.
Kaiser Fleetwings, Inc.
Kirk & Blum Mfg. Co., The
Le Fiell Mfg. Co.
Lone Star Plastics Co. Inc.
Lunn Laminates, Inc.
Marman Div., Aeroquip Corp.
***MARTIN CO., THE, DENVER DIV.**
McGregor Mfg. Corp.
Met-L-Wood Corp.
Nelson Electric Mfg. Co.
Northeast Metals Industries, Inc.
Parsons Corp., Special Products Div.
Parts Engrg. Co., Inc.
Plastic Age Sales, Inc.
Portland Copper & Tank Works Inc.
Prewitt Aircraft Co.
Edw. Renneburg & Sons Co.
J. R. Robbins Co.
Stahlin Bros. Inc.
Taylor Electric Inc.
Temco Aircraft Corp.
Thermoid Div.-H. K. Porter Co., Inc.
United Aircraft Products, Inc
Waste King Corp., Technical Products Div.
Westholt Mfg. Inc.
Winder Aircraft Corp. of Florida
Woolf Aircraft Products, Inc.

DUMMY LOADS

Aeroscience, Inc.
Airtron, Div.-Litton Industries
American Car & Foundry Div., ACF Industries, Inc.
American Electronic Labs., Inc.
Beacon Steel Corp.
Belmar Wheel & Machine Co., Inc.
Bendix Aviation Corp., Cincinnati Div.
Bogart Mfg. Corp.
Carborundum Co., The
Carborundum Co., Refractories Div.
Colonial Aircraft Corp.
Continental Electronics Mfg. Co., Sub.-Ling-Altec Electronics Inc.
Control Electronics Co., Inc.
Corning Glass Works
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Dynatronics, Inc.
Eastern Specialty Co., The
Eitel-McCullough, Inc.
FXR, Inc.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
John Gombos Co., Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hoover Electronics Co.
Kings Electronics Co., Inc.
Lieco, Inc.
***MARTIN CO., THE, DENVER DIV.**
Microlab
Mullenbach Div.-Electric Machinery Mfg. Co.
Narda Microwave Corp., The
Radalab Inc.
Radar Design Corp.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Sierra Electronic Corp., Div.-Philco Corp.
Solar Mfg. Corp.
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Stewart & Stevenson Services, Inc.
Tamar Electronics, Inc.
Technical Materiel Corp., The
Torwico Electronics, Inc.
Wacline, Inc.
Westinghouse Electric Corp
Wickes Engrg. & Construction Co.
Wind Turbine Co.
Winder Aircraft Corp. of Florida

DUPLEXERS

Airtron, Div.-Litton Industries
Bogart Mfg. Corp.
Budelman Electronics Corp.
Central Electronics Mfrs., Div.-Nuclear Corp. of America
Joe Davidson & Associates
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
General Instrument Corp., Defense & Engrg. Products Group
John Gombos Co., Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hazeltine Electronics Div.-Hazeltine Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
***KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS**
D. S. Kennedy & Co.

Lieco, Inc
Litton Industries, Inc.
Litton Industries Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
*MARTIN CO., THE DENVER DIV.
Meridian Metalcraft, Inc.
Microwave Associates, Inc.
Motorola, Inc
Narda Microwave Corp., The
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
Tober Electronic Corp.
Victor R. F. & Microwave Co.
Waveline, Inc

DYNAMOMETERS

Bogue Electric Mfg. Co.
Bytrex Corp
Clayton Mfg. Co.
Consolidated Diesel Electric Corp.
Cosa Corp.
Joe Davidson & Associates
Eaton Mfg. Co.
Flight Support, Inc.
General Electric Co., Apparatus Sales Div.
General Electro-Mechanical Corp.
Hammett-Mercury-Rex Div.
Howe Scale Co., The
L. A. B. Corp.
Lear, Inc.
Magtrol, Inc
George L. Nankervis Co.
Radio Development & Research Corp.
Reliance Electric & Engrg. Co.
Research, Inc.
Schaevitz Engrg
Simpson Electric Co.
Southwest Research Institute
Standard Electric Time Co., The
U. S. Industries, Inc.
Westinghouse Electric Corp.

DYNAMOTORS

Allied International Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div
Bendix Aviation Corp , Montrose Div.
Bogue Electric Mfg. Co.
Carter Motor Co.
Consolidated Diesel Electric Corp.
Eicor Div.-Scranton
Eureka Williams Corp.
General Electric Co., Apparatus Sales Div
General Instrument Corp., Defense & Engrg. Products Group
Paul E. Gerst & Co.
Gordon Enterprises
Hammett-Mercury-Rex Div
Hol-Gar Mfg. Corp.
Hoover Electric Co.
IMC Magnetics Corp.
Jack - Heintz, Inc.
Lear, Inc.
Heinz Mueller Eng. Co. Inc.
Radalab Inc
Radio Development & Research Corp
Redmond Co., Inc., Sub.-Controls Co. of America
Sangamo Electric Co.
Small Motors Inc.
Talley Corp., The
Task Corp.
Westinghouse Electric Corp.
Wincharger Corp., Sub.-Zenith Radio Corp.

EJECTION SYSTEMS

American Machine & Foundry Co.
American Machine & Foundry Co., Government Products, N. Y
American Potash & Chemical Corp., National Northern Div
Armament Div.-Universal Match Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bermite Powder Co.
A. M. Byers Co.
Chance Vought Aircraft, Inc.
Conax Corp.
Joe Davidson & Associates
Gabriel Co., Rocket Power Talco
Goodyear Aircraft Corp.
Hardman Tool & Engrg., Co.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Mc Cormick Selph Associates
Mc Donnell Aircraft Corp.
Mc Lean Development Labs., Inc.
Mechanics Research Div., American Machine & Foundry Co.
Olin Mathieson Chemical Corp., N. Y.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pacific Scientific Co.
Pastushin Industries, Inc.
Patterson Moos Research, Div.-Leesona Corp.
Propellex Chemical Div., Chromalloy Corp.
Republic Aviation Corp., Missile Systems Div.
Sargent Engrg. Corp.
Scott Aviation Corp.
Standard Armament Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp
Temco Aircraft Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Weatherhead Co., The
Weber Aircraft Corp.
Worthington Corp.

ELECTRIC POWER SYSTEMS

Acme Electric Corp.
Air Logistics Corp.
Aircraft Accessory Turbine Dept.-General Electric Co.
Allied International Corp.
Allis-Chalmers
American Rectifier Corp.
Associated Engineers, Inc.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bogue Electric Mfg. Co.
Budd Lewyt Electronics, Inc.
Chance Vought Aircraft, Inc.
Conoflow Corp
Consolidated Diesel Electric Corp
Curtiss-Wright Corp., Santa Barbara Div.
Joe Davidson & Associates
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Fairfield Engrg. Corp.
Food Machinery & Chemical Corp., Ordnance Div.
Fouch Electric Mfg. Co., Inc.
General Electric Co.
General Electric Co., Apparatus Sales Div
Georator Corp.
Hallamore Electronics Co., Div.-Siegler Corp.
Hammett-Mercury-Rex Div.
Huyck Systems Co.
International Fermont Machinery Co., Inc.
Leach Corp.
Lear, Inc.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Motoresearch Co.
Mullenbach Div.-Electric Machinery Mfg. Co.
Networks Electronic Corp.
Northwestern Electric Co.
D. W. Onan & Sons Inc.
Pesco Products Div.-Borg-Warner Corp.
Radio Development & Research Corp.
Ready-Power Co., The
Reliance Electric & Engrg. Co.
Schaevitz Engrg
Solar Aircraft Co.
Sun Electric Corp., Aeronautical Div.
Sundstrand Turbo
Talley Corp., The
Varo Mfg. Co., Inc
Vickers, Inc., Mich
Wallson Associates, Inc.
Wesrep Corp
Westinghouse Electric Corp.
Winpower Mfg. Co.
Wolverine Diesel Power Co.

ELECTROCARDIOGRAPHS

Birtcher Corp., The
Crescent Engrg. & Research Co.
Dallons Semiconductors, Div.-Dallons Labs.
Ensco, Inc
General Electric Co., X-Ray Dept.
Gulton Industries, Inc.
Offner Electronics Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.

ELECTRONIC COOLING EQUIPMENT

Accessory Products Co., Div.-Textron Inc.
Aeroquip Corp., Jackson Div.
Air Products, Inc.
Allied International Corp.
Amco Engrg. Co.
American Machine & Foundry Co., Government Products, N. Y.
Applied Electronics Corp. of N. J.
Barber-Colman Co.
Bar-Ray Products, Inc.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Benson Mfg. Co.
Birtcher Corp., The
Budd Lewyt Electronics, Inc.
Cambridge Filter Corp.
Joe Davidson & Associates
Dean & Benson Research, Div.-Benson Mfg. Co.
Dean Products, Inc.
Eastern Industries Inc.
Great Lakes Mfg. Corp.
Griscom-Russell Co., The
Hallicrafters Co., The
Hamilton Standard, Div.-United Aircraft Corp.
Huyck Systems Co.
Induction Heating Corp.
*KEARFOTT DIV., GENERAL PRECISION, INC.
Kentucky Metal Products Co.
Manning & Lewis Eng. Co.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Monrovia Aviation Corp.
Nevada Air Products Co.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
On Mark Couplings, Inc.
Pesco Products Div.-Borg-Warner Corp.
Pioneer Industries Div., Almar-York Co. Inc.
Pneumafil Corp.
Radex Corp.
*RADIO CORP. OF AMERICA
Recony Div.-Vinco Corp.
J. R. Robbins Co.
South Wind Div. Stewart Warner Corp.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
A. U. Stone & Co., Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Sunshine Scientific Instrument
Talley Corp., The
Task Corp.
United Aircraft Products, Inc.
United Control Corp.
United Mfg. Co., Div., The W. L. Maxson Corp.
Vemaline Products Co.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Waste King Corp., Technical Products Div.
Wells Industries Corp.
Western Devices Inc.
Western Div., Aeroquip Corp.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida

ELECTROPLATING EQUIPMENT

Allied Research Products, Inc.
S. Blickman, Inc.
Bogue Electric Mfg. Co.
Dean Products, Inc.
Djeco, Div.-Djordjevic Engrg. Co.
Engelhard Industries, Inc.
Enthone Inc.
Gates Electronic Co.
Hanson-Van Winkle-Munning Co.
Heil Process Equipment Corp.
*MARTIN CO., THE, DENVER DIV.
Metal & Thermit Corp.
George L. Nankervis Co.
Nevada Air Products Co.
Opad Electric Co.
Power Supplies Inc.
Technic Inc.
Udylite Corp., The
Unit Process Assemblies, Inc.
Westinghouse Electric Corp.

ELEMENTS, HEATING

Ackerman-Gould Co., Inc.
Aero Research Instrument Co. Inc.
American Instrument Co., Inc.
Andersen Labs., Inc.
Wallace Barnes Div. Associated Spring Corp.
Blue M Electric Co.
Carborundum Co., The
Carborundum Co., Refractories Div.
Continental Sensing, Inc.
Corning Glass Works
Cox & Co., Inc.
Dean Products, Inc.
Dmeter Mfg. Co.
Wilbur B. Driver Co.
Driver-Harris Co.
Eagle Electric Mfg. Co. Inc.
Electrofilm, Inc.
Fansteel Metallurgical Corp.

General Electric Co., Lamp Metals & Components Dept.
Globar Plant, Refractories Div.-The Carborundum Co.
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Hammett-Mercury-Rex Div.
Hathaway Instruments, Inc.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Kanthal Corp., The
Lear, Inc.
Manhattan Lighting Equipment Co., Inc.
Manning & Lewis Eng. Co.
Minco Products, Inc.
Miskella Infra-Red Co., The
Napier Engines Inc.
Nelson Electric Mfg. Co.
Norton Co., New Products Dept.
Piqua Engrg. Inc.
Research, Inc.
Safeway Heat Elements, Inc.
Temperature Engrg. Corp.
Thermionic Products Co.
Thermon Mfg. Co.
H. I. Thompson Fiber Glass Co.
H. W. Tuttle & Co.
Vacuum Specialties Co., Inc.
Waage Electric, Inc.
P. Wall Mfg. Co.
Westinghouse Electric Corp.
Edwin L. Wiegand Co.

ELEMENTS, HEATING, CRYSTAL OVEN

Cox & Co., Inc.
Gardner Laboratory, Inc.
Hammett-Mercury-Rex Div.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Palmer Instruments
Research, Inc.
Temperature Engrg. Corp.
Thermionic Products Co.

EMBEDDED ASSEMBLIES

Adept Industries Inc.
Advanced Electronics, Inc.
Airflyte Electronics Co.
Allied Engraving & Stamping Co.
Bacon Industries, Inc.
Carl H. Biggs Co.
California Plasteck Inc.
Clevite Ordnance, Div.-Clevite Corp.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Control Circuits Inc.
Control Data Corp.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Dale Products, Inc.
Daven Co., The
Decker Corp., The
***EQUIPMENT DIV., RAYTHEON CO.**
Filtron Co., Inc.
Forbes & Wagner, Inc.
Hallett Mfg. Co.
Hathaway Instruments, Inc.
Industrial Control Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
James Millen Mfg. Co. Inc.
***MINNESOTA MINING & MFG. CO.**
Motorola, Inc.
Mutron Corp.
National Co., Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Piqua Engrg. Inc.
***RADIO CORP. OF AMERICA**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Republic Aviation Corp., Missile Systems Div.
Milton Ross Metals Co., The
***SEMICONDUCTOR DIV., RAYTHEON CO.**
Sillcocks-Miller Co.
Sonex, Inc.
Southwestern Industrial Electronics Co.
Telechrome Mfg. Corp.
Telex, Inc.
Topper Mfg. Co., Inc.
Torwico Electronics, Inc.
Trio Laboratories, Inc.
Unison Products, Inc.
Virginia Electronics Co., Inc.
Walkirt Co.
Westinghouse Electric Corp.

EMBEDDED COMPONENTS

Adept Industries Inc.
Airflyte Electronics Co.
Allied Engraving & Stamping Co.
Bacon Industries, Inc.
Carl H. Biggs Co.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Continental-Emsco Co., Div.-The Youngstown Sheet Tube Co.
Control Circuits Inc.
Control Data Corp.
Corning Glass Works
Dale Products, Inc.
Daven Co., The
Decker Corp., The
Dmeter Mfg. Co.
***EQUIPMENT DIV., RAYTHEON CO.**
Filtron Co., Inc.
Fisher Engrg., Inc.
Forbes & Wagner, Inc.
Hallett Mfg. Co.
Hathaway Instruments, Inc.
Hydra-Power Corp.
JFD Electronics Corp.
Lockheed Aircraft Corp., Missiles & Space Div.
***MARTIN CO., THE, DENVER DIV.**
James Millen Mfg. Co. Inc.
Motorola, Inc.
Mutron Corp.
National Coil Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
***RADIO CORP. OF AMERICA**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Milton Ross Metals Co., The
***SEMICONDUCTOR DIV., RAYTHEON CO.**
Sillcocks-Miller Co.
Southwestern Industrial Electronics Co.
Telechrome Mfg. Corp.
Telex, Inc.
Topper Mfg. Co., Inc.
Torwico Electronics, Inc.
Unison Products, Inc.

ENAMEL, INSULATION

Better Finishes & Coatings Inc.
Dow Corning Corp.
E. I. Du Pont de Nemours & Co. Inc.
Food Machinery & Chemical Corp.-Epoxy Dept.
General Plastics Corp.
Insulation Mfrs. Corp.
Kanthal Corp., The
Midland Industrial Finishes Co.
Midland Paint & Varnish Co., The
Polymer Corp., The
Schenectady Varnish Co., Inc.
Westinghouse Electric Corp., Micarta Div.

ENCLOSURES, DUST

A&P Metal Products Mfg. Corp.
Baker Co., Inc., The
Beacon Steel Corp.
Brooks & Perkins, Inc.
Fouch Electric Mfg. Co., Inc.
Irving Air Chute Co., Inc.
Kirk & Blum Mfg. Co., The
***MARTIN CO., THE, DENVER DIV.**
Premier Metal Products Co.
REF Mfg. Corp.
Edw. Renneburg & Sons Co.
Rimak, Inc.
Sedco
Specialties, Inc.
Telkor, Inc.
Texstar Plastics, Div.-The Texstar Corp.
Unified Industries, Inc.
Weber Aircraft Corp.

ENERGY CONVERSION DEVICES

Aircraft Accessory Turbine Dept.-General Electric Co.
Allison Div., General Motors Corp.
American Machine & Foundry Co.
Bendix Aviation Corp,
Blonder-Tongue Labs. Inc., Special Products Div.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Consolidated Diesel Electric Corp.
Daven Co., The
De Havilland Aircraft of Canada, Ltd., Special Products Div.
General Electric Co.,-Missile & Space Vehicle Dept., Pa.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lockheed Aircraft Corp., Missiles & Space Div.
***MINNESOTA MINING & MFG. CO.**
National Scientific Labs., Inc.
Olin Mathieson Chemical Corp., N. Y.
Otis Elevator Co., Defense & Industrial Div
Patterson Moos Research, Div.-Leesona Corp.
Pesco Products Div.-Borg-Warner Corp.
Piasecki Aircraft Corp.
Rocketdyne Div.-North American Aviation, Inc.
Semi-Elements, Inc.
Servomechanisms, Inc.
Southwest Research Institute
Stratos, Div.-Fairchild Engine & Airplane Corp.
Sundstrand Turbo
Tapco Group, Thompson Ramo Wooldridge Inc.
Thiokol Chemical Corp., Hunter-Bristol Div.
Thompson Ramo Wooldridge Inc.
U. S. Sonics Corp.
Varo Mfg. Co., Inc.
Vickers Inc., Div.-Sperry Rand
Westinghouse Electric Corp.

ENERGY CONVERSION MATERIALS

Aircraft Accessory Turbine Dept.-General Electric Co.
Blonder-Tongue Labs. Inc., Special Products Div.
Broadview Research Corp.
Corning Glass Works
Food Machinery & Chemical Corp.-Epoxy Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Lockheed Aircraft Corp., Missiles & Space Div.
***MINNESOTA MINING & MFG. CO.**
Monsanto Chemical Co.
NUMEC-Nuclear Materials & Equipment Corp.
Semi-Elements, Inc.
Servomechanisms, Inc.
U. S. Sonics Corp.
Var-Lac-Oid Chemical Co.

ENGINE ACCESSORIES & COMPONENTS

Accessory Products Co., Div.-Textron Inc.
Aero Mfg. & Mach. Co., Inc.
Aero Supply Mfg. Inc.
Aeroquip Corp., Jackson Div.
Aircraft Accessory Turbine Dept.-General Electric Co.
***AiRESEARCH MFG. OF ARIZONA**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Corp.
Allison Div., General Motors Corp.
American Machine & Foundry Co., Government Products, N. Y.
American Standard Products, Inc.
Arde-Portland, Inc.
Automatic Switch Co.
B. H. Aircraft Co., Inc.
Bendix Aviation Corp.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix Aviation Corp., Montrose Div.
Bendix Filter Div., Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Bernco Engrg. Corp.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Carson Mach & Supply Co.
Caterpillar Tractor Co., Defense Products Dept.
Components Corp.
Conax Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Delavan Mfg. Co.
Delta Corp.
Dunbar-Kapple Inc.-Aircraft Components Div.
Dynamic Controls Corp.
Emhart Mfg. Co., Maxim Div
Ex-Cell-O Corp.
Garwin, Inc.
General Laboratory Associates, Inc.
B. H. Hadley, Inc.
Hallett Mfg. Co.
Hamilton Standard, Div.-United Aircraft Corp.
A. W. Haydon Co., The
Hoefner Corp.
Holley Carburetor Co.
Hoover Electric Co.
Houston Instrument Corp.
Hydra-Power Corp.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kerns Mfg. Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Laminated Shim Co., Inc.
Lear, Inc.
Leece-Neville Co., The
***WALLACE O. LEONARD, INC.**

Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lycoming Div., Avco Corp.
Marman Div., Aeroquip Corp.
J. E. Menaugh Co
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc
On Mark Couplings, Inc.
Parker-Hannifin Corp.
Parts Engrg. Co., Inc.
Pegasus Lab., Inc.
Pesco Products Div.-Borg-Warner Corp.
Phoenix Products Co.
Pneu-Hydro Valve Corp.
Portland Copper & Tank Works Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Rocketdyne Div.-North American Aviation, Inc.
Ronson Hydraulic Units Corp.
Sargent Engrg. Corp.
Servicair Co.
Servomechanisms, Inc.
Simmonds Aerocessories, Inc.
Solar Aircraft Co.
Southwest Products Co.
Southwest Research Institute
Squiers Gage Co.
A. U. Stone & Co., Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Teleflex Inc.
Thompson Ramo Wooldridge Inc.
Tube-Turns Div., Chemetron Corp.
United Aircraft Products, Inc.
Van der Horst Corp. of America
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Western Design, Div.-U.S. Industries, Inc.
Western Div., Aeroquip Corp.
Westinghouse Electric Corp

ENGINE CONTROL SYSTEMS

Aero Supply Mfg. Inc.
***AEROJET-GENERAL CORP.**
Aeronca Mfg. Corp.-Aerospace Div.
Airborne Accessories Corp.
***AiRESEARCH MFG. OF ARIZONA**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp
American Machine & Foundry Co., Government Products, N. Y.
Avien, Inc.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bernco Engrg. Corp
Budd Lewyt Electronics, Inc
Capital City Mfg. Co., Inc.
Chance Vought Aircraft, Inc.
Consolidated Airborne Systems, Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Designers for Industry, Inc.
Eastern Industries Inc
Ex-Cell-O Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
B. H. Hadley, Inc.
Hamilton Standard Div.-United Aircraft Corp.
Hoefner Corp.
Holley Carburetor Co.
Hoover Electric Co.
Hughes Tool Co., Aircraft Div.
Hydraulic Research & Mfg. Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co., Inc.
Leach Corp.
Lear, Inc.
***WALLACE O. LEONARD, INC.**
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
Napier Engines Inc.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
Parker-Hannifin Corp.
Pegasus Labs Inc
Pitometer Log Corp.
Rocketdyne Div.-North American Aviation, Inc.
Servomechanisms, Inc.
Simmonds Aerocessories, Inc.
Solar Aircraft Co.
Southwest Products Co
Southwest Research Institute
Southwestern Industrial Electronics Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
United Aircraft Products, Inc.
Varo Mfg. Co., Inc.
Vickers, Inc., Mich.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

ENGINE CONTROL SYSTEMS, AUTOMATIC

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
***AEROJET-GENERAL CORP.**
Aeronca Mfg. Corp.-Aerospace Div.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
American Machine & Foundry Co., Government Products, N. Y.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Bergen Labs., Inc.
Budd Lewyt Electronics, Inc.
Capital City Mfg. Co., Inc.
Carson Mach & Supply Co.
Consolidated Airborne Systems, Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Designers for Industry, Inc.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
B. H. Hadley, Inc.
Hallamore Electronics Co., Div.-Siegler Corp.
Hamilton Standard, Div.-United Aircraft Corp.
Hoefner Corp.
Holley Carburetor Co.
Hoover Electric Co.
Jeta, Inc.
Lab. for Electronics, Inc.
Leach Corp.
Lear, Inc.

***MARTIN CO., THE, DENVER DIV.**
Micro Gee Products, Inc
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Napier Engines Inc.
Pegasus Labs., Inc.
Pitometer Log Corp.
Ready-Power Co., The
Rocketdyne Div.-North American Aviation, Inc.
Simmonds Aerocessories, Inc.
Singer Military Products Div.-The Singer Mfg. Co.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Sun Electric Corp., Aeronautical Div.
Tapco Group, Thompson Ramo Wooldridge Inc
Thompson Ramo Wooldridge Inc.
United Electric Controls Co.
Varo Mfg. Co., Inc
Westinghouse Electric Corp.

ENGINE CONTROLS, MECHANICAL & VACUUM

***AC SPARK PLUG, THE ELECTRONICS DIV. GENERAL MOTORS**
Accessory Products Co., Div.-Textron Inc.
Aero Supply Mfg. Inc.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
American Machine & Foundry Co., Government Products, N. Y.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Budd Lewyt Electronics, Inc
Capital City Mfg. Co., Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Custom Component Switches Inc.
Designers for Industry, Inc.
Garwin, Inc.
B. H. Hadley, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hoefner Corp.
Holley Carburetor Co.
Hoover Electric Co.
***MARTIN CO., THE, DENVER DIV.**
Napier Engines Inc.
Ronson Hydraulic Units Corp.
Sargent Engrg. Corp.
Summers Gyroscope Co.
Sun Electric Corp., Aeronautical Div.
Teleflex Inc.
Temco Aircraft Corp.
United Electric Controls Co.
Western Gear Corp.-Precision Products Div.

ENGINE STARTING SYSTEMS & CONTROLS, GAS TURBINE ENGINE

***AC SPARK PLUG, THE ELECTRONICS DIV. GENERAL MOTORS**
Accessory Controls & Equipment Corp.
Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Corp.
Allison Div., General Motors Corp.
American Machine & Foundry Co., Government Products N. Y.
American Potash & Chemical Corp., National Northern Div.
Arde-Portland, Inc.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Breeze Corporations, Inc.
Capital City Mfg. Co., Inc.
Conax Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Cornelius Co., The, Aero Div.
Curtiss-Wright Corp., Santa Barbara Div.
Curtiss-Wright Corp., Wright Aeronautical Div.
Dynamic Controls Corp.
Gabriel Co., Rocket Power-Talco
General Electric Co.
General Electric Co., Apparatus Sales Div.
Hamilton Standard, Div.-United Aircraft Corp.
A. W. Haydon Co., The
Hoefner Corp.
Hol-Gar Mfg. Corp.
Holley Carburetor Co.
Jack & Heintz, Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear Inc.
***MARTIN CO., THE, DENVER DIV.**
Northrop Corp.
On Mark Couplings, Inc.
Pesco Products Div.-Borg-Warner Corp.
Rocketdyne Div.-North American Aviation Inc.
Solar Aircraft Co.
Southwestern Industrial Electronics Co.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Sundstrand Turbo
Varo Mfg. Co., Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Wells Industries Corp.
Westinghouse Electric Corp.
Whiton Machine Co., The

ENGINES

a. Auxiliary Jet
b. Auxiliary Rocket
c. Diesel
d. Gas Turbine
e. Nuclear Rocket
f. Nuclear Turbine
g. Pulse Jet
h. Ramjet
i. Rocket Liquid
j. Rocket, Solid

***AEROJET-GENERAL CORP., b, i, j.**
Aircraft Accessory Turbine Dept.-General Electric Co., **d.**
***AIRESEARCH MFG. OF ARIZONA., a, d, f, g.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., d.**
Allied International Corp., **d.**
Allis-Chalmers, **c.**
Allison Div., General Motors Corp., **a, b, d, f thru j.**
Amcel Propulsion Inc., **j.**
American Car & Foundry Div., ACF Industries, Inc., **j.**
American Potash & Chemical Corp., National Northern Div., **h, i, j.**
American Rocket Co., **b, i, j.**
Anderson, Greenwood & Co., **h.**
Arde-Portland, Inc., **h, j.**
Bell Aircraft Corp., Niagara Frontier Div., **b, e, j.**
Bermite Powder Co., **a, b, g thru j.**
A. M. Byers Co., **b, c, e, i, j.**
Caterpiller Tractor Co., Defense Products Dept., **c, d.**
Caterpiller Tractor Co., Engine Div., **c.**
Caterpiller Tractor Co., Industrial Engine Plant, **c.**
Clark Bros. Co., Div.-Dresser Operations, Inc., **d, f.**
Continental Aviation & Engrg. Corp., **a, c, d, h.**
Continental Motors Corp., **c.**
Cummins Engine Co., Inc., **c.**
Curtiss-Wright Corp., Santa Barbara Div., **d.**
Curtiss-Wright Corp., Wright Aeronautical Div., **a, b, d, h, i, j.**
Delta Corp., **a, b, d thru j.**
Detroit Diesel Engine Div.-General Motors Corp., **c.**
***EXCELCO DEVELOPMENTS INC., i, j.**

Falcon Machine & Tool Co., **a, d.**
Gabriel Co., Rocket Power-Talco., **b, j.**
General Electric Co., Apparatus Sales Div., **d.**
General Electric Co., Rocket Engine Section, **i, j.**
Giddings & Lewis Machine Tool Co., **i, j.**
B. F. Goodrich Aviation Products, **j.**
Grand Central Rocket Co., **b, j.**
Guided Missile Div., The Firestone Tire & Rubber Co., **i.**
Hahn & Clay, **j.**
Harnischfeger Corp., P&H Diesel Engine Div., **c.**
Hercules Powder Co., Chemical Propulsion Div., **b, j.**
ITE Circuit Breaker Co., Special Products Div., **a, b, d.**
International Fermont Machinery Co., Inc., **c.**
Kaiser Fleetwings, Inc., **a, b, e, h, i, j.**
Lear, Inc., **a, d.**
Lithium Corp. of America Inc., The Fulton-Irgon Div., **i, j.**
Lockheed Aircraft Corp., Missiles & Space Div., **i, j.**
Lycoming Div., Avco Corp., **a, b, d, h, j.**
Marquardt Corp., The, **b, e, g thru j.**
***MARTIN CO., THE, DENVER DIV., a, b, i, j.**
Mc Cormick Selph Associates, **j.**
Mc Donnell Aircraft Corp., **h.**
Mc Gregor Mfg. Corp., **d.**
Mechanics Research Div., American Machine & Foundry Co., **j.**
Napier Engines Inc., **a, c, d, h, i.**
Nordberg Mfg. Co., **c.**
Norris-Thermador Corp., **j.**
Olin Mathieson Chemical Corp., N. Y., **j.**
D. W. Onan & Sons Inc., **c.**
Ordnance Research & Development Co., Div.-Bermite Powder Co., **a, b, g thru j.**
Pemco Inc., **i.**
Pratt & Whitney Aircraft Div., United Aircraft Corp., **d, i, j.**
Pressed Steel Tank Co., **a, b, j.**
Propellex Chemical Div., Chromalloy Corp., **b, j.**
Reaction Motors Div., Thiokol Chem. Corp., **b, i.**
Rocketdyne Div.-North American Aviation, Inc., **b, e, i, j.**
Solar Aircraft Co., **d.**
Solid Propulsion Ops., Rocketdyne Div., North American Aviation, **b, j.**
Southwest Research Institute, **c, d, j.**
Stewart & Stevenson Services, Inc., **c.**
Sundstrand Turbo, **a, b.**
Tapco Group, Thompson Ramo Wooldridge Inc., **d.**
Thiokol Chemical Corp., Redstone Div., **b, j.**
Thompson Ramo Wooldridge Inc., **d.**
Van der Horst Corp. of America, **c.**
Westhold Mfg. Inc., **b.**
Westholt Mfg. Inc., **b.**
Westinghouse Electric Corp., **e, f.**
Whiton Machine Co., The, **d.**
Wolverine Diesel Power Co., **c.**
Young Development Div., Hercules Powder Co., **b, j.**

EXCITERS, FIELD

Joe Davidson & Associates
Electric Machinery Mfg. Co.
Fairfield Engrg. Corp.
General Devices, Inc.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
Lear, Inc.
Leece-Neville Co., The
MB Electronics
Radio Development & Research Corp.
Westinghouse Electric Corp.

EXHAUST

a. Ducts
b. Heat Exchangers
c. Muffs
d. Stacks
e. Systems

All American Engrg. Co., **a.**
Allied International Corp., **b, e.**
Allied Witan Co. Inc., **c, e.**
American Agile Corp., **a, b, d, e.**
American Tube Bending Co., Inc., **b.**
Anaconda Metal Hose Div., The American Brass Co., **a.**
Arde-Portland, Inc., **a.**
Associated Co., Inc., **a thru e.**
B. H. Aircraft Co., Inc., **a, d, e.**
Basic Tool Industries, Inc., **a.**
Cyril Bath Co., The, **a.**
Benson Mfg. Co., **a.**
Bethlehem Steel Co., **a, d.**
S. Blickman, Inc., **a thru e.**
Blowers Inc., **a, e.**
A. M. Byers Co., **b, d, e.**
Calcor Corp., **a thru e.**
California Aircraft Products, **a, b.**
California Stamping & Mfg. Co., **a thru e.**
Capital City Mfg. Co., Inc., **a.**
Carson Mach & Supply Co., **c.**
Cobra Metal Hose Div. DK Mfg. Co., **a, c, d, e.**
Colonial Aircraft Corp., **a thru e.**
Corning Glass Works, **b.**
Crane Co., Special Products Div., **a, c, d.**
Cromer Mfg. & Engrg., Inc., **a, d.**
Curtiss-Wright Corp.-Wright Aeronautical Div., **a.**
Delta Corp., **a, d.**
Dunbar-Kapple Inc.-Aircraft Components Div., **a, b.**
Dyna-Therm Chemical Corp., **a, d.**
Emhart Mfg. Co., Maxim Div., **b, e.**
Fansteel Metallurgical Corp., **a.**
Fibercraft, Inc., **a.**
Flexonics Corp., **a.**
Griscom-Russell Co., The, **b.**
Hanlon & Wilson Co., The, **a thru e.**
Heil Process Equipment Corp., **a, d, e.**
Herlo Corp., **a thru e.**
Highland Engrg. Co., **b.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., a, b, e.**
Industrial Acoustics Co., Inc., **a, c, d, e.**
Janitrol Aircraft Div.-Midland-Ross Corp., **b.**
Janke & Co. Inc., **a, d, e.**
Kaiser Fleetwings, Inc., **a, b, d.**
C. B. Kaupp & Sons, Inc., **a.**
Kerns Mfg. Corp., **a, b.**
Kirk & Blum Mfg. Co., The, **a, d, e.**
Kolcast Industries-Div.-Thompson Ramo Wooldridge Inc., **a.**
Koppers Co., Inc., Metal Products Div., **c, d.**
***LAVELLE AIRCRAFT CORP., a, c.**
Le Fiell Mfg. Co., **a.**
Manning & Lewis Eng. Co., **b.**
***MARTIN CO., THE, DENVER DIV., a, b, e.**
Mc Gregor Mfg. Corp., **a, b, d, e.**
Mead Specialties Co., Inc., **c.**
Narmco Mfg. Co., **a.**
Northeast Metals Industries, Inc., **a.**
Opelika Welding, Machine & Supply Inc., **b, d.**
Parts Engrg. Co., Inc., **a.**
Pastushin Industries, Inc., **a thru d.**
Penn-Michigan Mfg. Corp., **d, e.**
Phoenix Products Co., **a, b.**
Portland Copper & Tank Works Inc., **a thru e.**
Edw. Renneburg & Sons Co., **a, c, d, e.**
Republic Aviation Corp., Missile Systems Div., **a.**
J. R. Robbins Co., **a.**
Solar Aircraft Co., **a thru e.**
South Wind Div., Stewart Warner Corp., **a, b.**
Southwest Research Institute, **a thru e.**
Spaceatomics Div., The Budd Co., **a.**
Sun Electric Corp., Aeronautical Div., **b.**
T. O. D. Mfg. Co. Inc., **a.**
Texstar Plastics, Div.-The Texstar Corp., **a.**
Thermionic Aeronautical Div., **a, b.**
Thermoid Div.-H.K. Porter Co., Inc., **a thru e.**
Thermon Mfg. Co., **a, d.**
Torit Mfg. Co., **e.**
Twin Coach Co., Aircraft-Missiles, **a, b, e.**
United Aircraft Products, Inc., **b.**
United States Chemical Milling Corp., **a.**
Vac-Hyd Processing Corp., **b.**
Veeco Vacuum Corp., **e.**
Westholt Mfg. Inc., **a, d.**
Whitlock Mfg. Co., The, **b.**
Winder Aircraft Corp. of Florida, **a, e.**
Wolverine Diesel Power Co., **a thru e.**
Woolf Aircraft Products, Inc., **a, d.**
York Div., Borg-Warner Corp., **b.**

EXHAUST ASSEMBLIES

American Tube Bending Co., Inc.
Anaconda Metal Hose Div., The American Brass Co.
Associated Co., Inc.
Associated Engrg. & Mfg. Corp.
B. H. Aircraft Co., Inc.
S. Blickman, Inc.
A. M. Byers Co.
Calcor Corp.
California Stamping & Mfg. Co.
Cobra Metal Hose Div. DK Mfg. Co.
Colonial Aircraft Corp.
Crane Co., Special Products Div.
Delta Corp.
Douglas Aircraft Co., Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Ex-Cell-O Corp.
Fibercraft, Inc.
Hanlon & Wilson Co., The
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
ITE Circuit Breaker Co., Special Products Div.
Kaiser Fleetwings, Inc.
Kelsey-Hayes Co.
Lycoming Div., Avco Corp.
Marquardt Corp., The
Mc Gregor Mfg. Corp.
***MINNESOTA MINING & MFG. CO.**
Penn-Michigan Mfg. Corp.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Edw. Renneburg & Sons Co.
Rimak, Inc.
Solar Aircraft Co.
Stamping Div.-Rockwell Standard Corp.
Temco Aircraft Corp.
Thermionic Aeronautical Div.
United Aircraft Products, Inc.
Veeco Vacuum Corp.
Wolverine Diesel Power Co.
Woolf Aircraft Products, Inc.

EXHAUST CONES, GAS TURBINE ENGINE

Allison Div., General Motors Corp.
American Welding & Mfg. Co., The
B. H. Aircraft Co., Inc.
S. Blickman, Inc.
Calcor Corp.
California Aircraft Products
California Stamping & Mfg. Co.
Carson Mach & Supply Co.
Colonial Aircraft Corp.
Crane Co., Special Products Div.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Delta Corp.
Douglas Aircraft Co., Inc.
Hanlon & Wilson Co., The
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
ITE Circuit Breaker Co., Special Products Div.
C. B. Kaupp & Sons, Inc.
Kelsey-Hayes Co.
Kentucky Metal Products Co.
Kolcast Industries-Div.-Thompson Ramo Wooldridge Inc.
Ladish Co.
***LAVELLE AIRCRAFT CORP.**
Lycoming Div., Avco Corp.
Mc Gregor Mfg. Corp.
Napier Engines Inc.
Northeast Metals Industries, Inc.
Pastushin Industries, Inc.
Portland Copper & Tank Works Inc.
Edw. Renneburg & Sons Co.
Solar Aircraft Co.
Stalker Corp., The
Thermionic Aeronautical Div.
C. W. Torngren Co., Inc.
Young Development Div., Hercules Powder Co.

EXTENSIONS, SHAFT

Acme Industrial Co.
Amatom Electronic Hardware Co. Inc.
Birnbach Radio Co., Inc.
A.M. Byers Co.
Capital City Mfg. Co., Inc.
Cobra Metal Hose Div. DK Mfg. Co.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Jan Hardware Mfg. Co., Inc.
James Millen Mfg. Co. Inc.
Piasecki Aircraft Corp.
Edw. Renneburg & Sons Co.
Tube-Turns Div., Chemetron Corp.

EXTRUSIONS, METALLIC

Adam Metal Supply Inc.
Aero Mfg. & Mach. Co., Inc.
Allied Products Corp.
Aluminum Co. of America
American Brass Co., The
Ampco Metal, Inc.
Cyril Bath Co., The
Bohn Aluminum & Brass Corp.
Bridgeport Brass Co.
A. M. Byers Co.
Calinoy-Div.-Illinois Tool Works
Cincinnati Milling Machine Co., The
Croname Inc.
Curtiss-Wright Corp., Metals Processing Div.
Division Lead Co.
Dow Chemical Co., The
Fansteel Metallurgical Corp.
Fruehauf Trailer Co., Military Equipment Div.
H. M. Harper Co.
Harvey Aluminum
Huntington Alloy Products Div.-The International Nickel Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Kling Metal Spinning & Stamping Co.
Kwikset Powdered Metal Products
Ladish Co.
Le Fiell Mfg. Co.
NUMEC-Nuclear Materials & Equipment Corp.
National Tube Div., United States Steel Corp.
Northrop Corp.
Olin Mathieson Chemical Corp.-Metals Div.
Olin Mathieson Chemical Corp., N. Y.

Phelps Dodge Copper Products Corp.
Pressed Steel Tank Co.
REF Mfg. Corp.
Republic Steel Corp.
Revere Copper & Brass Inc.
Reynolds Metals Co.
Joseph T. Ryerson & Son, Inc.
Stamping Div.-Rockwell Standard Corp.
Texas Instruments Inc.
Tube-Turns Div., Chemetron Corp.

EXTRUSIONS, NON-METALLIC

American Agile Corp.
American Latex Products Corp.
Anchor Plastics Co., Inc.
Auburn Mfg. Co., The
Borden Chemical Co.
A. M. Byers Co.
Calinoy-Div.-Illinois Tool Works
Chemplast, Inc.
Connecticut Hard Rubber Co., The
Continental Rubber Works
Fluorocarbon Co., The
Jennings Machine Corp.
M & Q Plastic Products
*MINNESOTA MINING & MFG. CO.
NUMEC-Nuclear Materials & Equipment Corp.
National Beryllia Corp.
National Vulcanized Fibre Co.
Natvar Corp.
New England Tape Co., Div.-United-Carr Fastener Corp.
Northrop Corp
Norton Co., New Products Dept.
Polymer Corp., The
Raybestos-Manhattan, Inc.
Reeves Brothers, Inc
Resistoflex Corp
Fred T. Roberts & Co
Rubbercraft Corp. of California
Swan Rubber Co.
Taylor Electric Inc.
United States Rubber Co.
Westinghouse Electric Corp., Micarta Div.
Yardley Plastics Co.
Zirconium Corp. of America

EYELETS

Abbot Screw & Mfg. Co.
Amatom Electronic Hardware Co. Inc.
American Brass Co., The
Atlas Tack Corp.
J. Bishop & Co., Platinum Works
California Stamping & Mfg. Co.
Eyelet Tool Co. Inc.
Federal Screw Products Inc.
Gemex Corp., The, Indsl. Div
Joma Inc
Norrich Screw Machine Products
Ohlson Empire Inc.
Revere Copper & Brass Inc.
Scovill Mfg. Co.
C. Sjoberg & Son
Stevens Co. Inc.
F. M. Stevenson Co., Inc
Thor Ceramics, Inc.
United Shoe Machinery Corp.
United Supply Co
Vector Electronic Co., Inc.

FABRIC

Aero Leather Products Co.
Aviation Textile Associates
Carborundum Co., The
Connecticut Hard Rubber Co., The
Cordo Chemical Corp.
C. R. Daniels, Inc.
E. I. Du Pont de Nemours & Co. Inc.
Duracote Corp.
Flightex Fabrics Inc.
Kentucky Metal Products Co.
*MINNESOTA MINING & MFG. CO.
Reeves Brothers, Inc.
Reeves Bros. Inc., Vulcan Rubber Div.
Russell Mfg. Co.
Sawyer Coated Fabrics, Div.-Farrington Texol Corp.
F. M. Stevenson Co., Inc.
Swift Textile Metalizing & Laminating Corp.
E. F. Timme & Son Inc.
Uniform Hood Lace Co
Union Asbestos & Rubber Co.
United States Rubber Co.

FABRICATORS, POWDERED METAL PARTS

Aluminum Co. of America
American Brake Shoe Co.
Bendix Filter Div., Bendix Aviation Corp.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
Capital City Mfg. Co., Inc.
Custom Tool & Mfg. Co.
Engelhard Industries, Inc.
General Electric Co., Lamp Metals & Components Dept.
Hughes Tool Co., Aircraft Div.
Kerns Mfg. Corp.
Motorola, Inc.
NUMEC-Nuclear Materials & Equipment Corp.
Quartzite Processing Inc.
Ravenna Metal Products, Div.-Standard Screw Co.
Raybestos-Manhattan, Inc.
Rimak, Inc.
St. Marys Carbon Co.
Sylvania-Corning Nuclear Corp.
T. O. D. Mfg. Co., Inc.
Torrington Co., The
S. K. Wellman Co., The
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida

FANS

*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.
American Agile Corp.
American Standard Industrial Div.
Benson Mfg. Co.
Bud Radio, Inc.
Coppus Engrg. Corp.
Joe Davidson & Associates
Dean & Benson Research, Div.-Benson Mfg. Co.
Diehl Mfg. Co.
Dynamic Air Engrg., Inc.
Eastern Rotorcraft Corp.
Garden City Fan & Blower Co.
George E. Harris & Co., Inc.
Heil Process Equipment Corp.
A. F. Holden Co., The
ILG Electric Ventilating Co
IMC Magnetics Corp.
Jarvis Corp.
Joy Mfg. Co.
Koppers Co., Inc., Metal Products Div.
Lear, Inc.
Mamco Corp
Manhattan Lighting Equipment Co., Inc
Mc Lean Engrg. Laboratories
Heinz Mueller Eng. Co. Inc.
Nevada Air Products Co.
Northeast Metals Industries, Inc.
Peerless Electric Div.-H. K. Porter Co., Inc.
Pesco Products Div.-Borg-Warner Corp.
J. R. Robbins Co.
Rotron Mfg. Co.
Task Corp
Torrington Mfg. Co. Inc., The, Specialty Blower Div

FASTENERS

a. Blind
b. Cowl
c. Self-Locking
d. Slide
e. Snap

AVDEL, **a, c.**
Abbott Screw & Mfg. Co., **c, d, e.**
Aero Bolt & Screw Co., Inc., **c.**
Aero Spares, Inc., **a, c, d, e.**
Aero-Stat Co., The
Airhardware, Inc., **a thru e.**
All Specs Corp., **c.**
Allmetal Screw Products Co., Inc.
Aluminum Co. of America
American Standard Products, Inc., **a thru e.**
Anti-Corrosive Metal Products Co., Inc.
Autoscrew Co., Inc.
Aviation Textile Associates, **c.**
Avnet Corp., **c.**
Wallace Barnes Div. Associated Spring Corp., **a thru e.**
Best Aircraft Corp., **c, e.**
Bethlehem Steel Co.
Boots Aircraft Nut Corp., **a, c.**
C. E. M. Co., Inc. **c.**
California Stamping & Mfg. Co., **b.**
Calinoy-Div.-Illinois Tool Works, **a thru e.**
Camcar Screw & Mfg. Co., Div.-Textron Industries, Inc.
Camloc Fastener Corp., **b, c.**
Capewell Mfg. Co., **d.**
Carr Fastener Co., Div.-United-Carr Fastener Corp., **a, b, c, e.**
Central Screw Co., **c.**
Chase Brass & Copper Co., Inc.,
Cherry Rivet Div.-Townsend Co., **a, c.**
Chicago Screw Co., The, Div.-Standard Screw Co.,
Conmar Products Corp., **d.**
Continental Screw Co., **c.**
Deltron Co., Inc., The, **c.**
Deringer Metallurgical Corp.
Deutsch Co., The Electronic Components Div., **a, c, e.**
Deutsch Fastener Corp., **a, c, e.**
Dill Mfg. Co., The, **a.**
Dimco-Gray Co., **c.**
R.C. Dudek & Co., **a, c.**
Dulock, Inc., **c.**
Dzus Fastener Co., Inc., **b, c.**
Eaton Mfg. Co., Reliance Div.
Elastic Stop Nut Corp. of America, **a, c.**
Federal Screw Products Inc.
General American Transportation Corp.
General Tire & Rubber Co., The, Industrial Products Div., **a, c.**
B. F. Goodrich Aviation Products, **a, d.**
Gries Reproducer Corp.
Groov-Pin Corp., **c.**
H. M. Harper Co.
Hartford Machine Screw Co., Div.-Standard Screw Co.
Hartwell Aviation Supply Co., **b, c, e.**
Heli-Coil Corp., **a, c.**
Hi-Shear Rivet Tool Co., **a, c.**
Huck Mfg. Co., **a, c.**
Walter K. Jaros Aircrafters, **a thru e.**
Keystone Bolt & Nut Corp., **a, c.**
Klincher Locknut Corp., **c.**
Lion Fastener Co., Inc., **b, c.**
*MARTIN CO., THE, DENVER DIV., **c.**
Mercury Air Parts Co., Inc., **c.**
Moran JCo., **c.**
J. I. Morris Co., **c.**
Napier Engines Inc., **b.**
National Screw & Mfg. Co., The, **a, c.**
Nelson Stud Welding Div.-Gregory Industries, Inc., **e.**
Nylok Corp., The, **c.**
Ohlson Empire Inc., **a thru e.**
Olympic Screw & Rivet Corp., **a.**
Pastushin Industries, Inc., **b.**
Prestole Corp., **c.**
D. W. Price Corp., **c.**
Ravenna Metal Products, Div.-Standard Screw Co.
Republic Steel Corp., **c.**
Rosan, Inc., **a, c.**
Scovill Mfg. Co., **b, d, e.**
Screw Corp.
J. H. Sessions & Son **b.**
Shur-Lok Corp., **a, c.**
Simmonds Aerocessories, Inc., **b.**
Simmons Fastener Corp., **a thru d.**
Southco Div., South Chester Corp., **a, b, c.**
Standard Pressed Steel Co., **a, c.**
Stanley-Judd Div.-The Stanley Works, **a thru e.**
Star Stainless Screw Co., **c.**
Talon, Inc., **d.**
Thomson, Judson L.
Tinnerman Products, Inc., **a, b, c.**
Townsend Co., Cherry Rivet Div., **a, c.**
United Shoe Machinery Corp., **a.**
United States Chemical Milling Corp., **b.**
United Supply Co.,
Velcro Sales Corp., **c.**
Vlier Engrg. Corp., **e.**
Voi-Shan Mfg. Co., Div.-Voi-Shan Industries, Inc., **a, b, c.**
Waldes Kohinoor, Inc., **a thru e.**
Waldick Engrg. Co., **a, c, e.**
Western Sky Industries, **c.**
Zippertubing Co., The, **c.**

FEED SYSTEMS

Ainslie Corp.
Airtron, Div.-Litton Industries
Diamond Antenna & Microwave Corp.
Dynatronics,Inc.
Eyelet Tool Co. Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Guidance Controls Corp.
Lear, Inc.
Ordance Research & Development Co., Div.-Bermite Power Co.
Pegasus Labs., Inc.
Edw. Renneburg & Sons Co.
Southwest Research Institute
Wallace & Tiernan Inc.

FELT & FELT PARTS

Aero Leather Products Co.
American Felt Co.
Anchor Fence, Div.-Anchor Post Products, Inc.
Anchor Packing Co., The
Armstrong Cork Co.
Auburn Mfg. Co., The
Aviation Textile Associates
Commonwealth Felt Co.
Continental Felt Co.
C. R. Daniels, Inc.
Felters Co., The
Gasket Mfg. Co. Inc.
General Gasket Inc.
General Plastics Corp.

Mechanical Felt & Textiles Co.
National Felt Co.
Quaker City Felt Co.
Standard Felt Co.
Supreme Indsl. Products Co.
Western Felt Works & Acadia Synthetic Products Div.

FERRIC OXIDES

Allied Chemical Corp., General Chemical Div.
Columbian Carbon Co., Mapico Iron Oxides Unit
Delta Chemical Works, Inc.
Foote Mineral Co.
*MINNESOTA MINING & MFG. CO.
National Moldite Co.
Semi-Elements, Inc.
TRG, Inc.

FERRITE DEVICES

Acme Electric Corp.
Airtron, Div.-Litton Industries
Bendix Aviation Corp.
Bjorksten Research Labs. for Industry, Inc.
Communication Accessories Co.
Demornay-Bonardi
Douglas Microwave Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp., FXR, Inc.
General Electric Co., Heavy Military Electronics Dept.
*KEARFOTT DIV., GENERAL PRECISION, INC.
*KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS
Kollsman Instrument Corp., Sub.-Standard Coil Products Co., Inc.
Lab. for Electronics, Inc.
Lear, Inc.
Litton Industries, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Microwave Associates, Inc.
*MICROWAVE & POWER TUBE DIV., RAYTHEON CO.
National Co., Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Rantec Corp.
Sage Labs., Inc.
Spectra Electronics Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Sylvania Electric Products Inc., Special Tube Operations
TRG, Inc.
Technical Materiel Corp., The
Technicraft, Div.-Electronic Specialty Co.
Victor R. F. & Microwave Co.

FERRITES

Airtron, Div.-Litton Industries
Bjorksten Research Labs. for Industry, Inc.
Douglas Microwave Co., Inc.
Ferroxcube Corp. of America
GPL Div.-General Precision, Inc.
General Electric Co., Heavy Military Electronics Dept.
*KEARFOTT DIV., GENERAL PRECISION, INC.
*MICROWAVE & POWER TUBE DIV., RAYTHEON CO.
National Moldite Co.
Quartzite Processing Inc.
*RADIO CORP. OF AMERICA
Semi-Elements, Inc.
Stackpole Carbon Co.
Superex Electronics Corp.
Van der Horst Corp. of America

FIBER GLASS

Aero Leather Products Co.
Air Logistics Corp.
Aircraft Porous Media, Inc.
Allied Plastics Supply Corp.
American Printed Circuits Co., Inc.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Armstrong Cork Co.
Auburn Mfg. Co., The
Aviation Textile Associates
Bar-Ray Products, Inc.
Bjorksten Research Labs. for Industry, Inc.
Cadillac Plastic & Chemical Co.
Custom Tool & Mfg. Co.
Drico Industrial Corp.
Duracote Corp.
Eagle-Picher Co., The
Electrical Insulation Co., Inc.
Emerson Plastics Corp.
Enfab Inc.
Fabricon Corp.
Fibercraft, Inc.
Flightex Fabrics Inc.
George E. Harris & Co., Inc.
Hastings Plastics, Inc.
Hess, Goldsmith & Co., Inc.
Insulation Mfrs. Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Norrich Screw Machine Products
Owens-Corning Fiberglass Corp.
Reeves Brothers, Inc.
Robins Industries Corp.
Seaman Products, Div.-Seaman Paper Co.
William W. Stanley Co. Inc.
Stevens Products, Inc.
F. M. Stevenson Co., Inc.
Swedlow Inc.
H. I. Thompson Fiber Glass Co.
E. F. Timme & Son Inc.
Twin Coach Co., Aircraft-Missiles
Union Asbestos & Rubber Co.
United States Chemical Milling Corp.
Wolverine Diesel Power Co.
Zippertubing Co., The

FIBER GLASS REINFORCED PLASTICS

Air Logistics Corp.
Allied Plastics Supply Corp.
American Aerophysics Corp.
American Printed Circuits Co. Inc.
American Research & Mfg. Corp.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Atkins & Merrill, Inc.
Aviation Textile Associates
Bjorksten Research Labs. for Industry, Inc.
Bo Myte Co., Inc., The
Bonny Mfg. Corp.
Brook Molding Corp.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Butler Mfg. Co.
Chance Vought Aircraft, Inc.
Clark Equipment Co.
Clevite Ordnance, Div.-Clevite Corp.
Columbia Products Co.
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cordo Chemical Corp.
Custom Tool & Mfg. Co.
Dalmo Victor Co., Div.-Textron, Inc.
Dayton Aircraft Products, Inc.
Douglas Aircraft Co., Inc.
Duracote Corp.
Durez Plastics Div.-Hooker Chemical Corp.
Eastern Chemical Div., Hooker Chemical Corp.
Eljay Corp.
Emerson Plastics Corp.
Eubanks Industries, Inc.
Fabricon Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Fibercraft, Inc.
Food Machinery & Chemical Corp.-Epoxy Dept.
Franklin Fibre-Lamitex Corp.
Fruehauf Trailer Co., Military Equipment Div.
Gar Wood Industries Inc.
General American Transportation Corp.
General Plastics Corp.
General Tire & Rubber Co., The, Industrial Products Div.
Gentex Corp.
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Gordon Enterprises
Grant-Lehr Corp.
Harco Containers Div.-Harbor Boat Building Co
Hardman Tool & Engrg., Co.
George E. Harris & Co., Inc.
Hastings Plastics, Inc.
Heil Process Equipment Corp.
Hercules Powder Co., Chemical Propulsion Div.
Honeycomb Co. of America, Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Insulation Mfrs. Corp.
Joclin Mfg. Co., The
Kerrco
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kish Industries, Inc.
Lamtex Industries Inc.
Lone Star Plastics Co. Inc.
Lunn Laminates, Inc.
Magee-Bralla & Associates
*MARTIN CO., THE, DENVER DIV.
Mc Millan Companies, The
Mc Millan Lab., Inc.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Mico Instrument Co.
*MINNESOTA MINING & MFG. CO.
Molding Corp. of America
Monsanto Chemical Co.
Narmco Mfg. Co.
Narmco Materials Div., Narmco Industries, Inc.
National Vulcanized Fibre Co.
Naugatuck Chemical Div.-U.S. Rubber Co.
Norrich Screw Machine Products
Northrop Corp.
Olin Mathieson Chemical Corp., N. Y.
Olympic Plastics Co., Inc.
Owens-Corning Fiberglas Corp.
Parabam, Inc.
Parsons Corp., Special Products Div.
Pastushin Industries, Inc.
Penn Fibre & Specialty Co., Inc.
Piasecki Aircraft Corp.
Plastics Age Sales, Inc.
Plastics Distributor of New England
Prewitt Aircraft Co.
REF Mfg. Corp.
Resistoflex Corp.
Rogers Corp.
Milton Ross Metals Co., The
Scientific-Atlanta, Inc.
Seaman Products, Div.-Seaman Paper Co.
Skydyne, Inc.
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co
Spaulding Fibre Co., Inc.
Specialty Electronics Development Corp.
Stahlin Bros. Inc.
Structural Fibers, Inc.
Swedlow Inc.
Synthane Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Technical Materiel Corp., The
H. I. Thompson Fiber Glass Co.
Thompson Ramo Wooldridge Inc.
E. F. Timme & Son Inc.
Titeflex, Inc.
Topper Mfg. Co., Inc.
U. E. Electronics Corp.
United States Chemical Milling Corp.
United States Rubber Co.
Universal Moulded Products Corp.
Waldick Engrg. Co.
Warren Components, Div.-El-Tronics, Inc.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micarta Div.
Wolverine Diesel Power Co.
Young Development Div., Hercules Power Co.

FIBER VULCANIZED

Allied Plastics Supply Corp.
Auburn Mfg. Co., The
Aviation Textile Associates
Budd Co., The
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Electrical Insulation Co., Inc.
Eljay Corp.
Fabricon Corp.
Franklin Fibre-Lamitex Corp.
Gordon Enterprises
Insulation Mfrs. Corp.
Thomas J. Long, Inc.
Mica Fabricating Co.
National Vulcanized Fibre Co.
Norrich Screw Machine Products
Penn Fibre & Specialty Co., Inc.
Reeves Brothers, Inc.
Rogers Corp.
Spaulding Fibre Co., Inc.
Stahlin Bros. Inc.
F. M. Stevenson Co., Inc.
Taylor Fibre Co.
Technical Ply-Woods Sales
Wilmington Fibre Specialty Co.

FILES

Handicraft Tools, Inc., Div.-X-Acto, Inc.
Martindale Electric Co.
Neumade Products Corp.
Snap-On-Tools Corp.

FILM, MAGNETIC STRIPE

Budd Co., The
Fairchild Camera & Instrument Corp.
*MINNESOTA MINING & MFG. CO.
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS

FILM, PROTECTIVE

Antara Chemicals, Div.-General Aniline & Film Corp.
Carl H. Biggs Co.
Blossom Mfg. Co. Inc.
Cadillac Plastic & Chemical Co.
Carborundum Co., The
Hastings Plastics, Inc.
Merix Chemical Co.

*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
Naugatuck Chemical Div.-U. S. Rubber Co.
Neumade Products Corp.
Polymer Corp., The
Reynolds Metals Co., Plastics Div.
W. S. Shamban & Co.
Sillcocks-Miller Co.

FILMS, CAPACITOR

AMP Inc
Asheville-Schoonmaker Mica Co.
Cadillac Plastic & Chemical Co.
Dilectrix Corp.
Double E Products Co.
Film Capacitors, Inc.
Ford Radio & Mica Corp.
Insulation Mfrs. Corp.
Lear, Inc.
Mica Fabricating Co.
Natvar Corp.
TRG, Inc.
United Mineral & Chemical Corp.

FILMS, PLASTIC FOR WOUND INSULATION

Allied Plastics Supply Corp.
American Latex Products Corp.
Aries Laboratories, Inc.
Bjorksten Research Labs. for Industry, Inc.
Blossom Mfg. Co. Inc.
Bonny Mfg. Corp.
Cadillac Plastic & Chemical Co
Carmer Industries Inc.
Chemplast, Inc.
Dilectrix Corp.
E. I. Du Pont de Nemours & Co. Inc.
Garlock Packing Co., The-Electronic Products
Insulation Mfrs. Corp.
M & Q Plastic Products
*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
Monsanto Chemical Co
Plastic Age Sales, Inc.
Polymer Corp., The
Raybestos-Manhattan, Inc.
Reynolds Metals Co., Plastics Div
W. S. Shamban & Co
Swedlow Inc.
Tetrafluor, Inc.
United States Rubber Co

FILTERS

a. Air
b. Antenna
c. Audio
d. Band-Elimination
e. Band-Pass
f. Continuously Variable
g. Crystal
h. Detonation
i. Electric
j. Electric Wave Section
k. Equalizer
l. Fuel & Oil
m. High-Pass
n. Hydraulic
o. IF
p. Interference
q. Line
r. Low-Pass
s. Measurement
t. Mechanical
u. Microwave
v. Noise Suppression
w. Optical
x. Pneumatic System
y. Polarizing
z. RF
a-1. UHF & VHF
b-1. Vacuum System
c-1. Variable Electronic
d-1. Vestigial Sideband
e-1. Wave Trap

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, a, l.
ACDC Electronics, Inc., c, d, e, j, k, m, o, q, r, z.
ACF Industries Inc., a, l, n, x.
ADC Inc., c, d, e, j, k, m, o, q, r, d-1, e-1.
Accessory Controls & Equipment Corp., a, x.
Accessory Products Co., Div.-Textron Inc., a, l, x, b-1.
Acme Electric Corp., i.
Actuation Research Corp., x.
Advanced Engineering Div., D. S. Kennedy & Co., e, m, r, u.
Aero Supply Mfg. Inc., l, n.
*AEROJET-GENERAL CORP., w.
Aerovox Corp., e, m, p, q, r, v, z.
Agricultural Aviation Engineering Co. Inc., l.
Air Filter Corp., a.
Air Speed Tool Co., a.
Airborne Accessories Corp., i, p.
Aircom Inc., u, a-1.
Aircraft Porous Media, Inc., a, l, n, x, b-1.
*AiRESEARCH MFG. OF ARIZONA, v.
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., p, v.
Air-Maze Corp., a, l, n, x.
Airtron, Div.-Litton Industries, u.
Allied Witan Co. Inc., a, v.
Allison Labs. Inc., c thru f, m, r.
All-Tronics, Inc., i, p, q, r, u, y.
Alsop Engrg. Corp., n.
Amerac Inc., u.
American Electronic Labs., Inc., g, u.
American Electronics, Inc., t.
American Felt Co., a, l, n.
American Instrument Co., Inc., x.
American Machine & Foundry Co., Greenwich Engrg. Div., b.
American Missile Products Co., Inc.
American Optical Co., w.
American Optical Co., Instrument Div., w.
Amplex Div.-Chrysler Corp., a, l, n.
Applied Research Inc., b, d, e, f, k, o, u, z, a-1, e-1.
Associated Engineers, Inc., a, f, m, o thru r.
Astron Corp., b thru e, i, m, o thru r, v, z, a-1.
Axel Electronics-Div.-Axel Bros. Inc., d, i, p, q, r, v, z, a-1.
B & K Instruments, Inc., c thru f.
Baker Co., Inc., The, a.
Barker & Williamson Inc., e, m, o thru r, z.
Barnebey-Cheney Co., a.
Rex Bassett, Inc., p, v.
Bausch & Lomb Optical Co., w, y.
Bearing Inspection, Inc., l.
Bellows-Valvair Divs., a.
Bendix Aviation Corp., a, l, n, x, b-1.
Bendix Aviation Corp., Cincinnati Div., e, r.
Bendix Filter Div., Bendix Aviation Corp., a, l, n, x, b-1.
Birma Mfg. Co. Inc., a.
Blonder-Tongue Labs., Inc., f, k, q, r.
Blonder-Tongue Labs, Inc., Special Products Div., c, d-1.
Bogart Mfg. Corp., b, d, e, f, i, j, k, m, o, p, r, u, v, y, z, a-1, c-1, d-1, e-1.
Bowser, Inc., l, n.
Bowser Inc., Defense Div., l.
Briggs Filtration Co., The, l, n.
Bruno-New York Industries Corp., u.
Budd Lewyt Electronics, Inc., b, e, a-1.
Budelman Electronics Corp., d, e, q, r.
Bulova Watch Co., Electronics Div., d, e, g, m, o, p, r, a-1.
Burnell & Co., Inc., c, d, e, g, j, k, o, r, d-1.
CGS Labs., Inc., e, f, m, r, a-1.
Caledonia Electronics & Transformer Corp., c, d, e.
Cambridge Filter Corp., a, t, x, b-1.
Carborundum Co., The, t.
Carol Electronics Corp., e, z.
Central Electronic Mfrs., Div.-Nuclear Corp. of America, u.
Chance Vought Aircraft, Inc., b, c, e, u, v.
Chicago Electronic Engrg. Co., Inc., c, d, e, r.
Chicago Standard Transformer Corp., c, e, m, r.
Cleco Air Tools, Div.-Reed Roller Bit Co., a.
Clevite Ordnance, Div.-Clevite Corp., c, d, e.
Collins Radio Co., t.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., a, c, e, m, o thru r, z.
Commercial Filters Corp., a, l, x.
Communication Accessories Co., c, d, e, k, m, o thru r, t, u, v, z, a-1, d-1.
Conoflow Corp., a.
Consolidated Diesel Electric Corp., n.
Control Electronics Co., Inc., c, d, e, j, k, m, o, r, t, u, z, a-1, d-1.
Coppus Engrg. Corp., a.
Cornelius Co., The, Aero Div., a, x.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., a, x.
Cornell-Dubilier Electric Corp., c, d, e, m, o thru r, v, z.
Corning Glass Works, l, n, w.
Cuno Engrg. Corp., The, l.
Daven Co., The, c, a, e, i, j, o, r, z.
Davidson Optronics, Inc., w.
Dayton Rubber Co., The, a.
Dell Optics Co., Ltd., w.
Demornay-Bonardi, e, u.
Desomatic Products, Inc.-Anders-Driline, a, x.
Detrex Chemical Industries, Inc., t.
Diamond Antenna & Microwave Corp., b, d thru g, m, u, z.
Djeco, Div.-Djordjevic Engrg. Co., d, e, m, r.
Don-Lan Electronics Inc., b, u
Dorsett Electronic Labs., Inc., z.
Double E Products Co., b thru k, m thru s, u, v, w, z, a-1 thru e-1.
Douglas Microwave Co., Inc., u.
Drico Industrial Corp., a.
Du Kane Corp., c.
Dynamics Instrumentation Co., e, f, m, r, c-1.
Dytronics Co., c, e, f.
ESC Corp., d, e, k, o thru r, v.
Eastman Kodak Co., p, w.
Eddington Metal Specialty Co., l.
Edwards High Vacuum Ltd., b-1.
Electron Products Div.-Marshall Industries, v.
Electronic Applications, Inc., c, k, r, u.
Electronic Specialty Co., d, e, m, r, u, z, a-1.
Electro-Winders Co. Inc., e, m.
Ellison Draft Gage Co., Inc., s.
Emhart Mfg. Co., Maxim Div., v.
Empire Products Sales Corp., d, e, r, u, z, a-1.
Enfab Inc., a, l, n, x.
Erie Resistor Corp., o, r.
FXR, Inc., u.
Ferrotran Electronics Co., Inc., e, o.
Ferroxcube Corp. of America, a-1.
Filters Inc., a, l, n, x.
Filtron Co., Inc., p, q, r, v, z.
Fischer & Porter Co., a.
Fisher Governor Co., a, x.
Fish-Schurman Corp., p, w.
Flock Process Co. Inc., a.
Forbes & Wagner, Inc., d, e, m, r.
Ford Instrument Co., Div.-Sperry Rand Corp., e, r.
From Corp., a, l, n, x.
Freed Transformer Co., Inc., c, d, e, j, k, m, q, r.
Garwin, Inc., a, l, n, b-1.
Gates Radio Co., e, m, r, u, z, a-1, c-1, d-1, e-1.
General Bronze Electronics Corp., b, d, e, q, r, u, e-1.
General Coil Products Corp., b, d, e, m, o, r, z, a-1, e-1.
General Filters, Inc., l, n.
General Instrument Corp., Defense & Engrg. Products Group, u, a-1.
General Radio Co., c thru f, m, r, z, a-1, c-1.
Genistron, Inc., c, d, e, k, m, o thru r, v, z.
Gilfillan Bros. Inc., u.
Gits Brothers Mfg. Co., a.
John Gombos Co., Inc., u.
Gordon Enterprises, w.
Gorham Electronics-Div.-Gorham Mfg. Co., e, u.
Gudeman Co., The, b, m, p, q, r, v, z, e-1.
Guided Missile Div., The Firestone Tire & Rubber Co., w.
Gulton Industries, Inc., r.
Gyrex Corp., The, t.
HRB-Singer, Inc., Sub.-Singer Mfg. Co., e.
Hallett Mfg. Co., p, v.
Hammarlund Mfg. Co., The, c, e, j, z.
Hammett-Mercury-Rex Div., g, i.
Donald C. Harder Co., c, e, m, r.
Harman Equipment Co., l, n, t.
Haskel Engrg. & Supply Co., n.
Herlo Corp., x.
Hewlett-Packard Co., r, u, a-1.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., b-1.
Highland Engrg. Co., l, n.
Hill Electronics, Inc., d, e, g.
Hilliard Corp., The, a, l, n.
Hoke Inc., a, n.
Hopkins Engrg. Co., p, q, r, v.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., l, n, q, x.
Hughes Semiconductor Div.-Hughes Aircraft Co., e, g.
Walter J. Hyatt Co., The, a, l, n, x, b-1.
IMC Magnetics Corp., z.
ITT Federal Div., International Telephone & Telegraph Corp., b, o, z, a-1.
Imperial Brass Mfg. Co., The, n, x, b-1.
Industrial Acoustics Co., Inc., v, e-1.
Infrared Industries, Inc., p.
Instruments for Industry, Inc., z, a-1.
*INTERELECTRONICS CORP., c, d, e, i, j, k, p, q, r, v.
Interference Measurement Laboratory, Inc., p, r, v, z, e-1.
Interstate Electronics Corp., e, r, u, e-1.
JFD Electronics Corp., e, m, r, z, a-1.
J-V-M Microwave Co., j, u, z.
Jarrell-Ash Co., w.
Johns-Manville Sales Corp., a.
E. F. Johnson Co., r, z.
Johnson Electronics Inc., c, e, m, o, q, r, z.
Kahn & Co., Inc., a, t, x.
*KEARFOTT DIV., GENERAL PRECISION, INC., t, u.
*KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS, u, z.
D. S. Kennedy & Co., b, d, e, m, r, u.
Kentucky Metal Products Co., a, i, u, v, z.
Keystone Electronics Co., The, g, r.

Keystone Products Co., **c.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **a, x.**
Kieley & Mueller, Inc., **a.**
James Knights Co., The, **e, j, m, r, d-1.**
Kopp Glass, Inc., **w.**
Koppers Co., Inc., Metal Products Div., **v.**
Kwikset Powdered Metal Products, **a, e, p, v.**
Lear, Inc., **a thru e, g, i, k thru n, r, t, x, z, a-1, b-1, e-1.**
Warner Lewis Co., Div.-Fram Corp., **l.**
***WALLACE O. LEONARD, INC., x.**
Librascope Div., General Precision, Inc., **e.**
Lieco, Inc., **u.**
Litton Industries, Inc., **u.**
Litton Industries, Maryland Div., **z.**
Lockheed Aircraft Corp., Missiles & Space Div., **u.**
Luber-Finer Inc., **l, n.**
Lumen, Inc., **e, i, m, r.**
Lynch Carrier Systems Inc., **d, e, j, k, m, q, r.**
MB Electronics, **e, k.**
Magnasync Corp., **c.**
Magnetic Circuit Elements, Inc., **c, d, e, i, m, p thru s.**
Manhattan Lighting Equipment Co., Inc., **a.**
***MARTIN CO., THE, DENVER DIV., c, e, f, i, n, s, v, b-1.**
Mason-Neilan, **x.**
Mc Coy Electronics Co., **d, e, g, m, r, e-1.**
Mc Millan Companies, The, **e, i, p, q, r, u, v, z, a-1.**
Mc Millan Lab., Inc., **p, q, u, z, a-1.**
Mead Specialties Co., Inc., **a.**
Meridian Metalcraft, Inc., **d, e, m, r, u, z.**
Merit Coil & Transformer Corp., **e, m, o thru r, z, e-1.**
Micamold Electronics Mfg. Corp., **c, d, e, i, o thru r, v.**
Microlab, **b, e, j, m, p, r, u, z, a-1.**
Microphase Corp., **b, d, e, f, k, m, p thru s, u, v, z, a-1, e-1.**
Microwave Associates, Inc., **r, u, z.**
Mid-West Coil & Transformer Co., **c, e, m, q, r.**
James Millen Mfg. Co. Inc., **o, v, z, e-1.**
J. W. Miller Co., **b, d, e, m, o thru r, v, z, a-1, e-1.**
Millipore Filter Corp., **a, l, n, t.**
C. A. Morgren Co., **x.**
Motorola, Inc., **b thru g, i, m, o thru r, t, u, v, z, a-1, c-1, d-1.**
Muirhead Instruments Inc., **f, c-1.**
George L. Nankervis Co., **l, n.**
Narda Microwave Corp., The, **m, r, u.**
National Coil Co., **c, d, e, o, r, z, a-1.**
National Co., Inc., **b, e, g, m, o, z, a-1.**
Networks Electronic Corp., **c-1.**
New York Transformer Co. Inc., **c, d, e, i, j, k, m, r.**
Newark Wire Cloth Co., **l.**
Newton Co., The, **d.**
Northrop Corp., **i.**
Nuclear Development Corp. of America, **c, z.**
Nytronics, Inc., Essex Electronics Div., **e, o, r.**
Oil-Dyne, Inc., **n.**
Omega Labs., Inc., **u.**
Optical Coating Lab., Inc., **w.**
Optical Gaging Products, Inc., **w.**
Orbitran Co., Inc., **c, e, m, r.**
Ortho Filter Corp., **b thru e, g, i, j, k, m, o, r, s, z, a-1, d-1, e-1.**
Owens-Corning Fiberglas Corp., **a, t.**
Pacific Relays, Inc., **e.**
Pacific Universal Products Corp., **w.**
M. V. Palmer, Inc., **c, d, e, j, r, u.**
Ralph M. Parsons Co., The, Electronics Div., **b, e, z.**
Pequot Wire Cloth Co., **l.**
Performance Measurements Co., **m, r.**
Permanent Filter Corp., **a, l, n, t, x.**
Philco Corp.-Govt. & Industrial Group, **c, e, o thru r, u, v, z, a-1.**
Polarad Electronics Corp., **u.**
Polaroid Corp., **y.**
Polyphase Instrument Co., **i, j, m, o, r, z, d-1.**
Portland Copper & Tank Works Inc., **b, j, o, u, z, e-1.**
Precise Development Corp., **b thru e, g, i, m, o thru s, z.**
Precision Equipment Co., Inc., **a, l, t, z, b-1.**
Precision Lapping Co. Inc., **w.**
Production Research Corp., Sub.-Radio Condenser Co., **b, e.**
Projects Unlimited, Inc., **c, e.**
Pulse Engrg. Inc., **e, k, m, r.**
Puritan Aerospace Div.-Puritan Compressed Gas Corp., **x.**
Purolator Products Inc., **a, l, n, t, x.**
REF Mfg. Corp., **l, n.**
Radar Design Corp., **u, a-1.**
Radex Corp., **a.**
Radiaphone Co. Inc., **e, r.**
Radiation, Inc., **b, d, e, m, r, u, a-1.**
Radio Condenser Co., **b, d, e, f, m, r, z, a-1.**
***RADIO CORP. OF AMERICA, b thru e, g, m, o thru v, z, a-1 thru e-1.**
Radio Development & Research Corp., **i, q, r.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **a-1.**
Railway Communications, Inc., **d, e, k, m, r.**
Rantec Corp., **b, u.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., e, t.**
Reeves Brothers, Inc., **a.**
Reeves-Hoffman Div., **c, d, e, g, i, k, m, o, q, r, z.**
Republic Aviation Corp., Missile Systems Div., **u.**
Republic Lens Co., Inc., **w.**
Research Products Corp., **a.**
Riverbank Labs., Dept.-Engrg., **e, t.**
J. R. Robbins Co., **l, n.**
Robbins Aviation, Inc., **a.**
Royal Jet, Div.-Royal Industries, Inc., **l, n, x.**
Rucker Co., The, **n.**
Rytron Co., Inc., **d, e, k, m, p, r, v, z.**
S-P Mfg. Corp., The, **a.**
Sage Labs., Inc., **e, p, u.**
St. Marys Carbon Co., **a, l, n, t.**
San Fernando Electric Mfg. Co., **v.**
Sanders Associates, Inc., **u.**
Sangamo Electric Co., **d, e, m, p, r, s, v, e-1.**
Santa Barbara Research Center, **w, x.**
H. H. Scott, Inc., **c, e, m, r, s, v.**
Secode Corp., **c, d, e, g, m, o, q, r, z, a-1.**
Servomechanisms, Inc., **r.**
Shallcross Mfg. Co., **d, e, l, o, r, z.**
Sierra Electronic Corp., Div.-Philco Corp., **p, r, u, z, a-1.**
Simmonds Aerocessories, Inc., **n.**
Skytronics, Inc., **l, n.**
A. O. Smith Corp., Smith-Erie Div., **l.**
Solar Mfg. Corp., **a-1.**
Southwest Research Institute, **a, c thru f, i, j, l, m, n, p, r, t, v, w, x.**
Special Products Dept., Melpar, Inc., **e, m, r, u, a-1.**
Specialty Electronics Development Corp., **c, u.**
Spectracoat, Inc., **d, e, m, p, r, w.**
Spectrum Instruments, Inc., **c thru f, i, k, r, c-1.**
Spencer-Kennedy Labs., Inc., **d, e, f, m, r, z, a-1, c-1.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **u.**
Sprague Electric Co., **p, q, z.**
Standard Electronics Div.-Reeves Instrument Corp., **b thru e, g, m, o thru r, z, a-1.**
Standard Steel Corp., Cambridge Div., **b-1.**
William W. Stanley Co. Inc., **a.**
Stewart-Warner Electronics Div., **c, e, o, r, u, z.**
Sun Electric Corp., Aeronautical Div., **b, i, l, m, n, v, x, z.**
Superex Electronics Corp., **b, m, p, q, r.**
Superior Pneumatic & Mfg., Inc., **a, x.**
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., **b, e, u.**
Systems Incorporated, **g.**
T. O. D. Mfg. Co. Inc., **a, l, n, x.**
TRG, Inc., **b, u, e-1.**
Tamar Electronics, Inc., **b, d, e, f, j, m, o, r, u, z, a-1, e-1.**
Tapco Group, Thompson Ramo Wooldridge Inc., **u.**
Technicraft, Div.-Electronic Specialty Co., **u.**
Telechrome Mfg. Corp., **e.**
Tele Coil Co., **b, e, f, o, u, z, a-1.**
Telectro Industries Corp., **b, c, e.**
Telerad Mfg. Corp., **u.**
Telex, Inc., **c, e, j, m, r, e-1.**
Telkor, Inc., **i, p, v.**
Telonic Industries, Inc., **e, m, r, z, a-1.**
Temperature Engrg. Corp., **b-1.**
Texstar Plastics, Div.-The Texstar Corp., **a.**
Thermador Electrical Mfg. Co., **e.**
Thompson Ramo Wooldridge Inc., **u.**
Tinsley Labs., Inc., **w.**
Torwico Electronics, Inc., **c, d, e, m, q, r.**
Transco Products, Inc., **b, d, e, u, z.**
Transformer Design, Inc. of Milwaukee, **c, d, e, m, r.**
Transformers, Inc., **c, d, e, i, j, m, r.**
Tresco, Inc., **r.**
Trinity Equipment Corp., **a.**
U. E. Electronics Corp., **b, r.**
Udylite Corp., The, **l.**
U. S. Sonics Corp., **e, o, d-1.**
Universal Toroid Coil Winding, Inc., **d, e.**
University Loudspeakers, Inc., **m, r.**
Vacuum Specialties Co., Inc., **b-1.**
Valor Instruments, Inc., **e, o, r, z.**
Vanguard Electronics Co., **d, e, o, r, z, e-1.**
Varo Mfg. Co., Inc., **c thru g, i, j, m, o thru r, v, y, z, c-1, e-1.**
Vickers Inc., **n.**
Victor R. F. & Microwave Co., **r, u.**
Viewlex, Inc., **w.**
Virginia Electronics Co., Inc., **c, o.**
Wahlgren Magnetics, Div.-Marshall Industries, **d, e, m, r.**
Waterman Hydraulics Corp., **n.**
Waveline, Inc., **u.**
Wells Industries Corp., **a, x.**
Wenzlau Engrg. Co., **l.**
Westinghouse Air Brake Co., Industrial Products Div., **a.**
Westinghouse Electric Corp., **j.**
Wheelabrator Corp., **a.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **c, d, e, m, p.**
Wheeler Laboratories, Inc., **u.**
White Instrument Labs., **c, d, e, j, m, r.**
Winder Aircraft Corp. of Florida, **a.**
Wollensak Optical Co., **w.**
Wright Electronics Inc., **g.**
York Div., Borg-Warner Corp., **a.**
Zenith Optical Laboratory, **w.**
Zippertubing Co., The, **l.**
Zoomar Inc., **w.**

FINDERS, RANGE

Allied International Corp.
American Optical Co.
Davidson Optronics, Inc.
Eastman Kodak Co.
J. W. Fecker Div., American Optical Co.
Gordon Enterprises
Lear, Inc.
Librascope Div., General Precision, Inc.
Madigan Corp.
Motorola, Inc.
Northrop Corp.
Nortronics, Div.-Northrop Corp
Optomechanisms Inc
Philco Corp.-Govt. & Industrial Group
Spectra Electronics Corp.
Telectro Industries Corp.
Wollensak Optical Co.

FINDERS, VIEW

American Optical Co.
Eastman Kodak Co.
J. W. Fecker Div., American Optical Co.
Gordon Enterprises
***MARTIN CO., THE, DENVER DIV.**
Mitchell Camera Corp.
Optomechanisms Inc.
Philco Corp.-Govt. & Industrial Group
Zoomar Inc.

FINISHERS, PLASTIC

Allied Plastics Supply Corp.
American Latex Products Corp.
Duracote Corp.
Duralith Corp.
Eljay Corp.
Emeloid Co., Inc., The
***EQUIPMENT DIV., RAYTHEON CO.**
Fibercraft, Inc.
Grant-Lehr Corp.
Homalite Corp., The
Lone Star Plastics Co. Inc.
***MINNESOTA MINING & MFG. CO.**
Norrich Plastics Corp.
Olympic Plastics Co., Inc.
W. S. Shamban & Co.
Sillcocks-Miller Co.
Tetrafluor, Inc.

FINISHES

a. Crystal
b. Luminous Materials
c. Ripple
d. Wrinkle

California Plasteck Inc., **b.**
Canadian Radium & Uranium Corp., **b, d.**
Del's Tumbling Service
E. I. Du Pont de Nemours & Co. Inc., **b.**
***EQUIPMENT DIV., RAYTHEON CO., a.**
Hammett-Mercury-Rex Div., **a.**
Henry & Miller Industries, Inc., **c, d.**
Kish Industries, Inc., **a thru d.**
Maas & Waldstein Co., **d.**
Merix Chemical Co.
***MINNESOTA MINING & MFG. CO., b.**
Northeast Metals Industries, Inc., **c, d.**
Precision Lapping Co. Inc., **a.**
Raffi & Swanson, Inc., **b, d.**
Rimak, Inc., **b, c, d.**
Sillcocks-Miller Co., **b.**
Switzer Brothers, Inc., **b.**
Ultra-Violet Products, Inc., **b.**
United Mineral & Chemical Corp., **b.**
United States Radium Corp., **b.**

FINS

Aluminum Co. of America
American Brake Shoe Co.
Avco Corp., Crosley Div.
Brooks & Perkins, Inc.
Bruce Engrg. Co.
Calcor Corp.
California Stamping & Mfg. Co.
Chance Vought Aircraft, Inc.

Cutler Metal Products Co.
Doehler-Jarvis Div., National Lead Co.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Jarvis Corp
Kaiser Fleetwings, Inc.
Kanarr Corp.
Kellett Aircraft Corp.
Kelsey-Hayes Co.
*LAVELLE AIRCRAFT CORP.
Magline Inc.
*MARTIN CO., THE, DENVER DIV.
*MINNESOTA MINING & MFG. CO.
Monrovia Aviation Corp.
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
R. H. Osbrink Mfg. Co.
Parsons Corp., Special Products Div
Pastushin Industries, Inc.
Phoenix Products Co.
Prewitt Aircraft Co.
Republic Aviation Corp., Missile Systems Div.
Rimak Inc
Royal Jet, Div.-Royal Industries, Inc.
Southwest Research Institute
Stamping Div.-Rockwell Standard Corp.
Westinghouse Electric Corp., Micarta Div.
Winder Aircraft Corp. of Florida

FIRE

a. Alarm Systems
b. Detectors
c. Extinguishing Systems
d. Protection Systems

Accessory Products Co., Div.-Textron Inc., **c.**
Akron Brass Mfg. Co., Inc., **c, d.**
Allied International Corp., **c.**
American District Telegraph Co., **a, b, d.**
American La France Div.-Sterling Precision Corp., **c, d.**
Ansul Chemical Co., **c, d.**
California Plasteck Inc., **a.**
Cardox Div., Chemetron Corp., **a thru d.**
Chance Vought Aircraft, Inc., **c.**
Compudyne Corp., **a, d.**
Conax Corp., **c, d.**
Control Products Inc., **b.**
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **c.**
Daystrom, Inc., Control Systems Div., **a.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **a thru d.**
Electro-Seal Corp., **a, d.**
FWD Corp., **c.**
Fenwal Inc., **a thru d.**
Fyr-Fyter Co., The, **a thru d.**
Gamewell Co., The, **a, d.**
General Fire Extinguisher Corp., The, **c, d.**
Grinnell Co., **a thru d.**
Hallett Mfg. Co., **d.**
Hammett-Mercury-Rex Div., **c.**
George E. Harris & Co., Inc., **a, b, d.**
Interstate Electronics Corp., **a, b.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **a, d.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **a thru d.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **a.**
Leslie Co., **a.**
Lofstrand Co., The, **c.**
*MARTIN CO., THE, DENVER DIV., **a thru d.**
National Foam System, Inc., **c, d.**
Networks Electronic Corp., **b.**
Notifier Corp., **a.**
Patterson Moos Research, Div.-Leesona Corp., **a, b, d.**
Photobell Co., Inc., **a, b.**
Protectoseal Co., The, **d.**
Pyrotector Inc., **a, b.**
Richards-Wilcox Mfg. Co., **b.**
Rockwood Sprinkler Co., Div.-The Gamewell Co., **a thru d.**
Santa Barbara Research Center, **a, b.**
Southwest Research Institute, **a thru d.**
Special Products Dept., Melpar, Inc., **a, b.**
Spectra Electronics Corp., **a.**
Standard Electric Time Co., The, **a, b.**
Sun Electric Corp., Aeronautical Div., **a.**
Ullman Devices Corp., **a.**
United Electric Controls Co., **a.**
Victory Engrg. Corp., **b.**
Ward Lafrance Truck Corp
Wells Industries Corp., **a, b,** d.
Whittaker Controls, Div.-Telecomputing Corp., **c.**

FIRE STANDS, MISSILE

*AEROJET-GENERAL CORP.
Aeroscience, Inc.
Akron Brass Mfg. Co., Inc.
Allegany Instrument Co., Inc.
American Machine & Foundry Co., Government Products, N. Y.
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Basic Tool Industries, Inc.
A. M. Byers Co
Calcor Corp.
California Stamping & Mfg. Co.
Cromer Mfg. & Engrg., Inc.
Lofstrand Co., The
*MARTIN CO., THE, DENVER DIV.
McCathron Boiler Works Co., Inc.
Opelika Welding, Machine & Supply Inc.
Twin Coach Co., Aircraft-Missiles
Wells Industries Corp.

FIRE WALLS

American Machine & Foundry Co., Government Products, N. Y.
Calcor Corp.
California Stamping & Mfg. Co.
Colonial Aircraft Corp.
Douglas Aircraft Co., Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Kaiser Fleetwings, Inc.
*LAVELLE AIRCRAFT CORP.
*MARTIN CO., THE, DENVER DIV.
Penn-Michigan Mfg. Corp.
Solar Aircraft Co.
United States Plywood Corp.

FIRING STAND ACCESSORIES

*AEROJET-GENERAL CORP.
Aeroscience, Inc.
Aero-Test Equipment Co., Inc.
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div
Bendix Filter Div., Bendix Aviation Corp.
Calcor Corp.
California Stamping & Mfg. Co.
Douglas Aircraft Co., Inc.
Hydra-Power Corp.
*MARTIN CO., THE, DENVER DIV.
*MINNESOTA MINING & MFG. CO.
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Twin Coach Co., Aircraft-Missiles

FITTINGS, COAXIAL CABLE

American Tube Bending Co., Inc.
*ANDREW CORP.
Bendix Aviation Corp
Cal Connector Co.
Deutsch Co., The, Electronic Components Div.
Diamond Antenna & Microwave Corp.
Farwest Mfg. Div., Inc.
General Radio Co
Hallett Mfg. Co.
International Electric Industries, Inc.
Kings Electronics Co., Inc.
Norrich Screw Machine Products
Nugent Electronics Co., Inc.
Phelps Dodge Copper Products Corp.
Piasecki Aircraft Corp.
Sealectro Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thomas & Betts Co., Inc., The
Thompson Ramo Wooldridge Inc.
United Supply Co.

FITTINGS, METALLIC

Adam Metal Supply Inc.
Aero Bolt & Screw Co., Inc.
Aero Mfg. & Mach. Co., Inc.
Aero Spares, Inc.
Aeroquip Corp., Jackson Div.
Aircraft Fitting Co., The
Airdrome Parts Co.
American Brass Co., The
American Instrument Co., Inc
Ampco Metal, Inc.
Arnav Aircraft Associates, Inc.
Avica Corp.
Belmar Wheel & Machine Co., Inc.
Bergen Carbide Co.
Best Aircraft Corp.
Breeze Corporations, Inc.
Capewell Mfg. Co.
Capital City Mfg. Co., Inc.
Chase Brass & Copper Co., Inc.
Collins Mfg. Corp.
Components Corp.
Conrad & Moser
Crawford Fitting Co.
Dayton Aircraft Products, Inc.
Drilube Co.
Dumont Engrg. Co.
Fairbanks Co., The
Fenn Mfg. Co., The
Flowline Corp.
General Logistics Div., Aeroquip Corp.
Gideon & Ramey Mfg. Co.
Grinnell Co.
Harvey Aluminum
Huntington Alloy Products Div.-The International Nickel Co., Inc.
Imperial Brass Mfg. Co., The
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Walter K. Jaros Aircrafters
Kling Metal Spinning & Stamping Co.
Kohler Co.
Ladish Co.
*MARTIN CO., THE, DENVER DIV.
Norrich Plastics Corp.
Norrich Screw Machine Products
Northrop Corp.
Ohlson Empire Inc.
Parker Fittings & Hose Div., Parker-Hannifin Corp.
Rattan Mfg. Co., The
Resistoflex Corp.
Rimak, Inc.
J. R. Robbins Co.
Squiers Gage Co
Tapco Group, Thompson Ramo Wooldridge Inc.
Thomas & Betts Co., Inc., The
Thompson Ramo Wooldridge Inc
United Supply Co.
Weatherhead Co., The
Western Div., Aeroquip Corp.

FITTINGS, NON-METALLIC

American Latex Products Corp.
American Standard Products, Inc.
Bergen Carbide Co.
Carborundum Co., The
Continental Rubber Works
Crawford Fitting Co.
Crystal-X Corp.
Dayton Aircraft Products, Inc.
Grinnell Co.
Walter J. Hyatt Co., The
Imperial Brass Mfg. Co., The
Luzerne Rubber Co.
*MARTIN CO., THE, DENVER DIV.
Norrich Plastics Corp.
Norrich Screw Machine Products
Northrop Corp.
Olympic Plastics Co., Inc.
Polymer Corp., The
Rattan Mfg. Co., The
*STRATOFLEX, INC.
Tetrafluor, Inc.
Thomas & Betts Co., Inc., The
Wasley Products, Inc
Zippertubing Co., The

FLAMEHOLDERS, RAMJET

Allison Div., General Motors Corp.
Arde-Portland, Inc.
B. H. Aircraft Co., Inc
Crane Co., Special Products Div.
*LAVELLE AIRCRAFT CORP.
Lycoming Div., Avco Corp.
Portland Copper & Tank Works Inc.
Solar Aircraft Co.
Thermionic Aeronautical Div.

FLANGES, MICROWAVE

Ainslie Corp.
Aircom Inc.
Airtron, Div.-Litton Industries
*ANDREW CORP.
Cal Connector Co.
Chase Brass & Copper Co., Inc.
Connector Corp. of America
Co-Operative Industries, Inc.
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
Gar Products Corp.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammett-Mercury-Rex Div.
Interstate Electronics Inc
J-V-M Microwave Co.
Kings Electronics Co., Inc.
Lieco, Inc.
*MARTIN CO., THE, DENVER DIV.
Microwave Associates, Inc.
Olin Mathieson Chemical Corp., N. Y.
Omega Labs., Inc.
Radalab Inc.
Specialty Electronics Development Corp.
Technicraft, Div.-Electronic Specialty Co.
Telerad Mfg. Corp.
Waveline, Inc.

FLIGHT DIRECTORS

Allied International Corp.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Broadview Research Corp.
Collins Radio Co.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Daystrom Inc., Transicoil Div.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Gordon Enterprises
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Integrated Dynamics Div., Globe Industries, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Librascope Div., General Precision, Inc.
Motorola, Inc.
Nortronics, Div.-Northrop Corp.
Republic Aviation Corp., Missile Systems Div.
Santa Barbara Research Center
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Sun Electric Corp., Aeronautical Div.

FLIGHT TERMINATION DEVICES

*AEROJET-GENERAL CORP.
Arde-Portland, Inc.
Avco Corp., Crosley Div.
Babcock Radio Engrg., Inc.
Broadview Research Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Instrument Corp., Defense & Engrg. Products Group
Lockheed Aircraft Corp., Missiles & Space Div.
Mc Cormick Selph Associates
Motorola, Inc.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Republic Aviation Corp., Missile Systems Div.
Santa Barbara Research Center
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.

FLOWMETERS, DIFFERENTIAL PRESSURE

Aeroscience, Inc.
Aerotec Industries Inc., Aircraft Equipment Div.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Bendix Aviation Corp.
A. Biederman, Inc.
Bowser, Inc.
*BRISTOL CO., THE
Consolidated Diesel Electric Corp.
Cox Instruments Div., George L. Nankervis Co.
Crescent Engrg. & Research Co.
Daystrom Inc., Pacific Div.
Dynisco, Inc.
Ellison Draft Gage Co., Inc.
Fischer & Porter Co.
General Controls Co.
Hagan Chemicals & Controls Inc.
Haskel Engrg. & Supply Co.
Hays Corp., The
Huyck Systems Co.
*WALLACE O. LEONARD, INC.
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
George L. Nankervis Co.
National Instrument Laboratories, Inc.
National Scientific Labs., Inc.
Schaevitz Engrg.
Servomechanisms, Inc.
Southwest Research Institute
Trimount Instrument Co.

FLOWMETERS, MASS RATE

Aeroscience, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Auto-Control Labs. Inc.
Avien, Inc.
B & H Instrument Co., Inc.
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
Bowser, Inc.
Consolidated Diesel Electric Corp.
Cox Instruments Div., George L. Nankervis Co.
Crescent Engrg. & Research Co.
Decker Corp., The
*DEL MAR ENGRG. LABS.
Eclipse Fuel Engrg. Co.
Fischer & Porter Co.
Flow Corp.
General Controls Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Instrument Dept.
Hays Corp., The
Highland Engrg. Co.
Huyck Systems Co.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
*WALLACE O. LEONARD, INC.
Madigan Corp.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
George L. Nankervis Co.
National Instrument Laboratories, Inc.
Ohmart Corp., The
Potter Aeronautical Corp.
Revere Corp. of America, Sub., Neptune Meter Co.
Southwest Research Institute
Standard Controls, Inc.
Trans-Sonics, Inc.

FLOWMETERS, VOLUMETRIC

Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Auto-Control Labs. Inc.
B & H Instrument Co., Inc.
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp.
Bowser, Inc.
Bowser Inc., Defense Div.
*BRISTOL CO., THE
Budd Co., The
Consolidated Diesel Electric Corp.
Convair Instruments, Convair Div.-General Dynamics Corp.
Cox Instruments Div., George L. Nankervis Co.
*DEL MAR ENGRG. LABS.
Henry G. Dietz Co., Inc.
Eclipse Fuel Engrg. Co.
Fischer & Porter Co.
Flow Measurements Corp.
Food Machinery & Chemical Corp., Ordnance Div.
General Controls Co.
B. H. Hadley, Inc.
Hays Corp., The
Highland Engrg. Co.
Hoke Inc.
Huyck Systems Co.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
*WALLACE O. LEONARD, INC.
Madigan Corp.
W. L. Maxson Corp., The
J. J. Monaghan Co., Inc.
George L. Nankervis Co.
National Instrument Laboratories, Inc.
National Scientific Labs., Inc.
Potter Aeronautical Corp.
Revere Corp. of America, Sub., Neptune Meter Co.
Selas Corp. of America
Southwest Research Institute
Sun Electric Corp., Aeronautical Div.
Waugh Engrg. Co.

FLUID METERING PUMP SYSTEMS

ACF Industries Inc.
Adel Precision Products of Calif., Div.-General Metals Corp.
American Instrument Co., Inc.
Bendix Aviation Corp.
*BENDIX AVIATION CORP., HAMILTON DIV.
Bendix Utica Div., Bendix Aviation Corp.
A. Biederman, Inc.
Bowser, Inc.
Consolidated Diesel Electric Corp.
Eastern Industries Inc.
Edwards High Vacuum Ltd.
Flight Refueling, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
B. H. Hadley, Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Hughes Tool Co., Aircraft Div.
Kemp Aero Products
Kerns Mfg. Corp.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Lapp Insulator Co., Inc., Radio Specialties Div.
National Scientific Labs., Inc.
REF Mfg. Corp.
Milton Roy Co.
Sargent Engrg. Corp.
A. O. Smith Corp., Smith-Erie Div.
Southwest Research Institute
Sundstrand Turbo
Thayer Scale Corp.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Wallace & Tiernan Inc.
Weatherhead Co., The

FLUID MOTORS

Adel Precision Products of Calif., Div.-General Metals Corp.
Aircraft Accessory Turbine Dept.-General Electric Co
American Brake Shoe Co.
American Brake Shoe Co., Kellogg Div.
Bendix Aviation Corp.
*BENDIX AVIATION CORP., HAMILTON DIV.
Clark Equipment Co.
Commercial Shearing & Stamping Co.
Cornelius Co., The, Aero Div.
Eastern Industries Inc
Gar Wood Industries Inc.
Haskel Engrg. & Supply Co.
Kerns Mfg. Corp.
Link-Belt Co.
Oil-Dyne, Inc.
Pesco Products Div.-Borg-Warner Corp.
Sargent Engrg. Corp.
Sundstrand Turbo
Vickers Inc
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Wickfield, Inc.

FLUIDS, HYDRAULIC OILS, COOLANTS, ETC.

American Oil & Supply Co.
Anderson Chemical Co., Div.-Stauffer Chemical Co.
Anderson Oil & Chemical Co., Inc.
George Basch Co., The
Cincinnati Milling Machine Co., The
Dow Corning Corp.
Fluoro-Chem Corp.
Food Machinery & Chemical Corp.-Chemical & Plastics Div.
Halocarbon Products Corp.
E. F. Houghton & Co.
*MINNESOTA MINING & MFG. CO.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
Monsanto Chemical Co.
New York Air Brake Co., The, Watertown Div.
Pennsalt Chemicals Corp.
Southwest Research Institute
White & Bagley Co., The
York Div., Borg-Warner Corp.

FLUORESCENT COMPOUNDS, PHOSPHORS

Allied Chemical Corp., General Chemical Div.
Alloys Unlimited Inc.
Bios Labs., Inc.
Cadillac Plastic & Chemical Co.
Canadian Radium & Uranium Corp.
Cerium Metals & Alloys Div.-Ronson Metals Corp.
Cordo Chemical Corp.
Delta Chemical Works, Inc.
Farwest Mfg. Div., Inc.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
*MINNESOTA MINING & MFG. CO.
Semi-Elements, Inc.
Shannon Luminous Mat., Affiliate-Curtiss-Wright, Princeton Div.
Switzer Brothers, Inc.
TRG, Inc.
Ultra-Violet Products, Inc.
United States Radium Corp.
Var-Lac-Oid Chemical Co.
Westinghouse Electric Corp.

FLUOROMETERS

American Instrument Co., Inc.
Coleman Instruments, Inc.
*ENGIS EQUIPMENT CO.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Photovolt Corp.

FLUX, BRAZING OR SOLDERING

Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Alpha Metals, Inc.
Aluminum Co. of America
Anchem Products Inc.
American Brazing Alloys Corp.
American Silver Co., Inc.
American Solder & Flux Co.
Ampco Metal, Inc.
Blackstone Corp
Chase Brass & Copper Co., Inc.
Dalweld Co. Inc.
Delta Chemical Works, Inc.
Division Lead Co.
Dow Chemical Co., The
M. W. Dunton Co. Inc., The
Engelhard Industries, Inc.
Eutectic Welding Alloys Corp.
Fusion Engrg.
Goldsmith Bros. Div., National Lead Co.
Handy & Harman
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.

Huntington Alloy Products Div.-The International Nickel Co., Inc.
Johnson Mfg. Co., Inc.
Kester Solder Co.
Linde Co., Div.-Union Carbide Corp.
London Chemical Co., Inc.
Mico Instrument Co.
National Cylinder Gas, Div.-Chemetron Corp.
Ruby Chemical Co.
Solar Aircraft Co.
Superior Flux & Mfg. Co.
Texas Instruments Inc.

FLYWHEELS

Allison Div., General Motors Corp.
Bethlehem Steel Co.
G. O. Carlson, Inc.
Dodge Mfg. Corp
Integrated Dynamics Div., Globe Industries, Inc.
Lindgren Foundry Co.
Norrich Screw Machine Products
Squiers Gage Co
Telectro Industries Corp
U. S. Industries, Inc
Vickers, Inc., Mich.
Westinghouse Electric Corp.

FOIL, ALUMINUM

Accurate Specialties Co. Inc
Adam Metal Supply Inc.
Adept Industries Inc.
Allied Chemical Corp., General Chemical Div.
Alloys Unlimited Inc
Aluminum Co. of America
Bios Labs., Inc.
Engelhard Industries, Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Nuclear Development Corp. of America
Rea Magnet Wire Co., Inc., Div.-Aluminum Co. of America
Republic Foil Inc.
Revere Copper & Brass Inc
Reynolds Metals Co.
Roovers-Lotsch Corp.
Swift Textile Metalizing & Laminating Corp.
United Mineral & Chemical Corp
Zippertubing Co., The

FOIL, LEAD

Accurate Specialties Co. Inc.
Alloys Unlimited Inc
Alpha Metals, Inc.
Belmont Smelting & Refining Works, Inc.
Bios Labs., Inc.
Bow Solder Products Co., Inc
Nuclear Development Corp. of America
Revere Copper & Brass Inc.
Roovers-Lotsch Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co

FORCE MEASURING CELLS

Aeroscience, Inc.
*MARTIN CO., THE, DENVER DIV.
Morehouse Machine Co.
Revere Corp. of America, Sub., Neptune Meter Co.

FORGINGS, FLAT DIE

ACF Industries Inc
Aluminum Co. of America
American Brake Shoe Co.
American Car & Foundry Div., ACF Industries, Inc.
Ampco Metal, Inc.
Bethlehem Steel Co.
Billings & Spencer Co., The
Bridgeport Brass Co.
A. M. Byers Co.
Consolidated Industries, Inc.
Crucible Steel Co. of America
Custom Tool & Mfg. Co.
Eaton Mfg. Co., Valve Div
Harvey Aluminum
Earle M. Jorgensen Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kelsey-Hayes Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Ladish Co.
Charles E. Larson & Sons, Inc.
Midvale-Heppenstall Co.
National Forge Co
Ohlson Empire Inc.
Pettibone Mulliken Corp
Joseph T. Ryerson & Son, Inc
Scovill Mfg. Co.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Steel Improvement & Forge, The
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Universal-Cyclops Steel Corp.
Vanadium-Alloys Steel Co
Westinghouse Electric Corp.
Wilcox-Crittenden Div., North & Judd Mfg. Co.

FORGINGS, PRESS

Aluminum Limited Sales, Inc.
Aluminum Co. of America
American Brake Shoe Co.
American Brass Co., The
American Car & Foundry Div., ACF Industries, Inc.
Ampco Metal Inc.
Atlas Drop Forge Co
Bethlehem Steel Co.
Billings & Spencer Co., The
Bohn Aluminum & Brass Corp.
Bridgport Brass Co.
A. M. Byers Co.
*CAMERON IRON WORKS INC.
G. O. Carlson, Inc.
Chase Brass & Copper Co., Inc.
Collins Mfg. Corp.
Consolidated Industries, Inc.
Crucible Steel Co. of America
Curtiss-Wright Corp., Metals Processing Div.
Custom Tool & Mfg. Co.
Eaton Mfg. Co., Valve Div.
Harvey Aluminum
Earle M. Jorgensen Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kelsey-Hayes Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Kohler Co
Ladish Co
Charles E. Larson & Sons, Inc.
Midvale-Heppenstall Co
NUMEC-Nuclear Materials & Equipment Corp.
National Forge Co.
National Tube Div., United States Steel Corp.
Ohlson Empire Inc.
Pettibone Mulliken Corp.
Revere Copper & Brass Inc
Scovill Mfg. Co.
Solar Aircraft Co.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Steel Improvement & Forge, The
Struthers Well Corp
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc
Titan Metal Mfg. Co., Div.-Cerro de Pasco Corp.
Tube-Turns Div., Chemetron Corp.
United States Steel Corp.
Universal-Cyclops Steel Corp.
Vanadium-Alloys Steel Co.
Westinghouse Electric Corp.
Wyman-Gordon Co.

FORGINGS, UPSET

ACF Industries Inc.,
Allied Products Corp.
Aluminum Co. of America
American Brake Shoe Co
American Car & Foundry Div., ACF Industries, Inc.
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Ampco Metal, Inc.
Atlas Drop Forge Co.
Autoscrew Co., Inc.
Bethlehem Steel Co.
Billings & Spencer Co., The
A. M. Byers Co.
G. O. Carlson, Inc.
Commercial Shearing & Stamping Co.
Curtiss-Wright Corp., Metals Processing Div.
Custom Tool & Mfg. Co
Dana Corp.
Eaton Mfg. Co., Valve Div.
Endicott Forging & Mfg. Co., Inc.
H. M. Harper Co.
Harvey Aluminum
Earle M. Jorgensen Co.
Kaiser Aluminum & Chemical Sales, Inc.
Kelsey-Hayes Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Ladish Co
Ohlson Empire Inc
Pettibone Mulliken Corp.
Republic Steel Corp.
Scovill Mfg. Co.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Steel Improvement & Forge, The
Struthers Wells Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Tube-Turns Div., Chemetron Corp.
United States Steel Corp.
Universal-Cyclops Steel Corp.
Vanadium-Alloys Steel Co.
Westinghouse Electric Corp.
Wilcox-Crittenden Div., North & Judd Mfg. Co.
Wyman-Gordon Co.

FORMS, ANTENNA

Aeronca Mfg. Corp.-Aerospace Div.
Art Wire & Stamping Co.
Brooks & Perkins, Inc.
Chance Vought Aircraft, Inc.
*MARTIN CO., THE, DENVER DIV.
National Moldite Co.
Norrich Screw Machine Products
TRG, Inc.
Thor Ceramics, Inc.

FORMS, UPSET

ACF Industries Inc.
Art Wire & Stamping Co.
Chicago Screw Co., The, Div.-Standard Screw Co.
Ladish Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Republic Steel Corp.

FREQUENCY CALIBRATION SERVICES

Aeroscience, Inc
Amerac Inc.
American Machine & Foundry Co., Government Products Group.
Burton-Rodgers, Inc.
Designers for Industry, Inc.
Eidson Electric Co.
Electronic Applications, Inc.
FXR, Inc.
Fenske, Fedrick & Miller Inc
General Communication Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Gulton Industries, Inc.
Hathaway Instruments, Inc.
Hewlett-Packard Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Loral Electronics Corp.
*MARTIN CO., THE, DENVER DIV.
National Co., Inc.
New London Instrument Co. Inc.
Northeastern Engrg. Inc.
Northern Engrg. Laboratories, Inc.
Philamon Labs. Inc.
Production Research Corp., Sub.-Radio Condenser Co.
*RADIO CORP. OF AMERICA
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
State Testing Laboratory Inc.
Sunshine Scientific Instrument
TRG, Inc.

FREQUENCY METERS

Aero Instrument Co.
Airpax Electronics Inc., Cambridge Div.
Airpax Electronics Inc., Seminole Div.
Amerac Inc.
American Machine & Foundry Co., Government Products Group.
Avtron Mfg., Inc.
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp., Cincinnati Div.
James G. Biddle Co.
Budd Lewyt Electronics, Inc.
Budelman Electronics Corp.
Burton-Rodgers, Inc.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Crosby-Teletronics Corp.
Daystrom Inc., Weston Instruments Div.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Hugh H. Eby Co.
Electro Instruments, Inc.
Electronic Applications, Inc.
Epic, Inc.
FXR, Inc.
Fenske, Fedrick & Miller Inc.
General Communication Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Instrument Dept.
General Radio Co.
Helipot Div.-Beckman Instruments, Inc.
Hewlett-Packard Co.
I-L-S Instrument Div., The Meriam Instrument Co.
Iconix Inc.
Kahn & Co., Inc.
Kay Electric Co.
James Knights Co., The
Lampkin Labs., Inc., M.R. Div.
Lovoie Labs., Inc.
Loral Electronics Corp.
Mico Instrument Co.
Microwave Associates, Inc.
James Millen Mfg. Co. Inc.

Narda Microwave Corp., The
National Co., Inc.
National Electronics
Northeastern Engrg. Inc.
Piasecki Aircraft Corp.
Potter Aeronautical Corp.
Production Research Corp., Sub.-Radio Condenser Co.
*RADIO CORP. OF AMERICA
Sage Labs., Inc.
Sensitive Research Instrument Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Herman H. Sticht Co., Inc.
Sun Electric Corp., Aeronautical Div.
Sunshine Scientific Instrument
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Waugh Engrg. Co.
Waveline, Inc.
Westinghouse Electric Corp.

FUEL HANDLING EQUIPMENT

ACF Industries Inc.
Accessory Products Co., Div.-Textron Inc.
Aeroquip Corp., Jackson Div.
Aerotest Laboratories, Inc.
Agricultural Aviation Engineering Co. Inc.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
Bendix Filter Div., Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bowser, Inc.
Bowser Inc., Defense Div.
Buckeye Iron & Brass Works
Butler Mfg. Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
J. C. Carter Co., The
Compudyne Corp.
Consolidated Diesel Electric Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Dempster Brothers, Inc.
Douglas Aircraft Co., Inc.
Ex Cell-O Corp.
FWD Corp.
Flight Refueling, Inc.
Flight Support, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
General Mills, Inc.
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Grover Tank & Mfg. Co., Div.-Union Tank Car Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hamilton Standard
Harman Equipment Co.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Jeffrey Mfg. Co., The
Kieley & Mueller, Inc.
*MARTIN CO., THE, DENVER DIV.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
National Scientific Labs., Inc.
National Tube Div., United States Steel Corp.
Nelson Electric Mfg. Co.
On Mark Couplings, Inc.
Portland Copper & Tank Works Inc.
Pryor Mfg. Co.
Ref Mfg. Corp.
Scott Aviation Corp.
Simmonds Aerocessories, Inc.
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Standard Steel Works, Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Weatherhead Co., The
Western Div., Aeroquip Corp.
Whittaker Controls, Div.-Telecomputing Corp.

FUEL LINES

Aeroquip Corp., Jackson Div.
American Tube Bending Co., Inc.
Arnolt Corp.
Basic Tool Industries, Inc.
Breeze Corporations, Inc.
Consolidated Vacuum Corp.
Douglas Aircraft Co., Inc.
Dunbar-Kapple Inc.-Aircraft Components Div.
Flexible Metal Hose Mfg. Co.
Flexonics Corp.
B. F. Goodrich Aviation Products
Imperial Brass Mfg. Co., The
Kieley & Mueller, Inc.
Le Fiell Mfg. Co.
MB Electronics
M & Q Plastic Products
On Mark Couplings, Inc.
Parts Engrg. Co., Inc.
Resistoflex Corp.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div
Thermoid Div.-H. K. Porter Co., Inc.
United States Steel Corp.
Weatherhead Co., The
Western Div., Aeroquip Corp.
Whittaker Controls, Div.-Telecomputing Corp.
Woolf Aircraft Products, Inc.

FUEL SYSTEMS & EQUIPMENT

a. Balancing Controls
b. Flow Dividers Or Distributors
c. Injection Equipment
d. Lines
e. Mixture Controls, Automatic
f. Pressure Gauges
g. Pressure Warning Units
h. Ratio Controllers
j. Strainers

*AC SPARK PLUG, THE ELECTRONICS DIV. GENERAL MOTORS., **h.**
ACF Industries Inc., **c, e, f, h, j.**
Accessory Products Co., Div.-Textron Inc., **a, b, j.**
Acoustica Associates, Inc., **a, b, e.**
Actuation Research Corp., **b, i.**
Adel Precision Products of Calif., Div.-General Metals Corp., **h.**
Aero Supply Mfg. Inc., **a, b, e, j.**
Aeroquip Corp., Jackson Div., **d.**
Aerotec Industries Inc., Aircraft Equipment Div., **a, b, g.**
Air Logistics Corp.
Airaterra, **j.**
Aircraft Accessory Turbine Dept.-General Electric Co., **h.**
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., **b, e.**
Allison Div., General Motors Corp., **a, b, e.**
American Machine & Foundry Co., Government Products, N. Y.
Arnolt Corp., **d.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **d.**
Avien, Inc., **a, e, i.**
Benbow Mfg. Corp., **c.**
Bendix Aviation Corp., **c, e, f, h, j.**
*BENDIX AVIATION CORP., HAMILTON DIV., **h.**
Bendix Aviation Corp., Montrose Div., **f, g.**
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., **a, b, c, e, h, i, j.**
Bendix Utica Div., Bendix Aviation Corp., **b, h.**
A. Biederman, Inc., **f, g.**
Bowser, Inc., **a, b, c, e, h.**
Bowser Inc., Defense Div., **j.**
Brooks Rotameter Co., **e.**
Bruning Co., The., **a.**
Byron Jackson Pumps, Inc., **h.**
Captive Seal Corp., **b, i.**
Carleton Aviation Co., Inc., **a, e.**
J. C. Carter Co., The, **c, h.**
A. W. Cash Valve Mfg. Corp., **j.**
Caterpillar Tractor Co., Defense Products Dept., **c.**
Chance Vought Aircraft, Inc.
Components Corp., **e.**
Compudyne Corp., **e.**
Consolidated Controls Corp., **f, g, i.**
Consolidated Diesel Electric Corp.
Consolidated Vacuum Corp., **f, h.**
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co., **h.**
Crescent Engrg. & Research Co., **g.**
Custom Component Switches Inc., **a, b, g, i.**
Delavan Mfg. Co., **b, c.**
Douglas Aircraft Co., Inc.
Dynamic Controls Corp., **a, g, i.**
Eastern Industries Inc., **h.**
Electric Autolite Co., The, **f.**
Ellison Draft Gage Co., Inc., **f, g.**
Ex-Cell-O Corp., **b.**
Fischer & Porter Co., **i.**
Flexonics Corp., **d.**
Flight Refueling, Inc.,
Fram Corp., **j.**
Garwin, Inc., **f, g, h, j.**
Great Lakes Mfg. Corp., **f, g, h.**
Guided Missile Div., The Firestone Tire & Rubber Co., **b, d, j.**
B. H. Hadley Inc., **b, e, i.**
Hamilton Standard, Div.-United Aircraft Corp., **b, e, i.**
Harman Equipment Co., **j.**
George E. Harris & Co., Inc., **f.**
Haskel Engrg. & Supply Co., **f, h.**
Hoefner Corp., **e.**
Holley Carburetor Co., **b, e.**
Ludwig Honold Mfg. Co., **d.**
Huyck Systems Co., **b, c, h.**
Imperial Brass Mfg. Co., The, **d.**
Joclin Mfg. Co., The, **c.**
Kemp Aero Products, **a, b, h.**
Kieley & Mueller, Inc., **a, b, e, i, j.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **f.**
Lear, Inc., **a, c, e, g.**
Liquidometer Corp., The, **a.**
M. C. Mfg. Co., **h.**
Madigan Corp., **a, b, i.**
*MARTIN CO., THE, DENVER DIV., **b, c, e thru j.**
Meletron Corp., **g.**
Micro Gee Products, Inc., **a, e, i.**
Minneapolis-Honeywell Regulator Co., Aeronautical Div., **a, b.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **a, b, e, g, i.**
Mitchell Camera Corp., **g.**
Newark Wire Cloth Co., **j.**
On Mark Couplings, Inc., **d.**
Ordnance Engrg. Associates, Inc., **f.**
Parker-Hannifin Corp., **b, c.**
Parts Engrg. Co., Inc., **d.**
Peerless Pump Div., Food Machinery & Chemical Corp., **h.**
Pequot Wire Cloth Co., **j.**
Pesco Products Div.-Borg-Warner Corp., **h.**
Pneu-Hydro Valve Corp., **b, e.**
Potter Aeronautical Corp., **b, i.**
Purolator Products Inc., **j.**
Republic Mfg. Co., **b, g.**
Research Controls., **b, c, e.**
Resistoflex Corp., **d.**
Revere Corp. of America, Sub., Neptune Meter Co., **b.**
J. R. Robbins Co., **j.**
Rocketdyne Div.-North American Aviation, Inc.,
Roylyn Inc., **j.**
Sargent Engrg. Corp., **b.**
Schaevitz Engrg. **g.**
Servomechanisms, Inc., **e.**
Simmonds Aerocessories, Inc., **a, c, f.**
Skyvalve, Inc., **e.**
Southwest Research Institute, **a, b, c, e thru h.**
Standard Steel Corp., Cambridge Div., **h.**
Statham Instruments, Inc., **f, g.**
A. U. Stone & Co., Inc., **b.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **h.**
Sundstrand Turbo
T. O. D. Mfg. Co. Inc., **j.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, h.**
Thompson Ramo Wooldridge Inc., **a, b, h.**
Titeflex, Inc., **d.**
United Aircraft Products Inc.,
Varo Mfg. Co., Inc., **a, i.**
Vickers Inc., Div.-Sperry Rand, **h.**
Vickers, Inc., Mich., **h.**
Weatherhead Co., The, **d.**
Western Div., Aeroquip Corp., **d.**
Whittaker Controls, Div.-Telecomputing Corp., **a thru e, h.**
Woolf Aircraft Products, Inc., **d.**
Worthington Corp., **h.**

FUELS, LIQUID

Air Products, Inc.
Allied Chemical Corp., General Chemical Div.
Allied Chemical Corp., Nitrogen Div.
American Potash & Chemical Corp., National Northern Div.
Anderson Chemical Co., Div.-Stauffer Chemical Co.
Ashland Oil & Refining Co.
Bell Oil & Gas Co.
Bjorksten Research Labs. for Industry, Inc.
Callery Chemical Co.
Chlor-Alkali Div.-Food Machinery & Chemical Corp.
Esso Standard, Div.-Humble Oil & Refining Co.
Food Machinery & Chemical Corp., Ordnance Div.
Hughes Tool Co., Aircraft Div.
Hummel Chemical Co., Inc.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
Monsanto Chemical Co.
National Cylinder Gas, Div., Chemetron Corp.
Olin Mathieson Chemical Corp.
Olin Mathieson Chemical Corp., N. Y.
Pennsalt Chemicals Corp.
Rocketdyne Div.-North American Aviation, Inc.
Seminole Asphalt Refining, Ltd.
Shell Chemical Co., Indsl. Chemical Div.
Southwest Research Institute
Standard Oil Co. of Indiana
Stauffer Chemical Co.
U. S. Indsl. Chemicals Co., Div.-Natl. Distillers & Chemical Corp.

FUELS, SOLID

***AEROJET-GENERAL CORP.**
Allied Chemical Corp., Nitrogen Div.
Amcel Propulsion Inc.
American Latex Products Corp.
American Potash & Chemical Corp., National Northern Div.
Anderson, Greenwood & Co
Bermite Powder Co.
Bjorksten Research Labs for Industry, Inc
A. M Byers Co.
Callery Chemical Co.
Chlor-Alkali Div.-Food Machinery & Chemical Corp.
Eastern Chemical Div., Hooker Chemical Corp.
Food Machinery & Chemical Corp. Epoxy Dept.
Food Machinery & Chemical Corp., Ordnance Div.
Gabriel Co., Rocket Power-Talco
B. F. Goodrich Chemical Co.
Grand Central Rocket Co.
Hercules Powder Co., Chemical Propulsion Div.
Hughes Tool Co., Aircraft Div.
Hummel Chemical Co., Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Mc Cormick Selph Associates
Naugatuck Chemical Div.-U.S. Rubber Co.
Olin Mathieson Chemical Corp., N. Y
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pennsalt Chemicals Corp.
Propellex Chemical Div., Chromalloy Corp.
Rocketdyne Div.-North American Aviation, Inc.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation
Southwest Research Institute
Standard Oil Co of Indiana
Stauffer Chemical Co.
Young Development Div., Hercules Powder Co.

FURNACES

American Gas Furnace Co.
American Instrument Co., Inc.
Auto-Control Labs. Inc.
A. M. Byers Co.
California Stamping & Mfg. Co.
Consolidated Vacuum Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Despatch Oven Co.
Edwards High Vacuum Ltd.
Eisler Engrg. Co., Inc.
Engelhard Industires, Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General American Transportation Corp.
General Electric Co., Apparatus Sales Div.
General Vacuum Corp.
Hevi-Duty Electric Co., Div.-Basic Products Corp.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
A. F. Holden Co., The
Huppert, K. H., Co.
Kanthal Corp., The
Lepel High Frequency Labs. Inc.
Lindberg Engrg. Co
Lucifer Furnaces Inc.
NUMEC-Nuclear Materials & Equipment Corp.
Pacific Scientific Co.
Pioneer Industries Div., Almar-York Co. Inc
Edw. Renneburg & Sons Co.
Selas Corp of America
Shaw Burner Co.
Shaw Process Development Corp., Div.-British Industries Corp.
Sheridan-Gray Inc.
Special Products Dept., Melpar Inc.
Steiner-Ives Co.
Stewart Engrg. Co.
F. J. Stokes Corp.
Surface Combustion Div.-Midland-Ross Corp.
Thermal Research & Eng. Corp.
Tocco Div., The Ohio Crankshaft Co.
Vacuum Specialties Co., Inc.
Whiting Corp.
Zirconium Corp. of America

FUSES, ELECTRICAL

a. Cartridge
b. Grasshopper
c. Ordnance
d. Plug
e. Proximity

American Potash & Chemical Corp., National Northern Div., **a thru e.**
Associated Engineers, Inc., **a,** d.
Avco Corp., Crosley Div., **c, d,** e.
Bel Fuse Inc., **a.**
Bendix Aviation Corp., Cincinnati Div., **c, e.**
Bermite Powder Co., **c, e.**
Bulova Research & Development Labs., Inc., **c, e,**
Burndy Corp., Omaton Div., **a.**
Bussmann Mfg. Div., Mc Graw-Edison Co., **a, b, d.**
Cable Electric Products Inc., **d.**
Cleveland Metal Specialties Co., Electronics Div., **c, e.**
Clevite Ordnance, Div.-Clevite Corp., **c.**
Joe Davidson & Associates, **a.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **e.**
Eagle Electric Mfg. Co. Inc., **a, d.**
Eastman Kodak Co., **c, e.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **c, e.**
General Aniline & Film Corp., Ansco Div., **c.**
General Electric Co., Missile & Space Vehicle Dept. Pa., **c.**
Hamilton Watch Co., Military Products Div., **c, e.**
Hartwell Aviation Supply Co., **a, b.**
Hermetic Seal Corp. & Thermal Controls, Inc., **a.**
Littelfuse, Inc., **a.**
Lockheed Aircraft Corp., Missiles & Space Div., **c.**
Manhattan Lighting Equipment Co., Inc., **a, d.**
Monarch Electric Corp., **a, d.**
Olin Mathieson Chemical Corp., N. Y., **c.**
Olin Mathieson Chemical Corp., Winchester-Western Div., **c.**
Ordnance Research & Development Co., Div.-Bermite Powder Co., **c, e.**
Patterson Moos Research, Div.-Leesona Corp., **c, e.**
Photobell Co., Inc., **e.**
Royal Electric Corp., **a, b, d.**
Santa Barbara Research Center, **e.**
Sightmaster Corp., **a, b.**
Westinghouse Electric Corp., **a, c, e.**

GALVANOMETERS

B & H Instrument Co., Inc.
Bach Auricon, Inc.
James G. Biddle Co.
Bruno-New York Industries Corp.
Calvert Electronics Inc.
Century Electronics & Instruments, Inc.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Daystrom Inc., Weston Instruments Div.
***ENGIS EQUIPMENT CO.**
Epic, Inc.
Fisher Scientific Co., Maryland
G-M Labs. Inc.
General Electric Co., Apparatus Sales Div.
Greibach Instruments Corp.
Hathaway Instruments, Inc.
Hickok Electrical Instrument Co., The
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
Massa Div.-Cohu Electronics, Inc.
Meters Inc.
Midwestern Instruments, Inc.
Minneapolis-Honeywell, Heiland Div.
National Electronics
New England Scientific Instruments Co.
Pace Electrical Instruments Co., Inc.
Photron Instrument Co.
Pimex, Inc.
Sensitive Research Instrument Corp.
Shallcross Mfg. Co.
Simpson Electric Co.
Southwestern Industrial Electronics Co.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

GAS ANALYZERS

Air Products, Inc.
Allen Electric & Equipment Co.
American Instrument Co., Inc.
Baird-Atomic, Inc.
Bendix Aviation Corp.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Davis Instruments
Ellison Draft Gage Co., Inc.
Engelhard Industries, Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General Electric Co., Apparatus Sales Div.
Instrumentation Associates, Inc.
Jarrell-Ash Co.
Johnson-Williams, Inc.
Leeds & Northrup Co.
Mira Corp., The
Patterson Moos Research, Div.-Leesona Corp.
Perkin-Elmer Corp.
Pioneer Industries Div., Almar-York Co. Inc.
Process & Instruments
Milton Roy Co.
Southwest Research Institute
Sun Electric Corp., Aeronautical Div.
Victory Engrg. Corp.

GAS GENERATING DEVICES

Aerojet-General Corp., Downey Plant
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Aircraft Accessory Turbine Dept.-General Electric Co.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Potash & Chemical Corp., National Northern Div.
Amoco Chemicals Corp.
Arde-Portland, Inc.
Armament Div.-Universal Match Corp.
Bermite Powder Co.
Cryogenerators, Inc.
Engelhard Industries, Inc.
Gabriel Co., Rocket Power-Talco
Gas Atomospheres Inc.
Gow-Mac Instrument Co.
Hays Corp., The
Hevi-Duty Electric Co., Div.-Basic Products Corp.
***HOLEX, INC.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Janitrol Aircraft Div.-Midland-Ross Corp.
Kilgore Inc., International Flare-Signal Div.
Lithium Corp. of America Inc., The Fulton Irgon Div.
Mc Cormick Selph Associates
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pressed Steel Tank Co.
Propellex Chemical Div., Chromalloy Corp.
Rockeydyne Div.-North American Aviation, Inc.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Thermal Research & Eng. Corp.
Thiokol Chemical Corp, Hunter-Bristol Div.
Vickers, Inc., Mich.
Wallace & Tiernan Inc.

GASES, NITROGEN

Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Armour Industrial Chemical Co.
Engelhard Industries, Inc.
Gas Atmospheres Inc.
General Electric Co., Lamp Metals & Components Dept.
Linde Co., Div.-Union Corp.
Liquid Carbonic Div. General Dynamics Corp.
National Cylinder Gas, -Chemetron Corp.

GASES, RARE

Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Associated Engrg. & Mfg. Corp.
General Electric Co., Lamp Metals & Components Dept.
Linde Co., Div.-Union Carbide Corp.
National Cylinder Gas, Div.,-Chemetron Corp.

GASKET PASTE & CEMENT

ACF Industries Inc.
Air Products, Inc.
Anchor Packing Co., The
Armstrong Cork Co.
Connecticut Hard Rubber Co., The
Garlock Packing Co.
Greene, Tweed & Co.
***MARTIN CO., THE, DENVER DIV.**
***MINNESOTA MINING & MFG. CO.**
National Engrg. Products, Inc.
National Felt Co.
Parker Fittings & Hose Div., Parker-Hannifin Corp.

GASKETS, METALLIC

Advanced Products Co., The
Aero Gasket Corp.
Aero Spares, Inc.
Airtron, Div.-Litton Industries
All Specs Corp.
Allied International Corp.
Alloys Unlimited Inc.
Alpha Metals, Inc.
Alpitec, Inc.
American Instrument Co., Inc.
Anchor Metal Co. Inc.
Anchor Packing Co., The
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co. Inc.
Belmont Smelting & Refining Works, Inc.
Cadillac Gage Co.
California Stamping & Mfg. Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
D. S. D. Mfg. Co., The
Diamond Antenna & Microwave Corp.
Division Lead Co.
Garlock Packing Co.
Gasket Mfg. Co. Inc.
Greene, Tweed & Co.
Walter K. Jaros Aircrafters

Johns-Manville Sales Corp.
Kentucky Metal Products Co.
Kling Metal Spinning & Stamping Co.
Laminated Shim Co., Inc.
Mercury Air Parts Co., Inc.
Metallo Gasket Co.
Ohlson Empire Inc.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Penn Fibre & Specialty Co., Inc.
Resistoflex Corp.
United Aircraft Products, Inc.
Vacuum Research Co.
Victor Mfg. & Gasket Co.
Wilmington Fibre Specialty Co.
Winder Aircraft Corp. of Florida

GASKETS, NON-METALLIC

Acushnet Process Co.
Aero Gasket Corp.
Aero Leather Products Co.
Airtron, Div.-Litton Industries
All Specs Corp.
Allied Engraving & Stamping Co.
American Felt Co.
Anchor Packing Co., The
Armstrong Cork Co.
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co. Inc.
Cameratlex Div., The, Federal Mfg. & Engrg. Corp.
Carborundum Co., The
Chemplast, Inc.
Chicago Gasket Co.
Chicago Rawhide Mfg. Co.
Colonial Rubber Co.
Connecticut Hard Rubber Co., The
Continental Felt Co.
Continental Rubber Works
Crystal-X Corp.
Diamond Antenna & Microwave Corp.
Emerson Plastics Corp.
Enfab Inc.
Felters Co., The
Flock Process Co. Inc.
Fluorocarbon Co., The
Franklin Fibre-Lamitex Corp.
Garlock Packing Co.
Garlock Packing Co., The-Electronic Products
Gasket Mfg. Co. Inc.
General Gasket Inc.
B. F. Goodrich Sponge Products
Gordon Rubber & Packing Co. Inc.
Goshen Rubber Co., Inc.
Greene, Tweed & Co.
Halogen Insulator & Seal Corp.
Walter K. Jaros Aircrafters
Joclin Mfg. Co., The
Johns-Manville Sales Corp.
Linear, Inc.
Thomas J. Long, Inc.
Mechanical Rubber Products Co.
Mercury Air Parts Co., Inc.
Metallo Gasket Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
National Felt Co.
Ohlson Empire Inc.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Penn Fibre & Specialty Co., Inc.
Polymer Corp., The
Products Research Co.
Raybestos-Manhattan, Inc.
Reeves Brothers, Inc.
Reeves Bros. Inc., Vulcan Rubber Div.
Resistoflex Corp.
Fred T. Roberts & Co.
Rogers Corp.
Rubbercraft Corp. of California
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co.
Stillman Rubber Co.
Swift Textile Metalizing & Laminating Corp.
Tetrafluor, Inc.
Thermoid Div.-H. K. Porter Co., Inc.
Union Asbestos & Rubber Co.
United States Rubber Co.
Victor Mfg. & Gasket Co.
Western Felt Works & Acadia Synthetic Products Div.
Winder Aircraft Corp. of Florida
Wire Cloth Enterprises, Inc.

GAUGES

a. Air Pressure
b. Compression
c. Differential Pressure
d. Displacement Measuring
e. Fuel Pressure
f. Fuel Quantity
g. Hydraulic Pressure
h. Liquid Level
i. Manifold Pressure
j. Oil Level
k. Oil Pressure
l. Outside Air Temperature
m. Pressure
n. Quantity
o. Strain
p. Suction
q. Tension
r. Thickness, Electronic
s. Torque Pressure
t. Ultrasonic Thickness
u. Vacuum

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, k, m.**
ACF Industries Inc., **k.**
Aeroscience, Inc., **o, q, s.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **a, i, m.**

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **r.**
***AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP., a, c, thru g, l, m, u.**
Allegany Instrument Co., Inc., **m, o.**
Allied International Corp., **a, c, g, p, u.**
American Brake Shoe Co., **g.**
American Instrument Co., Inc., **a, c, g, h, k, m, o, r, u.**
American Machine & Foundry Co., Government Products, N. Y

***ARNOUX CORP., d, l.**
Atlantic Research Corp.
Automatic Timing & Controls, Inc., **d, m, q, r, u.**
Automation Products, Inc., **h.**
Avien, Inc., **f, h, j, l.**
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., **c, m, o, q, s.**
Bendix Aviation Corp., **f, h, l.**
Bendix Aviation Corp.-Montrose Div., **c, e, g, i, k, m, s.**
Bergen Labs., Inc., **s.**
A. Biederman, Inc., **a, c, e thru n, p, s, u.**
Binks Mfg. Co., **a.**
Breeze Corporations, Inc., **o.**
***BRISTOL CO., THE, a, c, g, h, m, p, u.**
Brown & Sharpe Mfg. Co., **r.**
Budd Co., The, **b,c, g, h, m, o, q, r.**
Bulova Research & Development Labs., Inc., **s.**
Bytrex Corp., **o, q, s.**
Central Electronic Mfrs., Div.-Nuclear Corp. of America, **u.**
Central Scientific Co., **u.**
Cincinnati Milling Machine Co., The, **a, g, r.**
Circo Equipment Co., **t.**
Circo Ultrasonic Corp., **t.**
Cleveland Instrument Co., **d, r.**
G. L. Collins Corp., **d.**
Conoflow Corp., **a, h, m.**
Consolidated Airborne Systems, Inc., **f, h, j.**
Consolidated Controls Corp., **a, c, e, g, j, k, m, p, s, u.**

***CONSOLIDATED ELECTRODYNAMICS CORP., c, d, m, o, u.**
Consolidated Vacuum Corp., **u.**
Continental Electric Co., **u.**
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **a.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **a, k, s.**
Crescent Engrg. & Research Co., **c, d, e, r.**
Custom Component Switches Inc., **a, c, e, g, i, k, m, u.**
Daystrom Inc., Pacific Div., **a, c, e, g, i, k, m.**
Daystrom Inc., Weston Instruments Div., **m, p, r.**
Daytronic Corp., **d, o, q, r, s.**
Decker Corp., The, **a, c, f, h, j, m, r, u.**
Delsen Corp., **r.**
De Vilbiss Co., The, **a.**
Diamond Power Specialty Corp., **h.**
J. W. Dice Co., **r.**
Dill Mfg. Co., The, **a.**
W. C. Dillon & Co., Inc., **q, s.**
Djeco, Div.-Djordjevic Engrg. Co., **r.**
Dumont Engrg. Co., **h.**
Dynisco, Inc., **a, b, c, g, m, o, q.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **e, g, i, k, l, m, s.**
Edwards High Vacuum Ltd., **m, u.**
Eitel-McCullough, Inc., **u.**
Electric Autolite Co., The, **a, g, k, l, m, u.**
Ellison Draft Gage Co., Inc., **a, c, m, p.**
Endevco Corp., **m.**
Erdco Engrg. Corp., **b, c, d, m, q.**
Falcon Machine & Tool Co., **o, s.**
Federal Products Corp., **r.**
Fisher Scientific Co., **h, u.**
Fisher Scientific Co., Maryland, **u.**
Fleetwood Labs., Inc., **r.**
Fonda Gage Co., Inc.
Frick Co., **m**
Friez Instrument Div., Bendix Aviation Corp., **e, g, i, k, s.**
Garwin, Inc., **c, e, g, i, k, l, p, u.**
General Controls Co., **a, l, m.**
General Electric Co., Apparatus Sales Div., **m, o, q, r, u.**
General Electric Co., X-Ray Dept., **h, r.**
General Kinetics Inc., **m, q.**
Paul E. Gerst & Co.
Gilmore Industries, Inc., **o.**
Gits Brothers Mfg. Co., **a, j.**
Glassco Instrument Co., **a, c, e, g, i, k, m, p, u.**
Great Lakes Mfg. Corp., **a, e, g.**
Sutton Industries Inc., **c, m.**
Hagan Chemicals & Controls Inc., **c.**
George P. Harris & Co. Inc., **c.**
Haskel Engrg. & Supply Co., **a, g, s.**
Helicoid Gage Div., American Chain & Cable Co., Inc., **a, e, g, h, k, m, p, u.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products Inc., **u.**
E. Vernon Hill & Co., **a, i, m, u.**
Hoke Inc., **a, e, g, i, k, m.**
Hunter Spring Co., Div. American Machine & Metals, Inc., **q.**
Illinois Testing Laboratories, Inc., **l.**
Imtra Corp., **q.**
Inferno Mfg. Corp., **h.**
Instrument Div., The Budd Co., **b, o, q, s.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **h, n.**
Wayne Kerr Corp., **d, r.**
Kieley & Mueller, Inc., **d, h.**
Kistler Instrument Corp., **b, g, i, m.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **a, c, e, i, m, p.**
Lear, Inc., **h, j, o.**
***WALLACE O. LEONARD, INC., a, c, e, g, h, m, u.**
Lewis Engrg. Co., The, **i.**
Liquidometer Corp., The, **f, h, j, n.**
MSA Research Corp., **m.**
Magnaflux Corp., Sub.-General Mills Inc., **t.**
Magnetic Instrument Co. Inc., **h.**
Marsh Instrument Co., Div. Colorado Oil & Gas Corp., **a, e, g, i, k, m, p, u.**
***MARTIN CO., THE, DENVER DIV., o, q, s.**
Martin-Decker Corp., **a, g, k, m, q, u.**
Mead Specialties Co., Inc., **a.**
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., **f, h, j.**
C. A. Morgren Co., **a.**
Muirhead Instruments Inc., **q, r.**
Narco Ultrasonics Corp., The, **h.**
National Ultrasonic Corp., **t.**
Newton Hydraulic Tooling Co., **g.**
Nuclear Corp. of America, **h, u.**
Nuclear Development Corp. of America, **h.**
Oil-Rite Corp., **h, j.**
Overload Control Co., **s.**
Oxygen Equipment & Service Co., **u.**
Pacific Scientific Co., **q.**
Pennsylvania Tool & Mfg. Co., The
Philips Electronic Instruments, **r.**
Photocon Research Products, **c, d, t.**
Pioneer Industries Div., Almar-York Co. Inc., **r, t.**
Wm. Powell Co., The, **h.**
Puritan Aerospace Div.-Puritan Compressed Gas Corp.
Rahm Instruments Div.-American Machine & Metals, **a, c, e thru n.**
Recony Div.-Vinco Corp.
Republic Mfg. Co., **h, j.**
Research Indsl. Lab. of Electronics, **u.**
Resitron Labs., Inc., **u.**
Revere Corp. of America, Sub., Neptune Meter Co., **f, h, j.**
Rochester Mfg. Co. Inc., **a, e thru n.**
Rochester Mfg. Co. Inc. of Calif., **a, e thru h, j thru n, p, u.**
Ronan & Kunzl, Inc., **h, u.**
Milton Roy Co., **h.**
Rucker Co., The, **j.**
Schaevitz Engrg., **b thru e, g, k, m, q, r, s.**
Scientific Engrg. Labs., Inc., **u.**
Scott Aviation Corp., **a, k, l, m.**
Servomechanisms, Inc., **a, c, h, m.**
Sierra Electronic Corp., Div.-Philco Corp., **u.**
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., **f, h, j.**
Simmonds Aerocessories, Inc., **a, e thru h, j, k, m, n.**
Skidmore-Wilhelm Mfg. Co., **q, s.**
Southwest Research Institute, **a, d, e, f, h thru m, o, r, t.**
Space Corp., **h, s.**
Sperry Products Co., Div.-Howe Sound Co., **t.**
Squiers Gage Co., **n, o.**
Statham Instruments, Inc., **a thru e, g, k, m, o, p, q, u.**
Stewart-Warner Corp., Alemite Div., **a, u.**
F. J. Stokes Corp., **u.**
Superior Pneumatic & Mfg., Inc., **a.**

Taft-Peirce Mfg. Co., The, **d.**
Technical Development Co., **h, j.**
Technology Instrument Corp., **a, c, d.**
Technoproducts, Inc., **m.**
Telechrome Mfg. Corp., **d, e, o, q.**
Texas Instruments Inc., **h.**
Tracerlab Inc., **h.**
Trans-Sonics, Inc., **h, m, o, u.**
Trimount Instrument Co., **h.**
Uehling Instrument Co., **a, c, f, h, j, m, p, u.**
Unit Process Assemblies, Inc., **r.**
Vacuum Specialties Co., Inc., **u.**
Vacuum Tube Products, Div.-Hughes Aircraft Co., **u.**
Veeco Vacuum Corp., **a, i, u.**
Wallace & Tiernan Inc., **m.**
Waters Mfg., Inc., **s.**
Weksler Instruments Corp., **a, b, c, e, g, i, k, l, m, u.**
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., **u.**
Wells Industries Corp., **h.**
Westinghouse Electric Corp., **t.**
Zep Aero

GAUSSMETERS

R. B. Annis Co.
Epic Inc
General Electric Co., Apparatus Sales Div
Keithley Instruments, Inc
Kollsman Instrument Corp., Sub.-Standard Coil Products Co Inc
Rawson Electrical Instrument Co
Sensitive Research Instrument Corp.
Sunshine Scientific Instrument

GEAR ASSEMBLIES REDUCTION

Advance Instrument Corp.
Aircraft Accessory Turbine Dept.-General Electric Co
Allison Div., General Motors Corp.
Arch Gear Works Inc
Belock Instrument Corp
Bendix Aviation Corp
Bendix Utica Div., Bendix Aviation Corp.
A. Biederman, Inc
Bowmar Instrument Corp
Bristol Instrument Gears, Inc.
A. M. Byers Co
Caterpillar Tractor Co., Defense Products Dept
Clark Equipment Co.
Croname Inc
Dalmo Victor Co., Div.-Textron, Inc
Dana Corp
Joe Davidson & Associates
***DEL MAR ENGRG. LABS.**
Dodge Mfg. Corp
Dynamic Gear Co., Inc.
Elgin Micronics, West Coast Div.-Elgin National Watch Co
Exact Engrg. & Mfg. Inc.
FAE Instrument Corp
Feedback Controls, Inc.
Fenn Mfg. Co., The
Florida Gears & Systems, Inc
Ford Instrument Co., Div.-Sperry Rand Corp.
Franke Gear Works, Inc
Gear Specialties, Inc.
General Aniline & Film Corp., Ansco Div.
General Mills, Inc
Graflex Inc.
Guidance Controls Corp
Hamilton Watch Co., Military Products Div.
Hoover Electric Co
ITE Circuit Breaker Co., Special Products Div.
Indiana Gear Works, Inc
Industrial Control Co
Insco Co.,-Div.-Barry Controls Inc.
Instru-Lec Corp
Jack & Heintz, Inc
Jan Hardware Mfg. Co., Inc.
Juall Gear Co., Inc
Lear, Inc.
Leemath Inc.
Link-Belt Co
Lycoming Div., Avco Corp.
McGregor Mfg. Corp
Metron Instrument Co.
Micron Gear Co., Inc.
National Pneumatic Co., Inc., Holtzer-Cabot Divs.
Piasecki Aircraft Corp
Precision Gears & Products, Inc
Rae Motor Corp
Rampe Mfg. Co
Reeves Instrument Corp
Research Development Mfg. Inc.
Sargent Engrg. Corp
Sier-Bath Gear & Pump Co., Inc.
Southwestern Industries Inc
Spiroid Div., Illinois Tool Works
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Sundstrand Turbo
Talley Corp., The
Transicoil Div.-Daystrom Inc.
U. S. Gear Corp.
U. S. Industries, Inc.
Vickers, Inc., Mich.
Victor Tool & Mfg., Inc.
Vinco Corp.
Waste King Corp., Technical Products Div.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.

GEARS, POWDERED METAL

Bergen Carbide Co.
Daystrom, Inc., Military Electronics Div.
Eaton Mfg. Co.
Keystone Carbon Co.
Kwikset Powdered Metal Products
Lear, Inc
Sier-Bath Gear & Pump Co., Inc.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.

GEARS, PRECISION

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
Aero Mfg. & Mach. Co., Inc
Aircraft Accessory Turbine Dept.-General Electric Co
Allied Products Corp.
Allison Div., General Motors Corp.
Arch Gear Works Inc.
Atlas Precision Products Co.
Beaver Gearworks, Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bergen Carbide Co.
A. Biederman, Inc
Boston Gear Works
Bristol Instrument Gears, Inc.
A. M. Byers Co.
Camdale Precision, Inc.
Clark Equipment Co
Commercial Shearing & Stamping Co.
Dalmo Victor Co., Div.-Textron, Inc.
Dana Corp
Joe Davidson & Associates
Daystrom, Inc., Military Electronics Div.
Daystrom Inc., Transicoil Div
Dynamic Gear Co., Inc.
Eastman Kodak Co
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co
Elgin Micronics, West Coast Div.-Elgin National Watch Co
Exact Engrg. & Mfg. In
FAE Instrument Corp
Feedback Controls, Inc.
Fenn Mfg. Co., The
Florida Gears & Systems, Inc
Ford Instrument Co., Div.-Sperry Rand Corp.
Franke Gear Works, Inc
Gap Instrument Corp.
Gear Specialties, Inc.
General Aniline & Film Corp., Ansco Div.
General Electric Co., Apparatus Sales Div.
General Mills, Inc.
Gleason Works
Gordon Enterprises
Graflex Inc.
Grant Gear Works, Inc.
Guidance Controls Corp.
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div
Hoover Electric Co.
Hupp Aviation Div.-Hupp Corp.
ITE Circuit Breaker Co., Special Products Div.
Indiana Gear Works, Inc.
Industrial Control Co.
Instru-Lec Corp
Juall Gear Co., Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kelsey-Hayes Co
Kollsman Instrument Corp., Sub.-Standard Coil Products Co Inc.
La Vezzi Machine Works
Lear, Inc
Leemath Inc.
Link-Belt Co
Lycoming Div., Avco Corp.
Massachusetts Gear Div.-Geartronics Corp.
W. L. Maxson Corp., The
Micron Gear Co., Inc.
W. H. Nichols Co
Precision Gears & Products, Inc.
Recony Div.-Vinco Corp.
Reeves Instrument Corp
Research Development Mfg. Inc.
Sargent Engrg. Corp.
Servomechanisms, Inc.
Sier-Bath Gear & Pump Co., Inc.
Spiroid Div., Illinois Tool Works
Herman D. Steel Co.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Sundstrand Turbo
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Telechrome Mfg. Corp.
Thompson Ramo Wooldridge Inc.
U. S. Gear Corp.
U. S. Industries, Inc.
Vickers, Inc., Mich.
Vinco Corp.
Waterbury Companies, Inc.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.

GEARS, RADIO & INSTRUMENT

Arch Gear Works Inc.
Beaver Gearworks, Inc.
Bristol Instrument Gears, Inc.
Camdale Precision, Inc
Dalmo Victor Co., Div.-Textron, Inc
Daystrom, Inc., Military Electronics Div.
Dynamic Gear Co., Inc.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
FAE Instrument Corp.
Florida Gears & Systems, Inc.
Frank Gear Works, Inc.
General Aniline & Film Corp., Ansco Div.
General Mills, Inc.
Gleason Works
Graflex Inc.
Gries Reproducer Corp.
Hamilton Watch Co., Military Products Div.
Indiana Gear Works, Inc.
Instru-Lec Corp.
Juall Gear Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc
La Vezzi Machine Works
Lear, Inc.
Massachusetts Gear Div.-Geartronics Corp.
Micron Gear Co., Inc.
Reeves Instrument Corp.
Research Development Mfg. Inc.
Spiroid Div., Illinois Tool Works
U. S. Gear Corp.
Vinco Corp.
Waterbury Companies, Inc.
Western Gear Corp.-Precision Products Div.

GENERATORS

a. Electric AC
b. Electric DC
c. Engine Driven
d. Liquid Oxygen
e. Liquid Oxygen, Mobile
f. Plasma
g. Sequence Indicators for Three Phase
h. Tachometer
i. Timing Marker

***AEROJET-GENERAL CORP., a, b.**
Aeronca Mfg. Corp.-Aerospace Div., **h.**
Air Products, Inc., **d, e.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **a, b, c.**
***AiRESEARCH MFG. OF ARIZONA, a, b, c.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, c.**
Allied International Corp., **a, b, c.**
Allis-Chalmers, **a, b, c.**
Allison Div., General Motors Corp., **a, b, c.**
American Machine & Foundry Co., Government Products Group, **h.**
Avco Corp.-Research & Advanced Development Div., **f.**
Barber-Colman Co., **h.**
Beckman Instruments, Inc., Berkeley Div., **h.**
Beech Aircraft Corp., **c.**
Bendix Aviation Corp., **a, b, c, h.**
Bendix Aviation Corp.-Montrose Div., **h.**
Bogue Electric Mfg. Co., **a, b, c, h.**
Breeze Corporations, Inc., **b.**
Brunswick Instruments, **g.**
Carson Mach & Supply Co., **a, c.**
Caterpillar Tractor Co., Defense Products Dept., **c.**
Caterpillar Tractor Co., Engine Div., **a.**
Caterpillar Tractor Co., Industrial Engine Plant, **a.**
Columbia Electric Mfg. Co., **a, b.**
Communication Measurements Lab., Inc., **a.**
Consolidated Diesel Electric Corp., **a, b, c.**
Cosmic Instruments Inc., **a, b.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **h.**
Curtiss-Wright Corp., Santa Barbara Div., **c.**
Davenport Mfg. Co., **g.**
Joe Davidson & Associates, **a, b, c, h.**
Daystrom Inc., Transicoil Div., **a, h.**

Daystrom Inc., Weston Instruments Div., **h.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **a.**
Delco Products Div.-General Motors Corp., **a, b.**
Detroit Diesel Engine Div.-General Motors Corp., **a, b, c.**
Diehl Mfg. Co., **a, b, h.**
Eicor Div.-Scranton, **a, b, c, h.**
Electric Autolite Co., The, **b, c.**
Electric Indicator Co. Inc., **a, b, h.**
Electric Machinery Mfg. Co., **a, c.**
Epic, Inc., **h.**
Eureka Williams Corp., **a, b.**
Ford Instrument Co., Div.-Sperry Rand Corp., **h.**
Garwin, Inc., **b, h.**
General Electric Co., Apparatus Sales Div., **a, b, h.**
Genisco, Inc., **a.**
Georator Corp., **a, b, c, h.**
Paul E. Gerst & Co., **a, b, c.**
Gordon Enterprises, **i.**
Gremco, Inc., **c.**
Hammett-Mercury-Rex Div., **a, b, c.**
Hanson-Van Winkle-Munning Co., **b.**
George E. Harris & Co., Inc., **a, h.**
A. W. Haydon Co., The, **h.**
Hertner Electric Co., The, **a, b.**
Hewlett-Packard Co., **h.**
High Voltage Engrg. Corp., **f.**
Hobart Brothers Co., **a, b.**
Hol-Gar Mfg. Corp., **a, b, c.**
Holtzer-Cabot Div., National Pneumatic Co., Inc., **a, b, h.**
Homelite, Div.-Textron Inc., **a, b, c.**
Hoover Electric Co., **a, b, c.**
William I. Horlick Co., Inc., **a, b.**
I-L-S Instrument Div., The Meriam Instrument Co., **h.**
IMC Magnetic Corp., **h.**
Induction Heating Corp., **a.**
***INTERELECTRONICS CORP., a, b.**
International Fermont Machinery Co., Inc., **c.**
Jack & Heintz, Inc., **a, b, c, h.**
Jeta, Inc., **a, c.**
Kato Engrg. Co., **a, b, c.**
Katolight Corp., **a, b, c.**
***KEARFOTT DIV., GENERAL PRECISION, INC., h.**
Ketay Dept., Norden Div., United Aircraft Corp., **h.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **h.**
Leach Corp., **a, b, c.**
Lear, Inc., **a, b, c, f.**
Leece-Neville Co., The, **a, b, c.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **a, b, c.**
Lincoln Electric Co., The, **a, b, c.**
Linde Co., Div.-Union Carbide Corp., **d, e.**
Motor Generator Corp., **a, b, c.**
Motordyne Inc., **a, b, h.**
Motoresearch Co., **a, b, c.**
Heinz Mueller Eng. Co. Inc., **a, b.**
Muirhead Instruments Inc., **h.**
National Pneumatic Co., Inc., Holtzer-Cabot Divs., **a, b, h.**
Navigation Computer Corp.
Northwestern Electric Co., **a, b.**
D. W. Onan & Sons Inc., **a, b, c.**
Orbitron Co., Inc., **i.**
John Oster Mfg. Co., Avionic Div., **a, h.**
Otis Elevator Co., Defense & Industrial Div., **a, b.**
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y., **h.**
Patterson Moos Research, Div.-Leesona Corp., **b.**
Pesco Products Div.-Borg-Warner Corp., **a, b, c.**
Pesco Products Div., Borg-Warner Corp., Calif., **a, b.**
Philco Corp.-Govt. & Industrial Group, **i.**
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp., **c.**
Pryor Mfg. Co., **e.**
Radalab Inc., **a.**
***RADIO CORP. OF AMERICA, f.**
Radio Development & Research Corp., **a, b, c, h.**
Ready-Power Co., The, **c.**
Reliance Electric & Engrg. Co., **a, b.**
S & G Mfg. Corp., **c.**
Safety Electrical Equipment Corp., **a, b.**
Sangamo Electric Co., **a, b, c.**
Servomechanisms, Inc., **h.**
Servo-Tek Products Co., **b, h.**
Small Motors Inc., **a, b, h.**
Solar Aircraft Co., **c.**
Standard Steel Corp., Cambridge Div., **d, e.**
Stewart & Stevenson Services, Inc., **a, b, c.**
Herman H. Sticht Co., Inc., **h.**
Stromberg-Carlson Div.-General Dynamics Corp., **i.**
Summers Gyroscope Co., **h.**
Sunshine Scientific Instrument, **g.**
Superior Air Products Co., **d.**
TKM Electric Corp., **a, b.**
Talley Corp., The, **a, b, c, h.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, h.**
Telectro Industries Corp., **a, i.**
Thompson Ramo Wooldridge Inc., **a, b, h.**
Transicoil Div.-Daystrom Inc., **h.**
Varo Mfg. Co., Inc., **a, b, c, g, h, i.**
Wacline, Inc., **h.**
Wang Labs., Inc., **i.**
Westinghouse Electric Corp., **a, b, c, f.**
Wincharger Corp., Sub.-Zenith Radio Corp., **a, c.**
Winpower Mfg. Co., **a, b, c.**
Wolverine Diesel Power Co., **c.**
Worthington Corp., **a, b, c.**

GENERATORS, ELECTRONIC

a. Microwave
b. Noise
c. Picture Signal
d. Pulse
e. Signal, AF
f. Signal, FM
g. Signal, RF
h. Signal, SHF
i. Signal, Single Sideband
j. Signal, Sweep
k. Signal, Television Synchronizing
l. Signal, UHF, VHF
m. Square Wave
n. Ultrasonic
o. Variable Frequency
p. Waveform

A.R.F. Products, Inc., **d.**
Admiral Corp., **d.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **b.**
Aircom Inc., **a.**
***AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP., o.**
Alcar Instruments, Inc., **n.**
Alfred Electronics, **a, d, j.**
Alto Scientific Co., Inc., **d, m.**
Amerac Inc., **a.**
American Electronic Labs., Inc., **d, m.**
Arkay Engrg., Inc., **d, m, o.**
Avco Corp.-Research & Advanced Development Div., **b.**
B & K Instruments, Inc., **e.**
Babcock Radio Engrg., Inc., **f.**
E. Bauches S. A., Freeport Engrg. Co.,
Beckman-Systems Div.
Bendix Aviation Corp., **n.**
Bendix Aviation Corp., Cincinnati Div., **f, g, j.**
Bendix Aviation Corp., Pioneer-Central Div., **n.**
Blackstone Corp., **n.**
Bogue Electric Mfg. Co., **o.**
Boonton Radio Corp., **e, f, j.**
Bruno-New York Industries Corp., **g, h, l, p.**
Budd Lewyt Electronics, Inc., **e, f, j.**
Burr-Brown Research Corp., **e, m, n.**
CBS Laboratories, Div.-Columbia Broadcasting System, **c, l.**
CGS Labs., Inc., **h, j, l, o.**
Carol Electronics Corp., **e, o.**
Chalco Engrg. Corp., **e, o.**
Chance Vought Aircraft, Inc., **d.**
Circo Equipment Co., **n.**
Circo Ultrasonic Corp., **n.**
Clegg Labs., Div.-Clegg, Inc., **a, b, d, g, i, j, m, o, p.**
Clevite Ordnance, Div.-Clevite Corp., **e, n.**
Collins Radio Co., **a, f, g, i, l.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., a, g, n.**
Communication Measurements Lab., Inc., **e, n, o.**
Crosby-Teletronics Corp., **d, i.**
Cubic Corp., **p.**
Curtiss-Wright Corp., Santa Barbara Div., **n.**
Dage Television Div., Thompson Ramo Wooldridge, Inc., **c, k.**
Data-Control Systems, Inc., **f.**
Daven Co., The, **d, g, m.**
Joe Davidson & Associates, **a, d, m, n, o.**
***DEL MAR ENGRG. LABS., j.**
Demornay-Bonardi, **b.**
Detrex Chemical Industries, Inc., **n.**
Djeco, Div.-Djordjevic Engrg. Co., **d, m.**
Allen B. Du Mont Labs., Inc., **d.**
Edgerton, Germeshausen & Grier, Inc., **d.**
Eitel-McCullough, Inc., **a.**
Electrical & Physical Instrument Corp., **d.**
Electronic Applications, Inc., **a, b, e thru h, j, l, o.**
Electronic Measurements Corp., **e, g, o.**
Electronic Tube Corp., **d.**
Electronics of Clearfield, Inc., **d, j.**
Electron-Radar Products, **b.**
Electro-Pulse, Inc., **d, o.**
Elgenco, Inc., **b.**
Elin Div., International Electronic Research Corp., **e.**
Empire Products Sales Corp., **a, b, d, g, l, o.**
Ensco, Inc., **d, e, p.**
***EQUIPMENT DIV., RAYTHEON CO., a, b, d, n.**
FXR, Inc., **a, d.**
Fla. Aircraft Radio & Marine, **e, f, g, l.**
Flight Research, Inc., **d.**
Flow Corp., **b.**
Gates Radio Co., **b, i.**
General Aniline & Film Corp., Ansco Div., **a.**
General Communication Co., **a, d, g, m, o.**
General Instrument Corp., Defense & Engrg. Products Group, **j, n.**
General Radio Co., **a, b, d, e, g, j, l thru o.**
Guided Missile Div., The Firestone Tire & Rubber Co., **b.**
Gulton Industries, Inc., **n.**
Hallamore Electronics Co., Div.-Siegler Corp., **k.**
Hallicrafters Co., The, **a, g.**
Hammett-Mercury-Rex Div., **a.**
Hathaway Instruments, Inc., **d, m.**
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co., **a, b, d thru h, j, l thru p.**
Hickok Electrical Instrument Co., The, **c thru g, j thru m, o, p.**
William I. Horlick Co., Inc., **a.**
I-L-S Instrument Div., The Meriam Instrument Co., **d, o.**
Iconix Inc., **d.**
Image Instruments, Inc., **c.**
Industrial Acoustics Co., Inc., **b.**
Industrial Control Co., **j.**
Industrial Test Equipment Co., **e, o.**
Instrument Div., The W. L. Maxson Corp., **i.**
Instruments for Industry, Inc., **g, l, o.**
Intercontinental Dynamics Corp., **b.**
***INTERELECTRONICS CORP., e, m thru p.**
International Electronic Research Corp., **e.**
J-V-M Microwave Co., **a, g.**
James Electronics Inc., **m.**
Kato Engrg. Co., **o.**
Kay Electric Co., **a thru g, j, l thru o.**
Wayne Kerr Corp., **e.**
Kollmorgen Optical Corp., **a, b.**
Lab. for Electronics, Inc., **a.**
Lampkin Labs., Inc., M.R. Div., **g, l, o.**
Lavoie Labs., Inc., **d.**
Lear, Inc., **b, e.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **m.**
Levinthal Electronic Products, Inc., **a, d.**
Litton Industries, Inc., **a, b.**
MB Electronics, **b, o, p.**
Manson Labs., Inc., **a, d, g, l, o.**
Marconi Instruments, **b, d thru j, l thru p.**
***MARTIN CO., THE, DENVER DIV., d thru g, i thru m, o.**
Mc Kenna Labs., **n.**
Micro Gee Products, Inc., **o.**
Microwave Associates, Inc., **a.**
Motorola, Inc., **a thru p.**
Muirhead Instruments Inc., **e, m, n, o.**
Narda Ultrasonics Corp., The, **n.**
National Co., Inc., **a, d thru i, l, o.**
National Ultrasonic Corp., **n.**
Navigation Computer Corp., **d.**
New London Instrument Co. Inc., **f, g, l, m, o.**
Northeast Scientific Corp., **a.**
Orbitron Co., Inc., **d.**
Otis Elevator Co., Defense & Industrial Div., **n.**
Paco Electronics Co., Inc., **e, f, g, j thru m.**
Panoramic Radio Products, Inc., **e, g, j, o.**
Parabam, Inc., **d, m, o, p.**
Philamon Labs. Inc., **e.**
Philco Corp.-Govt. & Industrial Group, **a thru p.**
Phillips Mfg. Co., **n.**
Piasecki Aircraft Corp., **a, e thru h, n, o.**
Pitometer Log Corp., **a.**
Polarad Electronics Corp., **a, b, d, j.**
Probescope Co. Inc., **j.**
RS Electronics Corp., **b.**
Radalab Inc., **a, b, e thru h, j, l, o.**
Radiation, Inc., **d.**
Radiation Instrument Development Lab., Inc., **d.**
Radio City Products Co. Inc., **e thru h, l.**
***RADIO CORP. OF AMERICA, a thru p.**
Radio Development & Research Corp., **n, o, p.**
Radio Frequency Co., Inc., **n.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **j.**
Rantec Corp., **a, i.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., b.**
Reeves Instrument Corp., **b, p.**
Reflectone Electronics, Inc., **d.**
Resdel Engrg. Corp., **a, l.**
Rese Engrg., Inc., **d.**
Research, Inc., **b.**
Rutherford Electronics Co., **d.**
Scientific-Atlanta, Inc., **a, g, j, l, o.**
H. H. Scott, Inc., **b.**
Servo Consultants Ltd., **e, f, g.**
Sierra Electronic Corp., Div.-Philco Corp., **a, f, g, l, o.**
Simpson Electric Co., **d, f, g, j, l, o.**
Southwest Research Institute, **n.**
Southwestern Industrial Electronics Co., **m, o.**
Specialty Electronics Development Corp., **a, d, g.**

Spectralab Instruments, **g, l.**
Spectrum Instruments Inc., **o, p.**
Spencer-Kennedy Labs., Inc., **d.**
Sperry Electronic Tube Div., Sperry Rand Corp., **a.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **a.**
Stewart-Warner Electronics Div., **a, d.**
Stillman Rubber Co., **d.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, d, f, g, i, l, o.**
Superior Electric Co., The, **d, g, o.**
Systems Incorporated, **e, f, l.**
TRG, Inc., **a, b.**
Talley Corp., The, **d thru g, l.**
Tektronix, Inc., **d, g, m, p.**
Telechrome Mfg. Corp., **a, b, c, k, l, o, p.**
Telectro Industries Corp., **a, b, d thru j, m.**
Telerad Mfg. Corp., **a.**
Television Utilities Corp., **c, k.**
Tel-Instrument Electronics Corp., **c, g, j, k, l, o.**
Telkor Inc., **m, o.**
Telonic Industries Inc., **a, c thru h, j, l, o.**
Ultrasonic Engineering Co., **n, o.**
Universal Transistor Products Corp., **d, m, p.**
Valor Instruments Inc., **d, m.**
Varo Mfg. Co. Inc., **b, d, e, m, o, p.**
Vicon Corp. Sub.-Insul-8-Corp., **k.**
Walkirt Co., **d, m**
Waltham Electronics Corp., **f, g, l, o.**
Wang Labs., Inc., **c, d, p.**
Waveline Inc., **b.**
Westinghouse Electric Corp., **a, b, e, f, i, l, n.**
Wheelock Signals Inc., **d.**
Wickes Engrg. & Construction Co., **g, k.**

GEOPHYSICAL APPARATUS

***ASKANIA-WERKE, U. S. BRANCH OFFICE**
Autometric Corp.
Bali Brothers Research Corp.
Benson-Lehner Corp.
Century Electronics & Instruments Inc.
Daimc Victor Co., Div.-Textron, Inc.
Georator Corp.
Gordon Enterprises
Guidea Missile Div., The Firestone Tire & Rubber Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Optomechanisms Inc.
Packard Bell Computer Corp.
Seiscor Div.-Seismograph Service Corp.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Spectra Electronics Corp.
Texas Instruments Inc.
Triad Transformer Corp.
Vector Mfg. Co.
Wang Labs, Inc.

GERMANIUM

Allegheny Electronic Chemicals Co.
Allied Chemical Corp., General Chemical Div.
Alloys Unlimited Inc.
American Smelting & Refining Co.
Belmont Smelting & Refining Works Inc.
Bios Labs, Inc.
Bram Metallurgical Chemical Co.
City Chemical Corp.
Delta Chemical Works Inc.
Eagle-Picher Co., The
Harmon, Lichtenstein & Co.
Republic Lens Co., Inc.
Santa Barbara Research Center
Semi-Elements, Inc.
Semimetals, Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

GLASS INSULATION

Actioncraft Products
Allied Plastics Supply Corp.
Semon Bache & Co.
Birma Mfg. Co., Inc.
William Brand Rex Div.-American Enka Corp.
Corning Glass Works
Deutsch Co., The Electronic Components Div.
Insulation Mfrs. Corp.
Lamtex Industries Inc.
Mechanical Felt & Textiles Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Mitronics Inc.
Natvar Corp.
Owens-Corning Fiberglas Corp.
Pittsburgh Corning Corp.
Plastic Age Sales Inc.
Saletee Glass Co.
Seaman Products Div.-Seaman Paper Co.
F. M. Stevenson Co., Inc.
H. I. Thompson Fiber Glass Co.
Westinghouse Electric Corp., Micarta Div.

GLASS, MICA-WOVEN OR LAMINATED

Allied Plastics Supply Corp.
Asheville-Schoonmaker Mica Co.
Semon Bache & Co.
Brunswick Balke Collender Co., The, Defense Products Div.
Continental Diamond Fibre Corp.
Insulation Mfrs. Corp.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
Pacific Universal Products Corp.
Saletee Glass Co.
Sierracin Corp., The
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micarta Div.

GOLD

Accurate Specialties Co. Inc.
Allied Engraving & Stamping Co.
Alloys Unlimited Inc.
Alpha Metals Inc.
American Silver Co., Inc.
American Smelting & Refining Co.
Attleboro Refining Co., Inc.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
Sigmund Cohn Corp.
Delta Chemical Works, Inc.
Deringer Metallurgical Corp.
Eastern Smelting & Refining Corp.
Engelhard Industries, Inc.
Goldsmith Bros. Div., National Lead Co.
Handy & Harman
Leach & Garner Co., Indsl. Div.
Metz Refining Co.
Secon Metals Corp.
Technic Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Western Gold & Platinum Co.

GOVERNORS, MISSILE CONTROL

Avco Corp., Crosley Div.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Holley Carburetor Co.
Integrated Dynamics Div., Globe Industries, Inc.
Republic Aviation Corp., Missile Systems Div.
Varo Mfg. Co. Inc.
Vickers, Inc., Mich.

GRAPHITE, COLLOIDAL

Acheson Colloids Co., Div.-Acheson Industries, Inc.
Grafo Colloids Corp.
Kano Labs.
Superior Graphite Co.

GRAPHITE, INSULATING

Custom Tool & Mfg. Co.
General Electric Co., Rocket Engine Section
Great Lakes Carbon Corp.-Electrode Div.
Hughes Tool Co., Aircraft Div.
National Carbon Co., Div.-Union Carbide Corp.
Olympic Plastics Co., Inc.
Pittsburgh Corning Corp.
Portland Copper & Tank Works Inc.
Southwest Research Institute
Speer Carbon Co.
Superior Graphite Co.

GRAPHITE, LUBRICATING

Acheson Colloids Co., Div.-Acheson Industries, Inc.
American Potash & Chemical Corp., National Northern Div.
Blaco Mfg. Co.
Grafo Colloids Corp.
National Carbon Co., Div.-Union Carbide Corp.
Superior Graphite Co.
United States Graphite Co., The, Div.-The Wickes Corp.

GREASES, VACUUM

***CONSOLIDATED ELECTRODYNAMICS CORP.**
Dow Corning Corp.
Esso Standard, Div.-Humble Oil & Refining Co.
Fluoro-Chem Corp.
Halocarbon Products Corp.
Lockrey Co., The, Lubricants Div.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Standard Oil Co. of Indiana

GRID FRAMES

California Plasteck Inc.
Fansteel Metallurgical Corp.
Fouch Electric Mfg. Co., Inc.
Rimak, Inc.
Thermionic Products Co.

GRIDS

Allegany Instrument Co., Inc.
Calcor Corp.
Emeloid Co., Inc., The
Fansteel Metallurgical Corp.
***RADIO CORP. OF AMERICA**
Thermionic Products Co.

GRILLES, METAL

Alpitec, Inc.
Anchor Metal Spinning Co., The
Bell Aircraft Corp., Niagara Frontier Div.
Belmar Wheel & Machine Co., Inc.
Bohn Aluminum & Brass Corp.
Brooks & Perkins, Inc.
Bud Radio, Inc.
A. M. Byers Co.
California Stamping & Mfg. Co.
Chemical Micro Milling Co.
Cronome Inc.
Farwell Metal Fabricating
Fouch Electric Mfg. Co., Inc.
G-C Electronics Co.
Kentucky Metal Products Co.
Kling Metal Spinning & Stamping Co.
Lofstrand Co., The
***MARTIN CO., THE, DENVER DIV.**
Olin Mathieson Chemical Corp., N. Y.
Parkway Specialties Co.
Penn Metal Co., Inc.
Pioneer Industries Div., Almar-York Co. Inc.
Premier Metal Products Co.
Rimak, Inc.
Rolock Inc.
Unified Industries, Inc.
Victor Tool & Mfg., Inc.

GRILLES, MOLDED PLASTIC

American Insulator Corp.
Brook Molding Corp.
Dura Plastics of N. Y., Inc.
Erie Resistor Corp.
General American Transportation Corp.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
M & Q Plastic Products
Olympic Plastics Co. Inc.
Parsons Corp., Special Products Div.
Remler Co.
Milton Ross Metals Co., The
Sillcocks-Miller Co.
U. S. Plastic Molding Corp.
Waterbury Companies, Inc.

GRILLS, SPEAKER

Belmar Wheel & Machine Co., Inc.
Bestcraft Products Co. Inc.
Bud Radio, Inc.
Cronome Inc.
Du Kane Corp.
Flock Process Co. Inc.
Kendall Co., The
Kentucky Metal Products Co.
Parkway Specialties Co.
Premier Metal Products Co.
Remler Co.
Unified Industries, Inc.

GROMMETS

A. P. M. Corp.
Abbott Screw & Mfg. Co.
Aero Spares, Inc.
All Specs Corp.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Brass Co., The
Best Aircraft Corp.
A. M. Byers Co.
Chase Brass & Copper Co., Inc.
Continental Rubber Works
Deutsch Co., The, Electronic Components Div.
Federal Screw Products Inc.
Fluorocarbon Co., The
G-C Electronics Co.
Garlock Packing Co.
General Gasket Inc.
Gordon Rubber & Packing Co. Inc.
Goshen Rubber Co., Inc.
Hallett Mfg. Co.
Heyman Mfg. Co.
Walter J. Hyatt Co., The
Walter K. Jaros Aircrafters
Lord Mfg. Co.
Mechanical Rubber Products Co.
Minnesota Rubber Co.
Norrich Plastics Corp.
Ohlson Empire Inc.
Olympic Plastics Co., Inc.

Roberts Toledo Rubber Co., The
Milton Ross Metals Co., The
Rubbercraft Corp. of California
Servicair Co.
Stevens Co. Inc.
Tetrafluor, Inc.
United Shoe Machinery Corp.
Western Felt Works & Acadia Synthetic Products Div.
Western Sky Industries
Wilmington Fibre Specialty Co.

GROUND HANDLING EQUIPMENT, MISSILES

ACF Industries Inc.
Accessory Products Co., Div.-Textron Inc.
Advance Industries, Inc.
Aerocal Div., Aeronca Mfg. Corp.
***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
Aeroquip Corp., Jackson Div.
Aeroscience, Inc.
Aero-Test Equipment Co., Inc.
Aerotest Laboratories, Inc.
Ainslie Corp.
Air Logistics Corp.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
All American Engrg. Co.
Allied International Corp.
Allison Steel Mfg. Co.
American Car & Foundry Div., ACF Industries, Inc.
American Machine & Foundry Co.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
American Research & Mfg. Corp.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Anaconda Metal Hose Div., The American Brass Co.
Anderson, Greenwood & Co.
Aro Equipment Corp., The
Associated Co., Inc.
Austin-Western, Constr. Equip. Div.-Baldwin-Lima-Hamilton Corp.
Avco Corp., Nashville Div.
Avco Corp., Research & Advanced Development Div.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs.
Basic Tool Industries, Inc.
Beech Aircraft Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
Benbow Mfg. Corp.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Benson Mfg. Co.
Bernco Engrg. Corp.
E. W. Bliss Co.
Bogue Electric Mfg. Co.
Bowser Inc., Defense Div.
Broadview Research Corp.
Brooks & Perkins, Inc.
Budd Co., The
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
A. M. Byers Co.
Byron Jackson Pumps, Inc.
CG Electronics Corp.
Calcor Corp.
California Aircraft Products
California Stamping & Mfg. Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Captive Seal Corp.
Caterpillar Tractor Co., Defense Products Dept.
Chance Vought Aircraft, Inc.
Clark Equipment Co.
Colonial Aircraft Corp.
Colorado Fuel & Iron Corp., The
Components Corp.
Consolidated Diesel Electric Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cornelius Co., The, Aero Div.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Craig Systems, Inc.
Crane Co., Special Products Div.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp., Santa Barbara Div.
Dalmo Victor Co., Div.-Textron, Inc.
Dana Corp.
Joe Davidson & Associates
Daystrom, Inc., Military Electronics Div.
Daystrom Inc., Transicoil Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
***DEL MAR ENGRG. LABS.**
Doak Aircraft Co. Inc.
Douglas Aircraft Co., Inc.
Drayer Hanson Div.-Crane Co.
Allen B. Du Mont Labs., Inc.
Eastern Rotorcraft Corp.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Eidal Mfg. Co., Inc.
Elwell-Parker Electric Co., The
***EQUIPMENT DIV., RAYTHEON CO.**
Erie Instrumation, Div.-Erie Resistor Corp.
***EXCELCO DEVELOPMENTS INC.**
Ex-Cell-O Corp.
FWD Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Falstrom Co.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co
Flight Refueling, Inc.
Flight Support, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Ford Instrument Co., Div.-Sperry Rand Corp
Fruehauf Trailer Co., Military Equipment Div
Gar Wood Industries Inc.
Gatewood Products, Inc.
General American Transportation Corp.
General Electric Co., Missile & Space Vehicle Dept., Pa
General Electric Co., Ordnance Dept.
General Logistics Div., Aeroquip Corp.
Genisco, Inc.
Goodyear Aircraft Corp.
Gramm Trailer Corp
Gremco, Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc
Hamilton Standard, Div.-United Aircraft Corp.
Hammett-Mercury-Rex Div
Hardman Tool & Engrg Co.
Haskel Engrg. & Supply Co.
Hendrickson Mfg. Co.
Herlo Corp.
Highland Engrg. Co.
Highway Trailer Co
Hoefner Corp.
C. G. Hokanson Co., Inc.
Hol-Gar Mfg. Corp.
Hoover Electric Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hughes Tool Co., Aircraft Div.
Hydra-Power Corp.
Hyster Co.
Indiana Gear Works, Inc.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Intercontinental Mfg. Co., Inc.
International Fermont Machinery Co., Inc.
Interstate Electronics Corp.
Irving Air Chute Co., Inc.
Jack & Heintz, Inc.
Jeta, Inc.
Jonco Aircraft Corp., Sub.-Fairchild Engine & Airplane Corp.
Kahn & Co., Inc.
Kanarr Corp.
Kellett Aircraft Corp.
Kittell-Lacy, Inc.
Langley Corp.
Leach Corp.
Lear, Inc.
Link-Belt Co.
Arthur D. Little, Inc.
Lockheed Aircraft Corp., Missiles & Space Div
Lofstrand Co., The
Lycoming Div., Avco Corp.
Machine Products Div., New Haven Trap Rock Co.
Magnesium Co. of America
Major Tool & Machine, Inc.
Mak Industries, Inc.
***MARTIN CO., THE, DENVER DIV.**
McDowell-Wellman Companies, The
Miami Engrg., Div.-Miami Shipbuilding Corp.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Monrovia Aviation Corp.
George L. Nankervis Co.
Nelson Electric Mfg. Co.
Neway Equipment Co.
Northeast Metals Industries, Inc.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
On Mark Couplings, Inc.
Opelika Welding, Machine & Supply Inc.
Otis Elevator Co., Defense & Industrial Div.
Pacific Coast Engrg. Co.
Parts Engrg. Co., Inc.
Pastushin Industries, Inc.
Pegasus Labs., Inc.
Philco Corp.-Govt. & Industrial Group
Richard Philin Co.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Pryor Mfg. Co
REF Mfg. Corp.
Radiaphone Co. Inc.
Radiation, Inc
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Development & Research Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc
Redco Corp
Regent Jack Mfg. Co., Inc
Republic Aviation Corp., Missile Systems Div.
Resistoflex Corp.
Rimak Inc
J. R. Robbins Co.
Ronan & Kunzl, Inc.
Sancor Corp.
Sargent Engrg. Corp.
Scott Aviation Corp.
Servomechanisms, Inc.
Sierra Engrg. Co
Silent Hoist & Crane Co
Skyline Electric & Mfg. Co.
Skyline Products, Inc.
Solar Aircraft Co
South Wind Div., Stewart Warner Corp
Spaceatomics Div., The Budd Co
Sperry Gyroscope Co., Div.-Sperry Rand Corp
Stainless Inc.
Stearns-Roger Mfg. Co., The
F. M. Stevenson Co Inc
Sundstrand Turbo
Superior Air Products Co
B. K. Sweeney Mfg. Co
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
TRG, Inc
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Thompson Ramo Wooldridge Inc
Trailmobile Inc.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products Inc
United Mfg. Co., The
United Mfg. Co., Div., The W. L. Maxson Corp
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries Inc
United States Rubber Co
Van Zelm Associates, Inc
Vickers Inc
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Waco Aircraft Co.
Waldick Engrg. Co
Ward Lafrance Truck Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp
Weber Aircraft Corp.
Welded Construction Inc
Wells Industries Corp.
Wenzlau Engrg. Co.
Western Disign, Div.-U.S. Industries, Inc.
Western Div., Aeroquip Corp
Western Gear Corp.-Precision Products Div.
Westholt Mfg. Inc.
Westinghouse Electric Corp.
Wiancko Engrg. Co
Wickes Engrg. & Contruction Co.
Wickfield, Inc
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.
Wright Hoist Div., American Chain & Cable Co., Inc

GROUND LANDING SYSTEMS

Air Logistics Corp.
All American Engrg. Co.
Allied International Corp.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
A. Biederman, Inc.
Broadview Research Corp.
Budd Co., The
Burroughs Corp.
A. M. Byers Co.
Calcor Corp.
Cubic Corp.
Curtiss-Wright Corp., Santa Barbara Div.
Diamond Antenna & Microwave Corp.

*EQUIPMENT DIV., RAYTHEON CO.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc
ITT Federal Div., International Telephone & Telegraph Corp
Lab. for Electronics, Inc.
Lear Inc
Arthur D. Little, Inc.
Litton Industries, Maryland Div.
Madigan Corp
Motorola, Inc.
A. M. Byers Co.
Northrop Corp.
Precision Lapping Co. Inc.
Radiaphone Co Inc.
Radio Condenser Co.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Republic Aviation Corp., Missile Systems Div
TRG Inc
Temco Aircraft Corp.
Van Zelm Associates, Inc
Weber Aircraft Corp.
Western Gear Corp.-Precision Products Div.
Winder Aircraft Corp. of Florida

GUIDANCE EQUIPMENT, MISSILES

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS
ACF Industries Inc
Advance Industries, Inc.
American Machine & Foundry Co., Government Products, N. Y
American Missile Products Co., Inc.
*ANDREW CORP.
Applied Electronics Corp. of N. J
*ARNOUX CORP
Associated Engineers, Inc
Autonetics, Div.-North American Aviation, Inc.
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
Bermite Powder Co.
A. Biederman, Inc.
Blonder-Tongue Labs., Inc., Special Products Div.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
A. M. Byers Co.
CG Electronics Corp.
Calcor Corp
Capital City Mfg. Co., Inc.
Chance Vought Aircraft, Inc.
Control Data Corp.
Joe Davidson & Associates
Davidson Optronics Inc
Daystrom, Inc., Military Electronics Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div
Delco Radio Div.-General Motors Corp.
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
Douglas Aircraft Co., Inc.
Allen B. Du Mont Labs., Inc.
Dunn Engrg. Associates Inc.
Electromation Co., Div.-Del Mar Engrg. Labs
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
FAE Instrument Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
GPL Div.-General Precision, Inc
Gates Radio Co.
General Devices, Inc.
General Electric Co., Instrument Div.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Ordnance Dept
General Instrument Corp., Defense & Engrg. Products Group.
General Mills, Inc.
Genisco, Inc.
Gilfillan Bros. Inc.
Goodyear Aircraft Corp.
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co
Gulton Industries, Inc.
Gyrex Corp., The
A. W. Haydon Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
Hoover Electric Co.
Hoover Electronics Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Integrated Dynamics Div., Globe Industries, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc

*WALLACE O. LEONARD, INC.
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div
Lockheed Electronics Co., Stavid Div.
Madigan Corp.
W. L. Maxson Corp., The
Mc Donnell Aircraft Corp.
Meridian Metalcraft, Inc.
Micro Gee Products, Inc,
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Boston Div
Motorola, Inc.
National Co., Inc
Newton Co., The
Norden Div., United Aircraft Corp.
Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Perkin Elmer Corp.
Philco Corp.-Govt. & Industrial Group
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc
Reeves Instrument Corp.
Remington Rand Univac Div.-Sperry Rand Corp.
Republic Aviation Corp., Missile Systems Div.
Sanders Associates, Inc
Singer Military Products Div.-The Singer Mfg. Co.
Skiatron Electronics & Television Corp.
Southwest Research Institute
Specialities Inc
Sperry Farragut Co., Div.-Sperry Rand Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Summers Gyroscope Co
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Texas Instruments Inc
Theta Instruments Corp.
Thompson Ramo Wooldridge Inc.
U. S. Industries, Inc.
United States Time Corp.
Varo Mfg. Co., Inc.
Vickers Inc., Electric Products Div
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Whittaker Gyro. Div.-Telecomputing Corp.
Wiancko Engrg. Co.
Winder Aircraft Corp. of Florida

GUIDANCE SYSTEMS

a. Inertial
b. Infrared
c. Pilotless Aircraft
d. Radar
e. Radio
f. Stellar

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS., a.
ACF Industries Inc., b.
ACF Electronics Div., ACF Industries Inc., b.
Advance Industries, Inc., b, d, e.
Aerollex Labs. Div., Aerollex Corp., a, b.
*AEROJET-GENERAL CORP., b, c.
Aeronca Mfg. Corp.-Aerospace Div., c.
Allied International Corp., e.
American Machine & Foundry Co., Government Products, N. Y., a thru f.
American Optical Co., Instrument Div., b.
American Potash & Chemcial Corp., National Northern Div., b.
Applied Electronics Corp. of N. J., a, d, f.
Armament Div.-Universal Match Corp., c.
Autonetics, Div.-North American Aviation, Inc., a, c, d, f.
Babcock Radio Engrg., Inc., e.
Beech Aircraft Corp., e.
Belock Instrument Corp., a.
Bendix Aviation Corp., a thru e.
Bendix Corp., The, Eclipse-Pioneer Div., a, b, c.
Bendix-Pacific Div., Bendix Aviation Corp., b thru e.
Bendix Radio Div., Bendix Aviation Corp.,
Bermite Powder Co., b.
Blonder-Tongue Labs. Inc., Special Products Div., b.
Broadview Research Corp., a thru e.
Bruno-New York Industries Corp., d.
Budd-Lewyt Electronics, Inc., a thru f.
Bulova Research & Development Labs., Inc., b.
Chance Vought Aircraft, Inc., a thru d.
Dage Television Div., Thompson Ramo Wooldridge, Inc., e.
Joe Davidson & Associates, b.
Davidson Optronics, Inc., a, b, f.
Daystrom Inc., Military Electronics Div., d.
Daystrom Inc., Transicoil Div., a.
De Havilland Aircraft of Canada, Ltd., Special Products Div., b.
*DEL MAR ENGRG. LABS., c, d, e.
Designers for Industry, Inc., a thru f.
Diamond Antenna & Mircrowave Corp., d, e.
Allen B. Du Mont Labs., Inc., d.
Dunn Engrg. Associates Inc., a, d.
Dynatronics, Inc., a.
Eastman Kodak Co., b.
Electromation Co., Div.-Del Mar Engrg. Labs.
Emertron, Sub.-Emerson Radio & Phonograph Corp., a thru f.
*EQUIPMENT DIV., RAYTHEON CO., a thru d.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., a, c thru f.
Ford Instrument Co., Div.-Sperry Rand Corp., a, c, d.
GPL Div.-General Precision, Inc., a, b, d, f.
Gates Radio Co., c, e.
General Bronze Electronics Corp., d.
General Devices, Inc., a thru f.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept., a thru f.
General Electric Co., Heavy Military Electronics Dept., d, e.
General Electric Co., Light Military Electronics Dept., a thru e.
General Electric Co., Ordnance Dept., a, d.
General Instrument Corp., Defense & Engrg. Products Group, b thru e.
General Mills, Inc., a.
Gilfillan Bros. Inc., d, e.
Goodyear Aircraft Corp., d.
Gorham Electronics-Div.-Gorham Mfg. Co., d.
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co., a, c, d, e.
Gulton Industries, Inc., a.
HRB-Singer, Inc., Sub.-Singer Mfg. Co., b.
Hallicrafters Co., The, b, d, e.
Hazeltine Electronics Div.-Hazeltine Corp., d.
Hoover Electric Co., c.
Hoover Electronics Co., a.
Hydra-Power Corp., a.
ITE Circuit Breaker Co., Special Products Div., d.
ITT Federal Div., International Telephone & Telegraph Corp., a, d, e.
Infrared Industries, Inc., b.
Integrated Dynamics Div., Globe Industries, Inc., a, c.
*KEARFOTT DIV., GENERAL PRECISION, INC., a thru d, f.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., a, b, f.
Lab. For Electronics, Inc., a, d.
Lovoie Labs., Inc., d.
Lear Inc., a thru f.
Leemath Inc., a.
Lel, Inc.,d.
Librascope Div., General Precision, Inc., a, f.
Litton Industries, Inc., a.
Litton Industries, Maryland Div., d.
Lockheed Electronics Co., Stavid Div., d.
Madigan Corp., e.
*MARTIN CO., THE, DENVER DIV.
W. L. Maxson Corp., The, a, c, d.
Micro Gee Products Inc.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., a, b, c.
Minneapolis-Honeywell Regulator Co., Boston Div., a.
Motorola, Inc., b thru e.
National Co., Inc., d, e.
Networks Electronic Corp., b.
Norden Div., United Aircraft Corp., a, b, d, f.
Northrop Corp., a thru f.
Nortronics, Div.-Northrop Corp., a, b, f.
Ordnance Research & Development Co., Div.-Bermite Powder Co., b.
Philco Corp.-Govt. & Industrial Group, b, d, f.
Precision Lapping Co. Inc., b.
Production Research Corp., Sub.-Radio Condenser Co., b.
Radio Condenser Co., b, e.
*RADIO CORP. OF AMERICA, a thru f.
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS a, d, e.
Radio Receptor Co., Inc., Sub.-General Instrument Corp., b thru e.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., b, d, e.
Reeves Instrument Corp., a, d.
Republic Aviation Corp., Missile Systems Div., a, c, d, e.
Resdel Engrg. Corp., d.
Sanders Associated, Inc., c.
Santa Barbara Research Center, b, f.
Singer Military Products Div.-The Singer Mfg. Co., b, c.
Skiatron Electronics & Television Corp., d.

Skydyne, Inc.
Southwest Research Insititute
Special Programs Section, General Electric Co., **a, d, e.**
Spectra Electronics Corp., **b.**
Sperry Farragut Co., Div.-Sperry Rand Corp., **a.**
Sperry Gyroscope Co., Div.-Sperry Rand Corp., **a, c thru f.**
Sperry Piedmont Co., Div.-Sperry Rand Corp., **d.**
Summers Gyroscope Co., **e.**
TRG, Inc., **a thru f.**
Tamar Electronics, Inc., **c, d, e,.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, c.**
Telerad Mfg. Corp., **d.**
Temco Aircraft Corp., **c, d.**
Texas Instruments Inc., **a thru f.**
Thompson Ramo Wooldridge Inc., **a, c.**
U. S. Industries, Inc., **b, c, d.**
Westinghouse Electric Corp., **b, d, e.**
Whittaker Gryo. Div.-Telecomputing Corp., **a, c.**

GUN MOUNTS, TELEVISION

Aeroflex Labs. Div., Aeroflex Corp.
American Machine & Foundry Co., Greenwich Engrg. Div.
Blonder-Tongue Labs. Inc., Special Products Div.
Capital City Mfg. Co., Inc.
Continental Electric Co
Dage Television Div., Thompson Ramo Wooldridge, Inc.
Gordon Enterprises
Hallamore Electronics Co., Div.-Siegler Corp.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Link-Belt Co.
Optomechanisms Inc.
***RADIO CORP. OF AMERICA**
Wollensak Optical Co.

GYROSCOPES

a. Attitude
b. Directional
c. Free
d. Integrating
e. Missiles
f. Rate

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS d, e, f.**
Aeroflex Labs. Div., Aeroflex Corp., **a, c, f.**
***R. C. ALLEN AIRCRAFT INSTR. DIV., R. C. ALLEN BUS. MACHINES, INC., f.**
American Beryllium Co.
Autonetics, Div.-North American Aviation, Inc.
Aviation Instrument Mfg. Corp., **a, b, c.**
Belock Instrument Corp., **a thru f.**
Bendix Aviation Corp., **a thru f.**
Bendix Corp., The, Eclipse-Pioneer Div., **a thru f.**
A. Biederman, Inc., **a thru f.**
Collins Radio Co., **b.**
Daystrom Inc., Pacific Div., **a, b, c, e, f.**
Decker Corp., The, **b, f.**
R. C. Dudek & Co., **a, b, e, f.**
Fairchild Controls Corp., **e, f.**
Fairchild Controls Corp., Components Div., **e, f.**
Ford Instrument Co., Div.-Sperry Rand Corp., **a, d, e, f.**
Garwin, Inc., **a, b.**
General Electric Co., Instrument Dept., **b, e.**
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Electric Co., Ordnance Dept.
Gordon Enterprises, **a thru f.**
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., **c thru f.**
Gyrex Corp., The, **f.**
Hammett-Mercury-Rex Div., **b, c, d.**
Hoffman Electronics Corp., Military Products Div., **a thru f.**
Humphrey, Inc. Electro Mechanical Instruments, **a. thru f.**
Integrated Dynamics Div., Globe Industries, Inc., **a, c, f.**
***KEARFOTT DIV., GENERAL PRECISION, INC., a thru f.**
Ketay Dept., Norden Div., United Aircraft Corp., **b, e, f.**
Lear, Inc., **a thru f.**
W. L. Maxson Corp., The, **c thru f.**
Merix Chemical Co.,
Minneapolis-Honeywell Regulator Co., Aeronautical Div., **a thru f.**
Minneapolis-Honeywell Regulator Co., Boston Div., **c thru f.**
Norden Div., United Aircraft Corp., **a thru f.**
Northrop Corp., **f.**
Reeves Instrument Corp., **d, e.**
Sanders Associates, Inc., **f.**
Sperry Farragut Co., Div.-Sperry Rand Corp., **d, e.**
Sperry Gyroscope Co., Div.-Sperry Rand Corp., **a thru d, f.**
Sperry Piedmont Co., Div.-Sperry Rand Corp., **b, f.**
Summers Gyroscope Co., **a, b, c, e, f.**
United States Chemical Milling Corp., **f.**
United States Time Corp., **a, c thru f.**
Westinghouse Electric Corp., **b, d, f.**
Whittaker Gyro. Div.-Telecomputing Corp., **a thru f.**

HAMMERS

Ampco Metal, Inc.
Billings & Spencer Co., The
California Stamping & Mfg. Co.
Capewell Mfg. Co.
Chase Brass & Copper Co., Inc.
Chicago Rawhide Mfg. Co.
Division Lead Co.
Greene, Tweed & Co.
Hunter Tool Co.
L & R Mfg. Co.
Miller Falls Co.
Proto Tool Co
Simonds Saw & Steel Co.
Snap-On-Tools Corp.
Superior Pneumatic & Mfg., Inc.
Vlchek Tool Co.

HAND SETS

American Microphone Mfg. Co., Div.-G-C Textron Electronics
G-C Electronics Co.
Hi-Shear Rivet Tool Co.
Keystone Electronics Corp.
Permoflux Products Co.
Remler Co.
Sun Electric Corp., Aeronautical Div.
Telectro Industries Corp.

HANDLES

Adams Rite Mfg. Co.
Alac. Inc
Allied Plastics Supply Corp.
Alpine Electronic Components, Inc.
Amatom Electronic Hardware Co. Inc.
American Brass Co., The
American Insulator Corp.
Balcrank Inc.
Bud Radio, Inc.
California Plasteck Inc.
Cambridge Thermionic Corp.
Dimco-Gray Co.
Friez Instrument Div., Bendix Aviation Corp.
Goe Engrg. Co.
Grant Pulley & Hardware Corp.
George E. Harris & Co., Inc.
Lerco Electronics, Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Precision Metal Products Co. Inc.
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Richards-Wilcox Mfg. Co.
Simonds Saw & Steel Co.
Skydyne, Inc.
TA Mfg. Corp.
Unified Industries, Inc.
Vemaline Products Co.
Waterbury Companies, Inc.

HANDLES, LEATHER

Auburn Mfg. Co., The
Milton Ross Metals Co., The

HARDWARE

Abbott Screw & Mfg. Co.
Adams Rite Mfg. Co.
Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Aeroquip Corp., Jackson Div.
Aero-Stat Co., The
Aerotron Supply Co.
Airhardware, Inc.
Airtron, Div.-Litton Industries
Alac, Inc.
All Specs Corp.
Amatom Electronic Hardware Co., Inc.
Ampco Metal, Inc.
Associated Engineers, Inc.
Atlee Corp.
Autoscrew Co., Inc.
Best Aircraft Corp.
Bland Burner Co., The
Bruning Co., The
Burndy Corp., Omaton Div.
California Stamping & Mfg. Co.
Cambridge Thermionic Corp.
Capewell Mfg. Co.
Deutsch Co., The, Electronic Components Div.
Eastern Rotorcraft Corp.
Federal Screw Products Inc.
Fenn Mfg. Co., The
Forseberg Mfg., Co., The
G-C Electronics Co
General Logistics Div., Aeroquip Corp.
Goe Engrg. Co.
Grant Pulley & Hardware Corp.
Gries Reproducer Corp.
Hobbs Mfg. Co.
Walter J. Hyatt Co., The
Imperial Brass Mfg. Co., The
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Jan Hardware Mfg. Co., Inc.
Janitrol Aircraft Div.-Midland-Ross Corp.
Keystone Electronics Corp.
Lerco Electronics, Inc.
Mercury Air Parts Co., Inc.
J. I. Morris Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
North & Judd Mfg. Co.
Northeast Metals Industries, Inc.
Northrop Corp.
Nylok Corp., The
Ohlson Empire Inc.
Olympic Plastics Co., Inc
Parker Seal Co., Div.-Parker-Hannifin Corp.
Richard Philip Co.
Precision Metal Products Co. Inc.
Prestole Corp.
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Richards-Wilcox Mfg. Co.
Robot Industries Inc.
J. H. Sessions & Son
Shur-Lok Corp.
Standard Pressed Steel Co.
Taurus Corp.
Unified Industries, Inc.
United States Chemical Milling Corp.
United States Steel Corp.
Vector Electronic Co., Inc.
Vlier Engrg. Corp.
Waldick Engrg Co.
Western Div., Aeroquip Corp.
Wilcox-Crittenden Div., North & Judd Mfg. Co.

HARNESSES

a. Electric
b. Ignition
c. Thermocouples
d. Wire

Advanced Electronics, Inc., **a thru d.**
Aero Research Instrument Co. Inc., **c.**
Aerolite Electronics Corp., **c.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, d.**
Alden Products Co., **d.**
Allen Electric & Equipment Co., **a.**
American Missile Products Co., Inc., **d.**
Anchor Specialty Mfg. Co. Inc., **a, d.**
Associated Engineers, Inc., **a.**
B G Corp., The, **c.**
Beaton & Corbin Mfg. Co., The, **b.**
Bendix Aviation Corp., **a, b.**
Bendix Aviation Corp., Cincinnati Div., **a.**
Bernco Engrg. Corp., **a thru d.**
Birnbach Radio Co., Inc., **d.**
Brach Mfg. Corp., **d.**
William Brand, Rex Div.-American Enka Corp., **a, c, d.**
Breeze Corporations, Inc., **a, b, d.**
Cable Electric Products Inc., **a, d.**
Cameraflex Div., The Federal Mfg. & Engrg. Corp., **a, b.**
Cannon Electric Co., **a.**
Chance Vought Aircraft Inc., **a, b, d.**
Clevite Ordnance, Div.-Clevite Corp., **a.**
Cole Electric Co., **a.**
Conax Corp., **c.**
Co-Operative Industries, Inc., **b, c.**
Cord Products Co., **a, d.**
Dejur-Amsco Corp., Electronic Sales Div., **c.**
Deutsch Co., The, Electronic Components Div., **a.**
Dit-Mco, Inc., **a, d.**
Double E Products Co., **a, b, d.**
Douglas Aircraft Co., Inc., **a, b.**
Du Kane Corp., **a, d.**
Dyna-Therm Chemical Corp., **a.**
Eagle Signal Co., **d.**
Electric Autolite Co., The, **a thru d.**
Electric Cords & Supply Corp., **a thru d.**
Electromath Corp., **d.**
Electronic Brazing Co., **a, d.**
Emertron, Sub.-Emerson Radio & Phonograph Corp. **a, c, d.**
Empire Electronics Co., Inc., **a, d.**
Farwest Mfg. Div., Inc., **a, d.**
Fenwal Inc., **c.**
General Aniline & Film Corp., Ansco Div., **d.**
General Electric Co., Apparatus Sales Div., **c.**
General Laboratory Associates, Inc., **a, b, d.**
Gilfillan Bros. Inc., **a.**

Claud S. Gordon Co., **c.**
Graflex Inc., **a, d.**
Graphik Circuits, Div.-Cinch Mfg. Co., **d.**
Guided Missiles Div., The Firestone Tire & Rubber Co., **a.**
Hallett Mfg. Co., **a thru d.**
Hamilton Watch Co., Military Products Div., **a.**
Hammett-Mercury-Rex Div., **a thru d.**
Harco Labs., Inc., **a thru d.**
George E. Harris & Co., Inc., **a, b.**
International Electric Industries, Inc., **a, b, d.**
Walter K. Jaros Aircrafters, **d.**
Jefferson Electronic Products, **a thru d.**
Lab-Tronics, Inc., **a, d.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **a, d.**
Lane Electronics Mfg. Corp., **a.**
Lear, Inc. **a, d.**
Leece-Neville Co., The, **a, b, d.**
Lewis Engrg. Co., The, **c, d.**
Lytle Corp., **a, d.**
MEG Products, Div.-Mandrel Industries, Inc., **a thru d.**
***MARTIN CO., THE, DENVER DIV., a, c.**
J. E. Menaugh Co., **b.**
***MINNESOTA MINING & MFG. CO., a, c, d.**
Modern Design Div.-H.C. Schloer, Inc., **d.**
Chester Morton Electronics Corp., **a thru d.**
Motorola, Inc.,
Mullenbach Div.-Electric Machinery Mfg. Co., **a.**
Mutron Corp., **a, b, d.**
Nevada Air Products Co., **d.**
M. M. Newman Corp., **d.**
Opad Electric Co., **a, d.**
Pacific Automation Products, Inc., **a, b, d.**
Packard Electric Div.-General Motors Corp., **a, b, d.**
Paraplegics Mfg. Co., Inc., **a, b, d.**
Performance Measurements Co., **a, d.**
Phalo Plastics Corp., **a, d.**
Piasecki Aircraft Corp., **a thru d.**
Piqua Engrg. Inc., **a.**
Radex Corp., **a.**
***RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY, a.**
Republic Aviation Corp., Missile Systems Div., **a.**
Research, Inc., **a, c.**
Revere Corp. of America, Sub., Neptune Meter Co., **a thru d.**
Fred T. Roberts & Co., **a, d.**
Milton Ross Metals Co., The, **a.**
Sanders Associates, Inc., **d.**
Sangamo Electric Co., **d.**
Scintilla Div., Bendix Aviation Corp., **a thru d.**
Seeger-Williams, Inc., **a, d.**
Servicair Co., **a, b.**
Sheltered Workshops, **d.**
Skyline Electric & Mfg. Co., **a.**
Skytronics, Inc., **a, b.**
Small Motors Inc
E. C. Smith Mfg. Co., Inc., **c.**
Specialty Electronics Development Corp., **b, d.**
Stewart & Stevenson Services, Inc., **a.**
Stewart-Warner Electronics Div., **d.**
Surprenant Mfg. Co., **a, d.**
Taffet Electronics, Inc., **a, d.**
Teleflex Inc., **c.**
Telkor, Inc., **a.**
Thermo Electric Co., Inc., **c.**
Thor Ceramics, Inc., **b.**
Titeflex, Inc., **b, d.**
Transco Products, Inc., **a.**
Twin Coach Co., Aircraft-Missiles, **a.**
U. S. Plastic Molding Corp., **a.**
Virginia Electronics Co., Inc., **d.**
Wesrep Corp., **a, d.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **a, b, d.**
Whitaker Cable Corp., **a, d.**
Winder Aircraft Corp. of Florida, **a thru d.**

HEADERS

Allied Products Corp.
American Research & Mfg. Corp.
***ARNOUX CORP.**
California Stamping & Mfg. Co.
L. L. Constantin & Co.
Eljay Corp
Fusite Corp.
Garde Mfg. Co
Hermetic Seal Corp.
Walter K. Jaros Aircrafters
***MARTIN CO., THE, DENVER DIV.**
Mitronics Inc
Robert E. Morris Co., The
Networks Electronic Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Milton Ross Metals Co., The
Spaceatomics Div., The Budd Co.
Torwico Electronics, Inc
Warren Components, Div.-El-Tronics, Inc

HEADPHONES & HEADSETS

American Microphone Mfg. Co., Div.-G-C Textron Electronics.
S. G. Brown
Calvert Electronics Inc.
C. F. Cannon Co.
David Clark Co., Inc.
Electronic Applications, Inc.
Fla. Aircraft Radio & Marine
Melody Master Mfg. Co.
Permoflux Products Co.
Radalab Inc
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Remler Co
Rye Sound Corp
Sierra Engrg Co.
Sonotone Corp
Sun Electric Corp., Aeronautical Div.
Superex Electronics Corp.
Telectro Industries Corp.
Telex, Inc
United States Instrument Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

HEADS, COMPUTER

Edwin A. Lipps Engrg.
Magne-Head Div., General Transistor Corp.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div
Norton Associates, Inc.
Philco Corp.-Govt. & Industrial Group
Potter Instrument Co., Inc.
***RADIO CORP. OF AMERICA**
J. B. Rea Co
Sonotone Corp.
Telex, Inc

HEAT TRANSFER CONTROL SYSTEMS

***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Corp.
American Machine & Foundry Co.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Blue M Electric Co.
Budd Lewyt Electronics, Inc.
Clark Controller Co., The
Drayer Hanson Div.-Crane Co.
Eastern Industries Inc.
Emhart Mfg. Co., Maxim Div.
Flight Refueling, Inc.
General American Transportation Corp
General Electric Co., Computer Dept.
Hastings Plastics, Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Janitrol Aircraft Div.-Midland-Ross Corp.
Kentucky Metal Products Co.
Lear, Inc
Manning & Lewis Eng. Co.
Nuclear Development Corp. of America
Ordnance Engrg. Associates, Inc
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Statham Development Corp.
Thermon Mfg. Co.
Tranter Mfg., Inc.
United Aircraft Products, Inc.
Vemaline Products Co.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Waste King Corp., Technical Products Div.
Whitlock Mfg. Co., The
Edwin L. Wiegand Co

HEAT TREATING SERVICE

American Gas Furnace Co.
American Machine & Foundry Co., Government Products Group
Bethlehem Steel Co.
E. W. Bliss Co.
California Stamping & Mfg. Co
Colonial Aircraft Corp.
Foster Wheeler Corp.
General American Transportation Corp
General Electric Co., Rocket Engine Section
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Griscom-Russell Co., The
Hamilton Watch Co., Military Products Div.
C. I. Hayes, Inc.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products Inc
A. F. Holden Co., The
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Intercontinental Mfg. Co., Inc.
Jan Hardware Mfg. Co., Inc.
Konarr Corp.
Kerns Mfg. Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lear, Inc.
Lucifer Furnaces Inc.
Metallurgical, Inc.
Nooter Corp.
Pennsylvania Tool & Mfg. Co., The
Portland Copper & Tank Works Inc.
J. W. Rex Co.
Rimak, Inc.
Sargent Engrg. Corp.
Sherman Indsl. Electronics Co., Div.-Electronic Development Inc.
State Testing Laboratory Inc.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Taft-Peirce Mfg. Co., The
Vac-Hyd Processing Corp.
Vickers, Inc., Mich.
Wall Colmonoy Corp., Stainless Processing Div.

HEATER MUFFLER ASSEMBLIES

Calcor Corp.
California Stamping & Mfg. Co.
Colonial Aircraft Corp.
Emhart Mfg. Co., Maxim Div.
Hanlon & Wilson Co., The
Industrial Acoustics Co., Inc.
Lucifer Furnaces Inc.
Edw. Renneburg & Sons Co.
Woolf Aircraft Products, Inc.

HEATERS

Aeroil Products Co., Inc.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Corp
American Air Filter Co., Defense Products Div.
American Instrument Co., Inc.
Blue M Electric Co.
Calcor Corp.
Carborundum Co., The
Cole Electric Co.
Crane Co., Special Products Div
Dampp-Chaser, Inc.
Dean Products, Inc.
Despatch Oven Co.
Drayer Hanson Div.-Crane Co.
Electrofilm, Inc.
Electro-Flex Heat, Inc.
Electromode, Div.-Commercial Controls Corp.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General American Transportation Corp.
General Electric Co., Apparatus Sales Div.
B. F. Goodrich Aviation Products
Hanlon & Wilson Co., The
Hastings Plastics, Inc.
C. G. Hokanson Co., Inc.
Hunter Mfg. Co.
ILG Electric Ventilating Co.
Janitrol Aircraft Div.-Midland Ross Corp.
Lear Inc
Manning & Lewis Eng. Co.
***MARTIN CO., THE, DENVER DIV.**
Minco Products, Inc.
Perfection Div.-Hupp Corp.
Edw. Renneburg & Sons Co.
Safeway Heat Elements, Inc.
Selas Corp. of America
Shaw Burner Co.
E. C. Smith Mfg. Co., Inc.
Smith-Gates Corp., The
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Surface Combustion Div.-Midland-Ross Corp.
Thermal Research & Eng. Corp.
Therm-O-Lab Corp.
Tober Electronic Corp.
United Aircraft Products, Inc.
Wenzlau Engrg. Co.
Whitlock Mfg. Co., The
Edwin L. Wiegand Co.
Worthington Corp.

HEATING EQUIPMENT, FLEXIBLE

American Air Filter Co., Defense Products Div.
American Instrument Co., Inc.
Briscoe Mfg. Co.
Cox & Co., Inc.
Dean Products, Inc.
Electrofilm, Inc.
Electro-Flex Heat, Inc.
General Electric Co., Apparatus Sales Div.
General Electric Co., Light Military Electronics Dept.
B. F. Goodrich Aviation Products
Goodyear Tire & Rubber Co., The, Aviation Products Div.

Hammett-Mercury-Rex Div.
Hanlon & Wilson Co., The
C. G. Hokanson Co., Inc.
Janitrol Aircraft Div.-Midland-Ross Corp.
Jet-Heet, Inc.
Lepel High Frequency Labs. Inc.
Manning & Lewis Eng. Co.
Missimers Inc
Napier Engines Inc.
Recony Div.-Vinco Corp.
Safeway Heat Elements, Inc.
Shaw Burner Co.
E. C. Smith Mfg. Co., Inc.
Smith-Gates Corp., The
Southwest Research Institute
Surface Combustion Div.-Midland-Ross Corp.
United States Rubber Co.
Vap-Air Aeronautical Products Div., Vapor Heating Corp.
Edwin L. Wiegand Co.
Worthington Corp.

HINGES

Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Airhardware, Inc.
Bergen Carbide Co.
Burklyn Co.
Capital City Mfg. Co., Inc.
Hartwell Aviation Supply Co.
Walter K. Jaros Aircrafters
Ohlson Empire Inc.
Precision Shapes, Inc.
Richards-Wilcox Mfg. Co.
J. H. Sessions & Son
TA Mfg. Corp
Twix Mfg. Co., Inc

HOISTS, AIRBORNE

Aero Supply Mfg. Inc.
Agricultural Aviation Engineering Co. Inc.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
All American Engrg. Co.
American Machine & Foundry Co., Government Products, N. Y.
Associated Co., Inc.
Atlas Industrial Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Breeze Corporations, Inc.
Calcor Corp.
Chisholm-Moore Hoist Div., Columbus McKinnon Chain Corp.
Cromer Mfg. & Engrg., Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Hoover Electric Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Indiana Gear Works, Inc.
Jack & Heintz, Inc.
Lear, Inc.
***MARTIN CO., THE, DENVER DIV.**
Pacific Scientific Co.
Robbins & Meyers, Inc., Hoist & Crane Div.
Silent Hoist & Crane Co.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Talley Corp., The
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Western Gear Corp.-Precision Products Div.
Wright Hoist Div., American Chain & Cable Co., Inc.

HOISTS, GROUND

Agricultural Aviation Engineering Co. Inc.
Air Logistics Corp.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
All American Engrg. Co.
Associated Co., Inc.
Atlas Industrial Corp.
Baker Industrial Trucks, Div.-Otis Elevator Co.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Breeze Corporations, Inc.
Budd Co., The
Calcor Corp.
Albert H. Cayne Equipment Corp.
Chisholm-Moore Hoist Div., Columbus McKinnon Chain Corp.
Coffing Hoist Div., Duff-Norton Co.
Colson Corp., The
Consolidated Diesel Electric Corp.
Cromer Mfg. & Engrg., Inc.
Drayer Hanson Div.-Crane Co.
Gardner-Denver Co.
Gar Wood Industries Inc
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Joy Mfg Co.
Link-Belt Co.
***MARTIN CO., THE, DENVER DIV.**
Miami Engrg., Div.-Miami Shipbuilding Corp.
National Screw & Mfg. Co., The
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Robbins & Meyers, Inc., Hoist & Crane Div.
Robot Industries Inc.
Rotary Lift Co., Div.-Dover Corp.
Sancor Corp.
Silent Hoist & Crane Co.
Standard Armament Inc.
B. K. Sweeney Mfg. Co.
Talley Corp., The
Thor Power Tool Co.
Weaver Mfg. Co., Div.-Dura Corp.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Westholt Mfg. Inc.
Wright Hoist Div., American Chain & Cable Co., Inc.

HOLDERS, CHASSIS

A&P Metal Products Mfg. Corp.
Budd Co., The
Crane Carrier Corp.
G-C Electronics Co.
Kellett Aircraft Corp.
***MARTIN CO., THE, DENVER DIV.**
Northeast Metals Industries, Inc
Edw. Renneburg & Sons Co.
Waldick Engrg. Co.
Western Devices Inc.

HOLDERS, CRYSTAL

Accurate Electronics Corp.
Birnbach Radio Co., Inc.
Birtcher Corp., The
***DEL MAR ENGRG. LABS.**
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
E. F. Johnson Co.
Meridian Metalcraft, Inc
Microwave Associates, Inc.
Permoflux Products Co.
Sage Labs., Inc
Sanders Associates, Inc.
Sillcocks-Miller Co.
Victor R. F. & Microwave Co.
Warren Components, Div.-El-Tronics, Inc.
Waveline, Inc.

HOLDERS, FUSE

Accurate Electronics Corp.
Alden Products Co.
Associated Engineers, Inc.
Bel Fuse Inc.
Birnbach Radio Co., Inc.
Burndy Corp., Omaton Div.
Hartwell Aviation Supply Co.
Kolton Electric Mfg. Co.
Kulka Electric Corp.
Littelfuse, Inc.
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**

HORNS, MICROWAVE

Ainslie Corp.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Aircom Inc.
American Beryllium Co.
American Electronic Labs., Inc.
Antlab Inc.
Bendix Aviation Corp.
Bogart Mfg. Corp.
Brooks & Perkins, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
FXR, Inc.
Gilfillan Bros. Inc.
John Gombos Co., Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammett-Mercury-Rex Div.
Ludwig Honold Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Corp.
J-V-M Microwave Co.
D. S. Kennedy & Co.
W. L. Maxson Corp., The
Meridian Metalcraft, Inc
Microwave Associates, Inc.
Motorola, Inc
Narda Microwave Corp., The
Omega Labs., Inc.
Polarad Electronics Corp.
Prodelin Inc.
Racon Electric Co. Inc.
Radalab Inc.
Radar Design Corp.
***RADIO CORP. OF AMERICA**
Rantec Corp.
Republic Aviation Corp., Missile Systems Div.
Sage Labs., Inc.
Special Products Dept., Melpar, Inc.
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stainless Inc.
Tamar Electronics, Inc
Telerad Mfg. Corp.
Tober Electronic Corp.
Transco Products, Inc.
Waveline, Inc.

HORNS, SPEAKER PROJECTOR

Atlas Sound Corp.
Electro-Voice, Inc.
Racon Electric Co. Inc
***RADIO CORP. OF AMERICA**
Wheelock Signals Inc.

HOSE

a. Air
b. Assemblies, Flexible
c. Flexible, Metallic
d. Flexible, Non-Metallic
e. Hydraulic

Aero Spares, Inc., **b, e.**
Aeroquip Corp., Jackson Div., **a thru e.**
Airaterra, **b.**
All Specs Corp., **b, e.**
Allied Plastics Supply Corp., **a thru e.**
American Brass Co., The, **a thru e.**
Anaconda Metal Hose Div., The American Brass Co., **a thru e.**
Anchor Coupling Co. Inc., **a, b, e.**
Anchor Packing Co., The, **a, c, d, e.**
Ardmore Products Div., Amco Corp., **b.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **a thru d.**
Atlantic Metal Hose Co., Inc., **c.**
Avica Corp., **a, c.**
Bemis Bro. Bag Co., **d.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., e.**
Binks Mfg. Co., **a.**
Borden Chemical Co., **d.**
Breeze Corporations, Inc., **a, b, c.**
Chance Vought Aircraft, Inc., **b thru e.**
Cleco Air Tools, Div.-Reed Roller Bit Co., **a.**
Cobehn, Inc., **a, b, d.**
Cobra Metal Hose Div., DK Mfg. Co., **b, c, e.**
Components Corp., **c.**
Continental Rubber Works, **a, b, d, e.**
Co-Operative Industries, Inc., **c.**
Crystal-X Corp., **d.**
D K Mfg. Co., **c.**
R. E. Darling Co., Inc., **a, b, d.**
De Vilbiss Co., The, **a, d.**
Douglas Aircraft Co., Inc., **b.**
Dunbar-Kapple Inc.-Aircraft Components Div., **a, b, c, e.**
Electric Hose & Rubber Co., **a, b, d, e.**
Federal Metal Hose Corp., **c.**
Flexaust Co., The, **a, c, d.**
Flexible Metal Hose Mfg. Co., **b, c.**
Flexible Tubing Corp., **b, d.**
Flexonics Corp., **b, c, e.**
Franklin Fibre-Lamitex Corp., **d.**
Gates Rubber Co., The, **a, d, e.**
B. F. Goodrich Aviation Products, **a, d, e**
B. F. Goodrich Industrial Products Co., **a, d, e.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **a, d.**
Hallett Mfg. Co., **b, c.**
George E. Harris & Co., Inc., **b, c, e**
Haskel Engrg. & Supply Co., **a, e.**
Imperial Brass Mfg. Co., The, **a, b, d, e**
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc., **b.**
Johnson Metal Hose, Inc., **a, b, c.**
Kennedy Aircraft Supply Co., **b.**
M & Q Plastic Products, **d, e.**
Marginator Co., **e.**
***MINNESOTA MINING & MFG. CO., b, d**
Minnesota Rubber Co., **d.**
J. J. Monaghan Co., Inc., **d.**
New England Tape Co., Div.-United-Carr Fastener Corp., **d.**
Parker Fittings & Hose Div., Parker-Hannifin Corp. **a, b, e.**
Parts Engrg. Co., Inc., **c.**
Polymer Corp., The, **a, b, d, e**
Raybestos-Manhattan Inc. **a, d e**
Reeves Bros. Inc., Vulcan Rubber Div. **a, d**
Resistoflex Corp., **a, b, d, e.**
Fred T. Roberts & Co., **a, b, d**
Roberts Toledo Rubber Co. The **d**
Roylyn Inc. **b**
Rubbercraft Corp. of California **d**
Scott Aviation Corp. **a.**

Servicair Co., **c.**
Sierra Engrg. Co., **b.**
Skytronics, Inc., **a, d.**
Standard-Thomson Corp., Clifford Mfg. Co. Div., **c.**
Stewart-Warner Corp., Alemite Div., **a, b, e.**
***STRATOFLEX, INC., a thru e.**
Superior Pneumatic & Mfg., Inc., **a.**
Swan Rubber Co., **a, d.**
Technicraft, Div.-Electronic Specialty Co., **c.**
Tetrafluor, Inc., **d.**
Texstar Plastics, Div.-The Texstar Corp., **a thru e.**
Thermoid Div.-H. K. Porter Co., Inc., **a thru e.**
Titeflex, Inc., **a thru e.**
United States Rubber Co., **a, d, e.**
Utility Brass & Copper Corp., **c.**
Weatherhead Co., The, **a thru e.**
Western Div., Aeroquip Corp., **a thru e.**
Winder Aircraft Corp. of Florida, **b.**
Zep Aero, **a thru d.**
Zippertubing Co., The, **b, c, d.**

HOT GAS SYSTEMS & CONTROLS

Chandler Evans Corp.

HUMIDITY CONTROL SYSTEMS

American Instrument Co., Inc.
American Research Corp.
Baker Co., Inc., The
Bendix Aviation Corp.
***BRISTOL CO., THE**
Budd Lewyt Electronics, Inc.
Chance Vought Aircraft, Inc.
Joe Davidson & Associates
Daystrom Inc., Weston Instruments Div
Decker Corp., The
Drayer-Hanson Div.-Crane Co.
Driaire, Inc
Dryomatic Corp
Eastern Industries Inc.
Frick Co.
Gardner Laboratory, Inc.
Great Lakes Mfg. Corp.
Hughes Tool Co., Aircraft Div.
Humidial Co.
***INTERELECTRONICS CORP.**
Kahn & Co., Inc
Lear, Inc
Leeds & Northrup Co.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div
Missimers Inc.
New England Scientific Instruments Co.
Pioneer Industries Div., Almar-York Co. Inc.
Powers Regulator Co., The
Research Products Corp.
Serdex, Inc.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Spraying Systems Co.
Statham Development Corp.
Surface Combustion Div.-Midland-Ross Corp.
Transco Products, Inc
Universal Dynamics Corp.
Warren Components, Div.-El-Tronics, Inc.
Wells Industries Corp.
York Div., Borg-Warner Corp.

HYDRAULIC RESERVOIRS

American Instrument Co., Inc.
Arnolt Corp.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Cadillac Gage Co.
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Colson Corp., The
Eastern Industries Inc.
Electrol Inc
Ex-Cell-O Corp.
Flight Support, Inc.
General American Transportation Corp.
Great Lakes Mfg. Corp
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hydra-Power Corp.
Integral Corp.
Kahn & Co., Inc.
Kelsey-Hayes Co.
***MARTIN CO., THE, DENVER DIV.**
George L. Nankervis Co
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
Northeast Metals Industries, Inc
Oil-Dyne, Inc
Ozone Metal Products Corp.
Peacock Engrg. & Mfg. Co
Richard Philip Co.
Pressed Steel Tank Co
REF Mfg. Corp.
Rucker Co., The
Sancor Corp.
Sargent Engrg. Corp.
Simmonds Aerocessories, Inc.
Sun Electric Corp., Aeronautical Div.
Sweetland Engrg. Co.
United Aircraft Products, Inc.
Vickers Inc
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Vinson Mfg Co Inc
Weatherhead Co., The
Wells Industries Corp.

HYDRAULIC SYSTEMS & CONTROLS

Adel Precision Products of Calif., Div.-General Metals Corp.
Aeroflex Labs. Div., Aeroflex Corp.
Aeronautical Machinists Inc.
Aircraft Accessory Turbine Dept.-General Electric Co.
Airdrome Parts Co.
Alco Valve Co.
Allison Div., General Motors Corp.
American Brake Shoe Co
American Brake Shoe Co., Kellogg Div.
American Machine & Foundry Co., Government Products, N. Y.
Anderson, Greenwood & Co.
Applied Dynamics Corp.
Arkwin Industries, Inc.
***ASSOCIATED TESTING LABS., INC.**
Auto-Control Labs. Inc
Autonetics, Div.-North American Aviation, Inc.
Benbow Mfg. Corp.
Bendix Aviation Corp
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix Aviation Corp., Montrose Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bowser, Inc
Budd Lewyt Electronics, Inc.
Cadillac Gage Co.
Cardell Mfrs.
Chance Vought Aircraft, Inc.
Cincinnati Milling Machine Co., The
Clark Equipment Co.
Colson Corp., The
Columbia Research & Development Corp
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Cornelius Co., The, Aero Div.
Douglas Aircraft Co., Inc.
Dynamic Controls Corp.
Eastern Industries Inc.
Electrol Inc
Electro-Seal Corp.
Ex-Cell-O Corp.
Flight Refueling, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Futurecraft Corp.
Gar Wood Industries Inc.
General American Transportation Corp.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
General Regulator Corp.
Gilfillan Bros. Inc.
Guided Missile Div., The Firestone Tire & Rubber Co
B. H. Hadley, Inc.
Hagan Chemicals & Controls Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hein-Werner Corp.
Holley Carburetor Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hughes Tool Co., Aircraft Div.
Huyck Systems Co.
Walter J. Hyatt Co., The
Hydra-Power Corp.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co.
Hydraulic Research & Mfg. Co
Hydraulics, Inc
Integral Corp.
Janitrol Aircraft Div.-Midland-Ross Corp.
Kahn & Co., Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kelsey-Hayes Co.
Kemp Aero Products
Kieley & Mueller, Inc.
Lear, Inc
***WALLACE O. LEONARD, INC.**
M. C. Mfg. Co.
Marginator Co.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div
J. E. Myles, Inc.
George L. Nankervis Co.
National Water Lift Co., Div.-Cleveland Pneumatic Industries, Inc.
New York Air Brake Co., The, Watertown Div.
Northrop Corp.
Oil-Dyne, Inc.
Ordnance Engrg. Associates, Inc.
Owatonna Tool Co. Precision Hydraulic Div.
Ozone Metal Products Corp.
Parabam, Inc.
Peacock Engrg. & Mfg. Co
Pegasus Labs., Inc.
Pesco Products Div.-Borg-Warner Corp.
Pneu-Hydro Valve Corp.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
REF Mfg. Corp.
Regent Jack Mfg. Co., Inc.
Republic Aviation Corp., Missile Systems Div.
Research, Inc.
Rimak, Inc
J. R. Robbins Co.
Ronson Hydraulic Units Corp.
Royal Jet, Div.-Royal Industries, Inc.
Rucker Co., The
Sancor Corp.
Sanders Associates, Inc.
Sargent Engrg. Corp.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Simmonds Aerocessories, Inc.
A. O. Smith Corp., Smith-Erie Div.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
A. U. Stone & Co., Inc.
Sun Electric Corp., Aeronautical Div.
Sundstrand Turbo
Sweetland Engrg. Co.
Tactair Valve Div.-Aircraft Products Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc
Trimount Instrument Co.
United Aircraft Products, Inc.
Vickers Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Vinson Mfg. Co. Inc.
Waterman Hydraulics Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Weatherhead Co., The
Weaver Mfg. Co., Div.-Dura Corp.
Wells Industries Corp.
Western Design, Div.-U. S. Industries, Inc.
Western Sky Industries
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.
Whittaker Controls, Div.-Telecomputing Corp.
Wickfield, Inc

HYDROMETERS

Automation Products, Inc.
Cox Instruments Div., George L. Nankervis Co.
Fischer & Porter Co.
Fisher Scientific Co., Maryland
Gardner Laboratory, Inc.
General Scientific Equipment Co.
Liquidometer Corp., The
George L. Nankervis Co.
Weksler Instruments Corp.

IGNITERS, JET ENGINE

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
Allied International Corp.
Allison Div., General Motors Corp
American Potash & Chemical Corp., National Northern Div.
Armament Div.-Universal Match Corp.
Auburn Spark Plug Co., Inc.
B G Corp., The
Beckman & Whitley, Inc., Missile Products Div
Bendix Aviation Corp.
Bermite Powder Co
Champion Spark Plug Co.
Delavan Mfg. Co.
***DEL MAR ENGRG. LABS.**
Electric Autolite Co., The
Ex-Cell-O Corp.
Gabriel Co., Rocket Power-Talco
General Laboratory Associates, Inc.
Hercules Powder Co., Chemical Propulsion Div.
***HOLEX, INC.**
Mc Cormick Selph Associates
Olin Mathieson Chemical Corp., N. Y.
Olin Mathieson Chemical Corp., Winchester-Western Div
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Plastic Age Sales, Inc.
Propellex Chemical Div., Chromalloy Corp.

Scintilla Div., Bendix Aviation Corp.

IGNITION ASSEMBLIES

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS
American Potash & Chemical Corp., National Northern Div.
Auburn Spark Plug Co., Inc.
Beaton & Corbin Mfg. Co., The
Bendix Aviation Corp.
Bermite Powder Co
Cosmic Instruments Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
*DEL MAR ENGRG. LABS.
Electric Autolite Co., The
Gabriel Co., Rocket Power-Talco
General Laboratory Associates, Inc.
Hallett Mfg. Co.
George E. Harris & Co., Inc.
*HOLEX, INC.
Kilgore Inc., International Flare-Signal Div.
Leece-Neville Co., The
*MARTIN CO., THE, DENVER DIV.
J. E. Menaugh Co.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Rimak, Inc.
Rocketdyne Div.-North American Aviation, Inc.
Scintilla Div., Bendix Aviation Corp.
Servicair Co.
Skytronics, Inc.
Southwest Research Institute
Thor Ceramics, Inc.
Titeflex, Inc.

IGNITION ASSEMBLIES, SOLID ROCKET

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS
*AEROJET-GENERAL CORP.
Amcel Propulsion Inc.
American Potash & Chemical Corp., National Northern Div.
American Rocket Co.
Auburn Spark Plug Co., Inc.
Beckman & Whitley, Inc., Missile Products Div.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
Bermite Powder Co.
A. M. Byers Co.
*EXCELCO DEVELOPMENTS INC.
Food Machinery & Chemical Corp., Ordnance Div.
Gabriel Co., Rocket Power-Talco
Grand Central Rocket Co.
Hallett Mfg. Co.
Hercules Powder Co., Chemical Propulsion Div.
Hicks Corp., The
*HOLEX, INC.
Kilgore Inc., International Flare-Signal Div.
Librascope Div., General Precision, Inc.
*MARTIN CO., THE, DENVER DIV.
Mc Cormick Selph Associates
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Plastic Age Sales, Inc.
Propellex Chemical Div., Chromalloy Corp.
Scintilla Div., Bendix Aviation Corp.
Solar Aircraft Co.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation
Southwest Research Institute
Thiokol Chemical Corp., Hunter-Bristol Div.
Thiokol Chemical Corp., Redstone Div.

IGNITION SYSTEMS, AIRBORNE

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS
American Potash & Chemical Corp., National Northern Div.
Auburn Spark Plug Co., Inc.
Beckman & Whitley, Inc., Missile Products Div.
Bendix Aviation Corp.
Bermite Powder Co.
Gabriel Co., Rocket Power-Talco
General Electric Co., Rocket Engine Section
General Laboratory Associates, Inc.
Hallett Mfg. Co
George E. Harris & Co., Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
*MARTIN CO., THE, DENVER DIV.
J. E. Menaugh Co.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Skytronics, Inc.

IGNITION SYSTEMS, ELECTRONIC

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS
American Potash & Chemical Corp., National Northern Div.
Auburn Spark Plug Co., Inc.
Bendix Aviation Corp.
Bermite Powder Co.
Electric Autolite Co., The
Engrg. Specialties
General Laboratory Associates, Inc.
Hammett-Mercury-Rex Div.
*HOLEX, INC.
Lear, Inc.
Librascope Div., General Precision, Inc.
*MARTIN CO., THE, DENVER DIV.
Modelectric Products Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Rimak, Inc.
Scintilla Div., Bendix Aviation Corp.

IGNITION TUBE ASSEMBLIES

American Potash & Chemical Corp., National Northern Div.
Bermite Powder Co.
*DEL MAR ENGRG. LABS.
Food Machinery & Chemical Corp., Ordnance Div.
General Laboratory Associates, Inc.
Lamtex Industries Inc.
J. E. Menaugh Co.
Norrich Plastics Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Plastic Age Sales, Inc.
Scintilla Div., Bendix Aviation Corp.

IMPELLERS

Aero Mfg. & Mach. Co., Inc.
Allison Div., General Motors Corp.
American Insulator Corp.
Beckman & Whitley, Inc., Missile Products Div.
Bendix Utica Div., Bendix Aviation Corp.
Bethlehem Steel Co.
A. M. Byers Co.
Capital City Mfg. Co., Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
*EXCELCO DEVELOPMENTS INC.
General American Transportation Corp.
George Gorton Machine Co.
Jarvis Corp.
Kerns Mfg. Corp.
Lycoming Div., Avco Corp.
Small Motors Inc.
Stalker Corp., The
Sundstrand Turbo
Tapco Group, Thompson Ramo Wooldridge Inc.
Therm, Inc.
Thompson Ramo Wooldridge Inc.
Worthington Corp.

INCLINOMETERS

A. Biederman, Inc.
Eastman Kodak Co.
*ENGIS EQUIPMENT CO.
Integrated Dynamics Div., Globe Industries, Inc.
A. Lietz Co., The
Micro Gee Products, Inc.
Spectra Electronics Corp.
Warren-Knight Co.

INDICATORS

a. Antenna Position
b. Arc-Back
c. Arc-Over
d. Capacitor Leakage
e. Data Display
f. Detonation Indicators & Meters
g. Deviation
h. Dew Point
i. Dielectric Constant
j. Film Thickness
k. Fluid Conductivity
l. Fluid Flow, Electronic
m. Frequency
n. Fuel Flow Rate
o. Fuel Mixture
p. Humidity
q. Illumination
r. Liquid Level
s. Magnetic Field
t. Materials Thickness
u. Miss-Distance
v. Modulation
w. Moisture
x. Null
y. Null-Balance
z. Oxygen
a-1. Ph
b-1. Photographic Exposure
c-1. Plan Position
d-1. Pressure
e-1. Proximity
f-1. Pulse Timer Riser
g-1. Radiation
h-1. Radiation, Nuclear
i-1. Recording Engine
j-1. Remote
k-1. Servo
l-1. Smoke & Combustion, Electronic
m-1. Sound Level
n-1. Specific Gravity
o-1. Speed
p-1. Strain
q-1. Telemetering
r-1. Temperature
s-1. Thrust
t-1. Timing
u-1. Torque
v-1. Vacuum
w-1. Variable
x-1. Vibration
y-1. Volume
z-1. Weight
a-2. Wind Direction
b-2. Wind Speed, Electronic

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, r, u-1.
ACF Industries Inc., d-1, v-1.
ASCOP Div., Electro-Mechanical Research, Inc., q-1.
*ABRAMS INSTRUMENT CORP., t-1.
Acromag Inc., m.
Actuator Products Div., Geartronics Corp., o-1.
Admiral Corp., c-1.
Advance Instrument Corp., e, p, j-1, k-1, r-1, a-2.
Advanced Electronics, Inc., x-1.
Aero Instrument Co., m, t-1.
Aero Supply Mfg. Inc., l.
*AEROJET-GENERAL CORP., d-1.
Aeronca Mfg. Corp.-Aerospace Div., e, u, e-1, q-1.
Aeroscience, Inc., m, p-1, s-1, u-1, y-1, z-1.
Aerotec Industries Inc., Aircraft Equipment Div., n, r, z, d-1, v-1.
Ainslie Corp., a.
Air Products, Inc., z.
Airaterra, r.
Aircraft Armaments, Inc., u.
Aircraft Instruments Co., r, c-1, d-1.
*AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., l, n, d-1, k-1, r-1, y-1, z-1.
Airpax Electronics Inc., Cambridge Div., m.
Airpax Electronics Inc., Seminole Div., m.
Allard Instrument Corp., e.
Allegany Instrument Co., Inc., p-1, s-1.
Allied International Corp., a, v-1.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., q-1.
American Instrument Co., Inc., h, j, p, t, a-1, d-1, p-1, r-1, v-1.
American Machine & Foundry Co., Government Products, N. Y., m, t.
American Research & Mfg. Corp., x-1.
American Tradair Corp., h-1.
B. C. Ames Co., t.
Amthor Testing Instrument Co., Inc., o-1.
Analytical Measurements, Inc., w, a-1.
Andersen Labs., Inc., r-1.
Antlab Inc., a, k-1, q-1.
Applied Electronics Corp. of N. J., e, q-1.

*ARNOUX CORP., e, q-1, r-1.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., r, z.
Associated Research, Inc., d, i.
Auto-Control Labs. Inc., n.
Automatic Timing & Controls, Inc., l, r, x, d-1, e-1, k-1, t-1, y-1, z-1.
Automation Products, Inc., o, r, n-1.
Autotronics Inc., u-1.
Avien, Inc., n, o, r, y, q-1, r-1.
Avtron Mfg., Inc., v.

B & H Instrument Co., Inc., l, m, n, x, y, d-1, i-1, k-1, o-1, q-1, r-1, z-1.
B & K Instruments, Inc., m-1, x-1.
Baird-Atomic, Inc., g-1, h-1.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., y, p-1, u-1, z-1.
Barnes Development Co., d, x, y.
Beckman Instruments, Inc., Berkeley Div., e, l, m, n, j-1, o-1, r-1, t-1.
Beckman & Whitley, Inc., Instrument Div., r-1, a-2, b-2.
Belock Instrument Corp., e, j-1, k-1, t-1.
Bendix Aviation Corp., a, e, g, h, l, n, o, p, r, u, w, z, d-1, e-1, g-1, h-1, j-1, k-1, l-1, o-1, q-1, r-1, v-1, x-1, a-2, b-2.
Bendix Aviation Corp., Cincinnati Div., e, m, w, g-1, h-1.

Bendix Aviation Corp., Montrose Div., **a, e, g, l, n, d-1, j-1, o-1, s-1, u-1, a-2.**
Bendix Aviation Corp., Pioneer-Central Div., **l, n, r, z.**
Bendix Corp., The, Eclipse-Pioneer Div., **j-1, k-1.**
Benson-Lehner Corp., **e, l.**
Bergen Labs., Inc., **r-1, u-1.**
James G. Biddle Co., **m, o-1.**
A. Biederman, Inc., **a, n, o, z, d-1, o-1, r-1, s-1, u-1, v-1, a-2.**
Blonder-Tongue Labs. Inc., Special Products Div., **r-1.**
Boonton Electronics Corp., **x.**
Boston Auto Gage Co., The, **r.**
Bowmar Instrument Corp., **a, g, k-1, t-1, w-1, a-2.**
Bowser Inc., Defense Div., **n.**
Branson Instruments, Inc., **t.**
***BRISTOL CO., THE, h, p, r, y, d-1, k-1, q-1, r-1, v-1.**
Brooks Rotameter Co., **l, n, o, r, n-1.**
Bruno-New York Industries Corp., **u, y, q-1.**
Budd Co., The, **p-1, u-1.**
Budd Lewyt Electronics, Inc., **e, m, c-1, k-1.**
Bulova Research & Development Labs., Inc., **d-1, k-1, o-1, q-1, t-1, u-1.**
Burr-Brown Research Corp., **x.**
Burroughs Corp., Electronic Tube Div., **e.**
Bytrex Corp., **n, x, y, j-1, k-1, p-1, s-1, u-1, z-1.**
CG Electronics Corp., **a, e.**
California Plasteck Inc., **q.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **k-1.**
Carling Electric, Inc., **q.**
Cedar Engrg. Div.-Control Data Corp., **k-1.**
Central Scientific Co., **a-1, v-1.**
Chalco Engrg. Corp., **e.**
City Chemical Corp., **a-1.**
Clark Electronic Laboratories, **d-1, z-1, b-2.**
Coleman Instruments, Inc., **a-1.**
Collins Radio Co., **g, c-1.**
Colvin Labs., Inc., **j, q.**
Conoflow Corp., **r, d-1.**
Consolidated Airborne Systems, Inc., **r, x, y, k-1.**
Consolidated Controls Corp., **d-1, s-1.**
***CONSOLIDATED ELECTRODYNAMICS CORP., e, w, d-1, p-1, q-1, v-1, x-1.**
Consolidated Vacuum Corp., **v-1.**
Continental Electric Co., **v-1.**
Convair Instruments, Convair Div.-General Dynamics Corp., **k-1.**
Control Sw. Div. Controls Co. of America, **e, q.**
Courier Products, Div.-Model Engrg. & Mfg., Inc., **e, l, d-1.**
Cox Instruments Div., George L. Nankervis Co., **e, l, m, n, d-1, i-1, j-1, k-1, n-1, o-1, p-1, r-1, s-1, u-1, w-1, z-1.**
Cramer Controls Corp., **t-1.**
Crescent Engrg. & Research Co., **l, x, d-1, k-1, o-1, q-1.**
Cubic Corp., **u.**
DBM Research Corp., **p, w.**
Dalmo Victor Co., Div.-Textron, Inc., **k-1.**
Datascan Inc., **b, c, e.**
Daven Co., The, **y-1.**
Joe Davidson & Associates, **o-1, r-1, u-1.**
Daystrom, Inc., Military Electronics Div., **e.**
Daystrom Inc., Transicoil Div., **a, e, j-1, k-1, b-2.**
Daystrom Inc., Weston Instruments Div., **m, p, q, v, w, x, b-1, m-1, o-1, r-1, t-1, y-1.**
Daytronic Corp., **t, p-1, u-1**
Decker Corp., The, **i, j, l, m, p, r, t, w, d-1, e-1, n-1, u-1, x-1**
Deiur-Amsco Corp., Electronic Sales Div., **b-1, r-1, t-1**
***DEL MAR ENGRG. LABS., e, u.**
Delsen Corp., **i, t, y.**
Desomatic Products, Inc.-Anders-Driline, **h, w.**
Draught Corp., **e.**
Diamond Power Specialty Corp., **r.**
J. W. Dice Co., **j, t.**
Henry G. Dietz Co., Inc., **n.**
Digitel Sensors Inc., **j-1, t-1.**
W. C. Dillon & Co. Inc., **r-1, u-1, z-1.**
Dreyer Hanson Div.-Crane Co., **a.**
Driaire Inc., **p, w.**
Allen B. Du Mont Labs., Inc., **e, u, i-1.**
Dumont Engrg. Co., **r.**
Eastern Industries Inc., **p.**
Eastman Kodak Co., **u, b-1, d-1, e-1, q-1, t-1.**
Eberline Instrument Corp., **g-1, h-1.**
Eclipse-Pioneer Div.-Bendix Aviation Corp., **k-1, u-1.**
Edcliff Instruments, **d-1.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **d-1, k-1, r-1.**
Edwards High Vacuum Ltd., **d-1, v-1.**
Ertel-McCullough, Inc., **v-1.**
Electro Instruments Inc., **d, e, g, i, m, j-1.**
Electro Products Labs., Inc., **e-1, o-1, t-1.**
Electronic Control Corp., **l-1.**
Electron Radar Products, **h, p, w.**
Ellison Draft Gage Co., Inc., **w, z, d-1, v-1.**
Emerson Radio & Phonograph Corp., **e-1, t-1, h-1, j-1, q-1, x-1, a-2, b-2.**
Engelhard Industries, Inc., **z.**
Epic, Inc., **m, x, r-1, x-1.**
***EQUIPMENT DIV., RAYTHEON CO., a, e, u, c-1.**
Erie Instrumation, Div.-Erie Resistor Corp., **e.**
Erie Resistor Corp., **l, m, q-1, r-1, t-1.**
Eureka Williams Corp., **p.**
Exact Engrg. & Mfg. Inc., **k-1.**
FXR, Inc., **m.**
FAE Instrument Corp., **k-1, o-1.**
Federal Products Corp., **t.**
Feedback Controls, Inc., **k-1.**
Fenwal Inc., **k-1, l-1 r-1.**
Fischer & Porter Co., **l, n, r, r-1.**
Fisher Scientific Co., **z, a-1, n-1, r-1, v-1.**
Fisher Scientific Co., Maryland, **h, p, a-1, n-1, r-1, v-1, z-1.**
Flight Refueling, Inc., **r.**
Flow Measurements Corp., **l, n.**

Fluid Power Inc., **z.**
Freed Transformer Co., Inc., **x.**
Friez Instrument Div., Bendix Aviation Corp., **p, d-1, q-1, a-2, b-2.**
Furane Plastics, Inc., **i, j.**
Gardner Laboratory, Inc., **j, p, t, w, q-1, n-1, a-2.**
Garwin, Inc., **n, d-1, r-1.**
General Communication Co., **n-1.**
General Controls Co., **r, d-1, j-1, r-1.**
General Devices, Inc., **v, v, f-1, q-1, t-1.**
General Electric Co., Apparatus Sales Div., **m, n, t, b-1, h-1, j-1, k-1, l-1, o-1, r-1, s-1, v-1, x-1.**
General Electric Co., Instrument Dept., **n, r, c-1, k-1, r-1, u-1.**
General Electric Co., Missile & Space Vehicle Dept., Pa
General Instrument Corp., Defense & Engrg. Products Group, **e, c-1, j-1, q-1.**
General Radio Co., **i, m, v, x, y, m-1, x-1.**
Gilfillan Bros. Inc., **a, q-1.**
Gilmore Industries, Inc., **e, l, n, x, y, d-1, i-1, k-1, n-1, o-1, p-1, r-1, s-1, u-1, z-1.**
Glassco Instrument Co., **d-1, v-1.**
Good Electronic Corp., **b-2.**
Gordon Enterprises, **b-1.**
Graflex Inc., **e, k-1.**
Greibach Instruments Corp., **x.**
Gulton Industries, Inc., **a, e, l, r, d-1, k-1, m-1, q-1, r-1, x-1.**
W. & L. E. Gurley, **a-2, b-2.**
B. H. Hadley, Inc., **r.**
Haledy Electronics Co., **l, r.**
Hallamore Electronics Co., Div.-Siegler Corp., **a, q-1.**
Hallicrafters Co., The, **e.**
Hammett-Mercury-Rex Div., **k-1, q-1.**
Hathaway Instruments, Inc., **r-1.**
A. W. Haydon Co., The, **j-1, q-1, t-1.**
Hays Corp., The, **z, a-1, d-1, j-1, k-1, v-1.**
Hazeltine Electronics Div.-Hazeltine Corp., **e.**
Hickok Electrical Instrument Co., The, **p, r, w, a-2.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., **v-1.**
E. Vernon Hill & Co., **h, p, w, d-1, o-1, r-1, v-1, x-1.**
John W. Hobbs Corp., Div.-Stewart-Warner Corp., **t-1.**
Hoffman Electronics Corp., Military Products Div., **s-1.**
Honeywell, Marion Instruments Div., **e, g, u, x.**
Hoover Electronics Co., **q-1.**
Houston Fearless Corp., **a.**
Humidial Co., **p.**
Huyck Systems Co., **e, l, n, k-1, a-2, b-2.**
Walter J. Hyatt Co., The, **d-1.**
I-L-S Instrument Div., The Meriam Instrument Co., **l, m, n, r, e-1, f-1, o-1, t-1, u-1.**
ITT Federal Div., International Telephone & Telegraph Corp., **e, k-1, b-2.**
Ideal-Aerosmith, Div.-Royal Industries, Inc., **d-1.**
Illinois Testing Laboratories, Inc., **h, r-1.**
Image Instruments, Inc., **e, j-1, y-1.**
Impact-O-Graph Corp., The, **n-1, s-1.**
Imperial Brass Mfg. Co., The, **r.**
Industrial Acoustics Co., Inc., **m-1.**
Industrial Control Co., **a, d, x, y.**
Industrial Electronic Engineers, Inc., **e.**
Industrial Instruments Inc., **d, i, k, r.**
Industrial Test Equipment Co., **d, x, y.**
Industrial Timer Corp., **t-1.**
Ingraham Co., The, **t-1.**
Instrument Div., The Budd Co., **g-1, p-1.**
Intercontinental Electronics Corp., **c-1.**
International Electronic Research Corp., **n, g-1, h-1, j-1, z-1.**
Interstate Electronics Corp., **u, g-1, h-1, q-1.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **r, t, h-1.**
Jeffrey Mfg. Co., The, **t.**
Kahn & Co., Inc., **h, m, p, r-1.**
Kay Electric Co., **m, x-1.**
***KEARFOTT DIV., GENERAL PRECISION, INC., e, d-1, j-1, k-1, o-1, r-1, u-1, a-2, b-2.**
Keithley Instruments, Inc., **x, y.**
Wayne Kerr Corp., **d, i, j, e-1, x-1.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **r-1.**
Kieley & Mueller, Inc., **r.**
Kin Tel Div.-Cohu Electronics, Inc., **x.**
Kistler Instrument Corp., **s-1, x-1.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **e, u, d-1, j-1, k-1, o-1, r-1, s-1, b-2.**
Lab. for Electronics, Inc., **e, q-1.**
Lampkin Labs., Inc., M.R. Div., **g, m, v.**
Langley Corp., **r-1.**
Leor, Inc., **a, d, e, g, k, l, n, o, p, r, s, u, w, y, c-1, d-1, i-1, j-1, k-1, o-1 thru s-1, u-1, v-1, b-2.**
Leeds & Northrup Co., **k, q, x, y, a-1, r-1.**
Leetronics, Inc., **j-1.**
***WALLACE O. LEONARD, INC., r, x, y, d-1, k-1, o-1, q-1, v-1.**
***LEWIS ENGRG. CO., THE, y, r-1.**
Liquidometer Corp., The, **r, x, y, z, k-1, n-1, r-1, y-1.**
Lockheed Aircraft Corp., Missiles & Space Div., **u, q-1.**
MB Electronics, **x-1.**
Madigan Corp., **a, e, l, n, u, c-1, d-1, k-1, q-1, s-1, a-2, b-2.**
Magnaflux Corp., Sub.-General Mills, Inc., **s, t, p-1.**
Magnetic Circuit Elements, Inc., **j-1.**
Magnetic Instrument Co., Inc., **r, r-1.**
Magtrol, Inc., **u-1.**
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co., **x.**
Marsh Instrument Co., Div.-Colorado Oil & Gas Corp., **d-1, r-1, v-1.**
***MARTIN CO., THE, DENVER DIV., e, g, m, j-1, k-1, p-1.**
Mason-Neilan, **r.**
W. L. Maxson Corp., The, **n, r, j-1.**
Metron Instrument Co., **o-1, u-1.**
Milgo Electronic Corp., **e, k-1.**
James Millen Mfg. Co. Inc., **v, x, y.**
Minco Products, Inc., **r-1.**
Mine Safety Appliances Co., **h, m, r, z, m-1.**
Minneapolis-Honeywell Regulator Co., Aeronautical Div., **r, x, y, z.**
Minneapolis-Honeywell Regulator Co., Boston Div., **a, y.**
Mira Corp., The, **z.**
Mitchell Camera Corp., **e, d-1, j-1, k-1, r-1, s-1.**
Molded Insulation Co., **p, r-1.**
J. J. Monaghan Co., Inc., **y-1.**
Motorola, Inc., **e, u, v, c-1, e-1, j-1, q-1.**
Muirhead Instruments Inc., **t, x, y, k-1.**
NUMEC-Nuclear Materials & Equipment Corp., **g-1, h-1, y-1, z-1.**

National Co., Inc., **e, m, u, q-1, v-1.**
National Cylinder Gas, Div.-Chemetron Corp., **z.**
National Electronics, **m, o-1, r-1.**
Navigation Computer Corp., **e.**
New England Scientific Instruments Co., **p, a-1.**
New London Instrument Co. Inc., **g, v.**
Non-Linear Systems, Inc., **e, g.**
Northrop Corp., **j.**
Nuclear Corp. of America, **r, h-1.**
Nuclear Measurements Corp., **h-1.**
Nuclear-Chicago Corp., **g-1, h-1.**
Ohmart Corp., The, **h-1.**
Optomechanisms Inc., **b-1.**
Orbitran Co., Inc., **s-1, z-1.**
John Oster Mfg. Co., Avionic Div., **l, d-1, k-1, s-1.**
Owen Labs., Inc., **p-1.**
Oxygen Equipment & Service Co., **z.**
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y., **a, j-1.**
Paco Electronics Co., Inc., **d.**
Palmer Thermometers, Inc., **p, r-1.**
Panoramic Radio Products, Inc., **g, m, v, q-1, x-1.**
Ralph M. Parsons Co., The, Electronics Div., **u, e-1.**
Patterson Moos Research, Div.-Leesona Corp., **e-1, g-1, t-1.**
Patwin, Div.-Patent Button Co., **e.**
Penn Keystone Corp., **e, r, c-1, j-1.**
Performance Measurements Co., **n, y, d-1, j-1, k-1, n-1, o-1, p-1, r-1, s-1, u-1, z-1.**
Philco Corp.-Govt. & Industrial Group, **e.**
Philips Electronic Instruments, **j.**
Photocon Research Products, **d-1, e-1.**
Photovolt Corp., **a-1, b-1.**
Pimex, Inc., **p, w, a-1, r-1.**
Pitometer Log Corp., **g, m, o-1, u-1.**
Pittsburgh Lectrodryer Div.-Mc Graw-Edison Co., **h.**
Polarad Electronics Corp., **k-1.**
Polyphase Instrument Co., **p-1.**
Potter Aeronautical Corp., **l, m, n, n-1, a-1.**
Powers Regulator Co., The, **r-1.**
Precision Thermometer & Instrument Co., **p, r-1, v-1.**
Process & Instruments, **v-1.**
Pyrometer Instrument Co., Inc., **r-1.**
Radalab Inc., **a.**
Radiation Instrument Development Lab., Inc., **h-1.**

*RADIO CORP. OF AMERICA, a, d, e, g, i, j, l, m, p, t, e-1, j-1, k-1, m-1, v-1.
Radio Development & Research Corp., n, z, o-1.
Radio Receptor Co., Inc., Sub.-General Instrument Corp., e, c-1, j-1, q-1.
Radio Specialty Mfg., Co., g.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., q-1.
Rawson Electrical Instrument Co., s.
Reeves Instrument Corp., k-1.
Republic Mfg. Co., d-1.
Research Indsl. Lab. of Electronics, j, v-1.
Revere Corp. of America, Sub., Neptune Meter Co., l, n, r, s-1, z-1.
Robbins Aviation, Inc., h.
Rochester Mfg. Co. Inc., r, d-1, r-1, v-1.
Rosemount Engrg. Co., d-1, r-1.
Milton Roy Co., r, z, a-1, e-1.
Roylyn Inc., r.
St. John X-Ray Laboratory, g-1, h-1.
Schaevitz Engrg., t, k-1, s-1.
Schutte & Koerting Co., n-1.
Scientific-Atlanta, Inc., a.
H. H. Scott, Inc., x, y, m-1, x-1.
Scott Aviation Corp., z.
Serdex, Inc., p.
Servomechanisms, Inc., e, o, r, d-1, k-1, s-1, a-2, b-2.
Servo-Tek Products Co., j-1, k-1, o-1.
Shallcross Mfg. Co., x, y.
Sierra Electronic Corp., Div.-Philco Corp., q-1, v-1.
Sierra Engrg. Co., z, d-1.
Sigma Instruments, Inc., e.
Sillcocks-Miller Co., h, p, g-1, r-1.
Simmonds Aerocessories, Inc., l, n, r, d-1.
Simpson Electric Co., d, x, r-1.
Skiatron Electronics & Television Corp., e.
Skidmore-Wilhelm Mfg. Co., u-1.
Southwest Research Institute, a, e, h, k, l, n, o, p, r, u, w, z, a-1, b-1, d-1, r-1, y-1, z-1, a-2, b-2.
Southwestern Industrial Electronics Co., x-1.
Specialties, Inc., e, k-1.
Specialty Electronics Development Corp., g-1, h-1, q-1, a-2, b-2.
Spectra Electronics Corp., e-1, g-1, r-1.
Spectrol Electronics Corp., e, j-1, k-1.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., m, g-1.
Sperry Piedmont Co., Div.-Sperry Rand Corp., e, j-1.
L. S. Starrett Co., The, t.
M. C. Stewart, a-2, b-2.
Herman H. Sticht Co., Inc., m.
Stromberg-Carlson Div.-General Dynamics Corp., e, q-1, t-1.
Summers Gyroscope Co., j-1.
Sun Electric Corp., Aeronautical Div., d, m, n, o, v, d-1, j-1, q-1, t-1, v-1, x-1, a-2, b-2.
B. K. Sweeney Mfg. Co., d, e-1, u-1.
Systron Corp., e, m, n, o, t-1.
TRG, Inc., a, g-1, h-1, a-2, b-2.
*TABER INSTRUMENT CORP., d-1, r-1.
Tally Register Corp., e.
Topco Group, Thompson Ramo Wooldridge Inc., k-1.
W. A. Taylor & Co., a-1.
Technical Development Co., r.
Technique Associates Div., Duncan Electric Co., Inc., r-1.
Technology Instrument Corp., d-1.
Telechrome Mfg. Corp., e, l, r, p-1, q-1, t-1.
Temperature Engrg. Corp., r-1, v-1.
Texas Instruments Inc., u-1.
Thermo Electric Co., Inc., l, p, r, y, a-1, d-1, k-1, m-1, o-1, p-1, r-1.
Theta Instrument Corp., a, x, y, j-1, k-1.
Thompson Ramo Wooldridge Inc., k-1.
Tracerlab Inc., j, r, h-1, z-1.
Traid Corp., b-1.
Transco Products, Inc., a.
Transicoil Div.-Daystrom Inc., e, k-1.
Transistor Electronics Corp., e.
Trans-Sonics, Inc., l, r, u, d-1, r-1, v-1.
Trepac Corp. of America, g, j-1.
Trimount Instrument Co., i.
Trio Laboratories, Inc., g, k-1.
Union Switch & Signal, Div.-Westinghouse Air Brake Co., e.
Unit Process Assemblies, Inc., j, t.
United Electric Controls Co., r-1.
U. S. Science Corp., Div.-Topp Industries, Inc., e, b-1, c-1, k-1.
Universal Dynamics Corp., p.
Universal Transistor Products Corp., g-1, h-1, j-1.
Vacuum Tube Products, Div.-Hughes Aircratt Co., v-1.
Varo Mfg. Co., Inc., g, m, v, x, k-1, o-1.
Veeco Vacuum Corp., v-1.
Vickers, Inc., Mich., r, o-1, y-1.
Victoreen Instrument Co., g-1, h-1.
Victory Engrg. Corp., l, r, r-1.
Video Instruments Co., Inc., x, y, p-1.
Virginia Electronics Co., Inc., y-1.
Wacline, Inc., m, o-1.
Wallace & Tiernan Inc., r, a-1, d-1, n-1, r-1.
Warren Components, Div.-El-Tronics, Inc., p, w.
Waugh Engrg. Co., l, m, n.
Weksler Instruments Corp., p, d-1, r-1.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., a-1, b-1.
Wells Industries Corp., h, p thru s, w, j-1, l-1, n-1, r-1, t-1, z-1.
Westberg Mfg. Co., m, o-1, a-2, b-2.
Westinghouse Electric Corp., e, m, h-1.
Westronics Inc., e, k thru n, p, q, r, t, w, x, y, a-1, g-1, h-1, j-1, k-1, n-1, o-1, p-1, r-1, s-1, u-1, v-1, z-1.
Wind Turbine Co., a.
Wollensak Optical Co., b-1.
Zep Aero, z.

INDUCTANCE SPECIALTIES, MEASUREMENT

Coil Co. of America
Electro Instruments, Inc.
Electro Scientific Industries
Electronic Applications, Inc.
Freed Transformer Co., Inc.
General Instrument Corp., Defense & Engrg. Products Group
General Radio Co.
Industrial Instruments Inc.
*MARTIN CO., THE, DENVER DIV.
Optomechanisms Inc.
*RADIO CORP. OF AMERICA
Servo Consultants Ltd.
Southwestern Industrial Electronics Co.
Sunshine Scientific Instrument

INDUCTANCES, VARIABLE

ACDC Electronics, Inc.
Barker & Williamson Inc.
CGS Labs., Inc.
Coil Co. of America
Corning Glass Works
Ferrotran Electronics Co., Inc.
Forbes & Wagner, Inc.
Freed Transformer Co., Inc.
Fugle-Miller Labs. Inc.
Gates Radio Co.
General Radio Co.
JFD Electronics Corp.
Johnson Electronics Inc.
Lear, Inc.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
Motorola, Inc.
Pulse Engrg. Inc.
*RADIO CORP. OF AMERICA
Servo Consultants Ltd.
Southwestern Industrial Electronics Co.
Stanwyck Winding Co., Inc.
Superex Electronics Corp.
Taffet Electronics, Inc.
Tele Coil Co.
Valor Instruments, Inc.
Vanguard Electronics Co.
Varo Mfg. Co., Inc.

INDUCTION HEATING EQUIPMENT

Airaterro
Allis-Chalmers
Cincinnati Milling Machine Co., The
Djeco, Div.-Djordjevic Engrg. Co.
Eisler Engrg. Co., Inc.
Erdco Engrg. Corp.
General Electric Co., Apparatus Sales Div.
General Electrodynamics Corp.
C. I. Hayes, Inc.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Hobart Brothers Co.
Induction Heating Corp.
Industron Corp.
Lepel High Frequency Labs. Inc.
Lindberg Engrg. Co.
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co.
*MARTIN CO., THE, DENVER DIV.
Motor Generator Corp.
Radio Frequency Co., Inc.
Reeve Electronics, Inc.
Roylyn Inc.
Scientific Electric Inc.
Sherman Indsl. Electronics Co., Div.-Electronic Development Inc.
Tocco Div., The Ohio Crankshaft Co.
Westinghouse Electric Corp.

INDUCTORS

ACDC Electronics, Inc.
ADC Inc.
Aladdin Electronics, Div.-Aladdin Industries Inc.
Associated Engineers, Inc.
Barker & Williamson Inc.
Barwood Electronics Inc.
Burnell & Co., Inc.
Caledonia Electronics & Transformer Corp.
Cambridge Thermionic Corp.
Communication Accessories Co.
Computer Engrg. Associates, Inc.
Corning Glass Works
De Havilland Aircratt of Canada, Ltd., Special Products Div.
Deluxe Coils Inc.
Electronic Transformer Co., Inc.
Ferrotran Electronics Co., Inc.
Filtron Co., Inc.
Fisher Engrg., Inc
Forbes & Wagner, Inc.
Freed Transformer Co., Inc.
Fugle-Miller Labs. Inc.
Gates Radio Co.
General Radio Co.
Genistron, Inc.
Donald C. Harder Co
Induction Heating Corp.
JFD Electronics Corp.
Johnson Electronics Inc.
Lear, Inc.
Lindberg Engrg. Co
Magnetic Circuit Elements, Inc.
*MARTIN CO., THE, DENVER DIV.
Merit Coil & Transformer Corp.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
National Coil Co.
National Co., Inc.
Networks Electronic Corp.
New York Transformer Co. Inc.
Nytronics, Inc., Essex Electronics Div.
Palo Alto Engrg. Co.
Polyphase Instrument Co.
Pulse Engrg. Inc.
Redman Electronics Corp.
Servo Consultants Ltd.
Southwestern Industrial Electronics Co.
Sprague Electric Co.
Standard Electronics Div.-Reeves Instrument Corp.
Statham Instruments, Inc.
Tele Coil Co.
Topper Mfg. Co., Inc.
Torwico Electronics, Inc.
Transformer Design, Inc. of Milwaukee
Transformers, Inc.
Tresco, Inc.
U. E. Electronics Corp.
Valor Instruments, Inc.
Varo Mfg. Co., Inc.

INDUCTORS, COILS

ACDC Electronics, Inc.
ADC Inc.
Alladdin Electronics, Div.-Aladdin Industries Inc.
Arnold Magnetics Corp.
Barker & Williamson Inc.
Burnell & Co., Inc
CG Electronics Corp.
Caledonia Electronics & Transformer Corp.
Communications Accessories Co.
Cycle Transformer Corp.
De Havilland Aircratt of Canada, Ltd., Special Products Div.
Deluxe Coils Inc.
De Witt Development Co.
Electronic Transformer Co., Inc.
Ferrotran Electronics Co., Inc.
Filtron Co., Inc.
Fisher Engrg., Inc.
Forbes & Wagner, Inc.
Fugle-Miller Labs. Inc.
Gates Radio Co.
Genistron, Inc.
Donald C. Harder Co.
Induction Heating Corp.
JFD Electronics Corp.
Johnson Electronics Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc.
Lindberg Engrg. Co.
Magnetico, Inc.
*MARTIN CO., THE, DENVER DIV.
Merit Coil & Transformer Corp.
Mid-West Coil & Transformer Co.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
Motorola, Inc.
National Coil Co.
National Co., Inc.
Networks Electronic Corp.
New York Transformer Co. Inc
Nytronics, Inc., Essex Electronics Div.
Palo Alto Engrg. Co.

Polyphase Instrument Co
Redman Electronics Corp
Southwestern Industrial Electronics Co
Standard Electronics Div -Reeves Instrument Corp
Stanwyck Winding Co Inc
Stewart Warner Electronics Div
Tele Coil Co
Thermionic Products Co.
Topper Mfg Co., Inc
Torwico Electronics Inc
Transformer Design, Inc, of Milwaukee
Transformers Inc
U. E. Electronics Corp
Universal Toroid Coil Winding, Inc
Valor Instruments, Inc
Vanguard Electronics Co.
Vari-L Co Inc
Varo Mfg. Co., Inc
Virginia Electronics Co., Inc.

INFRARED

a. Cooling Systems
b. Detection Systems
c. Detector Cells
d. Image Converters
e. Optics
f. Systems
g. Systems, Guidance

ACF Electronics Div., ACF Industries Inc., **b, f, g.**
ACF Industries Inc., **b, c, f, g.**
Advance Industries, Inc., **f, g.**
Aeroflex Labs. Div., Aeroflex Corp., **g.**
***AEROJET-GENERAL CORP., a thru g.**
Air Products, Inc., **a.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, b.**
Alite Div., U. S. Stoneware Co., **b, c.**
American Instrument Co., Inc., **c.**
American Machine & Foundry Co., Government Products, N. Y., **b, e, f, g.**
American Optical Co., Instrument Div., **e, f, g.**
American Potash & Chemical Corp., National Northern Div , **f.**
Armament Div.-Universal Match Corp., **f.**
Aro Equipment Corp., The, **a.**
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., **a.**
Associated Engineers, Inc., **e.**
Avco Corp., Crosley Div., **f.**
Baird-Atomic, Inc., **b thru g.**
Ball Brothers Research Corp., **f.**
Bausch & Lomb Optical Co., **b, e, f, g.**
Beech Aircraft Corp., **f.**
Bendix Aviation Corp., **a, b, c, g.**
Bendix Aviation Corp., Pioneer-Central Div., **a.**
Bendix-Pacific Div., Bendix Aviation Corp., **b, f, g.**
Bermite Powder Co., **f.**
Bjorksten Research Labs. for Industry, Inc., **c, e.**
Blonder-Tongue Labs. Inc., Special Products Div., **b, c, d, f, g.**
Budd Lewyt Electronics, Inc., **a, b, f, g.**
Bulova Research & Development Labs., Inc., **b, e, f, g.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **e.**
Chance Vought Aircraft, Inc., **f, g.**
Connecticut Instrument Corp., **e.**
***CONSOLIDATED ELECTRODYNAMICS CORP., e.**
Continental Electric Co., **c.**
Cornelius Co., The, Aero Div., **a.**
Corning Glass Works, **e.**
Cryogenerators, Inc., **a, f.**
Dage Television Div., Thompson Ramo Wooldridge, Inc., **d.**
Joe Davidson & Associates., **f, g.**
Davidson Optronics, Inc., **e, f.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **b, e, f, g.**
Del Optics Co., Ltd., **e.**
Designers for Industry, Inc., **b, f, g.**
Douglas Aircraft Co., Inc., **b, f.**
Dow Corning Corp., **e.**
Allen B. Du Mont Labs., Inc., **b, d.**
Eastman Kodak Co., **b thru g.**
Edmund Scientific Co., **d, e, f.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **b, d thru g.**
***ENGIS EQUIPMENT CO., c, e.**
***EQUIPMENT DIV., RAYTHEON CO., b, c, f, g.**
J. W. Fecker Div., American Optical Co., **e.**
Fenwal Inc., **b, f.**
GPL Div.-General Precision, Inc., **f, g.**
Gabriel Co., Rocket-Power-Talco, **f.**
General Bronze Electronics Corp., **b, c, e.**
General Electric Co., Instrument Dept., **c, e.**
General Electric Co., Light Military Electronics Dept , **b, f, g.**
General Electric Co., Missile & Space Vehicle Dept Pa .
General Electrodynamics Corp., **d.**
General Instrument Corp., Defense & Engrg Products Group, **g.**
Gordon Enterprises, **b, e, f.**
Guided Missile Div., The Firestone Tire & Rubber Co., **b, c, e, f.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co., **f, g.**
Hallicrafters Co., The, **f, g.**
Hamilton Standard, Div.-United Aircraft Corp., **a.**
Hughes Semiconductor Div.-Hughes Aircraft Co., **e.**
Image Instruments, Inc., **f.**
Infrared Industries, Inc., **a, b, c, e, f, g.**
Interstate Electronics Corp., **g.**
Jeffrey Mfg. Co., The, **a.**
Joseph Kaye & Co., **a.**
***KEARFOTT DIV., GENERAL PRECISION, INC., f, g.**
Hugo P. Keller, Jr., **e.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **a.**
Kollmorgen Optical Corp., **e.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **b, e, f, g.**
Kopp Glass, Inc., **e.**
Lear, Inc., **b, c, e, f, g.**
Leetronics, Inc., **e.**
Liberty Mirror Div., Libbey-Owens-Ford Glass Co., **e.**
Librascope Div., General Precision, Inc., **b.**
Linde Co., Div.-Union Carbide Corp., **a.**
Marquardt Corp., The, **f.**
***MARTIN CO., THE, DENVER DIV.**
Mine Safety Appliances Co., **b.**
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., **b, f, g.**
Motorola, Inc., **b, d, g, g.**
Networks Electronic Corp., **b, c, f.**
Northrop Corp., **a, b, d thru g.**
Optical Coating Lab., Inc., **e.**
Optomechanisms Inc., **b.**
Ordnance Research & Development Co., Div.-Bermite Powder Co., **f.**
Pacific Optical Corp., Div.-Chicago Aerial Industries **b, e, f.**
Patterson Moos Research, Div.-Leesona Corp., **b, c, e, f, g.**
Perkin-Elmer Corp., **b, e, f.**
Pesco Products Div.-Borg-Warner Corp., **a, b.**
Philco Corp.-Govt. & Industrial Group, **b thru g.**
Photobell Co., Inc., **b.**
Polaroid Corp., **e.**
Precision Lapping Co. Inc., **e, f.**
Production Research Corp., Sub.-Radio Condenser Co., **b, f, g.**
Pyroferric Co. Inc., **d.**
Pyrotector Inc., **b, e.**
Radio Condenser Co., **b, f, g.**
***RADIO CORP OF AMERICA, b thru g.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **g.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **b, f, g.**
Republic Aviation Corp., Missile Systems Div., **b, e, f, g.**
Santa Barbara Research Center, **a thru e, g.**
Semi-Elements, Inc., **e.**
Singer Military Products Div.-The Singer Mfg. Co., **b, d thru g.**
Southwest Research Institute
Spectra Electronics Corp., **b, f, g.**
Spectracoat, Inc., **e.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **a.**
Sun Electric Corp., Aeronautical Div., **b.**
TRG, Inc., **b, e, f, g.**
Texas Instruments Inc., **b thru g.**
Thompson Ramo Wooldridge Inc., **b, f, g.**
Tinsley Labs , Inc , **e.**
Topper Mfg. Co., Inc., **f, g.**
U. S. Industries, Inc., **b, e, f, g.**
Valpey Crystal Corp., **e.**
Westinghouse Electric Corp., **a, b, c, g.**
Wollensak Optical Co., **e, f.**
Zenith Optical Laboratory, **e, f.**

INJECTION SYSTEMS, FUEL

B. H. Aircraft Co., Inc.
Bendix Aviation Corp
***BENDIX AVIATION CORP., HAMILTON DIV.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bowser Inc
Caterpiller Tractor Co., Defense Products Dept
Delavan Mfg. Co
***DEL MAR ENGRG. LABS.**
Ex-Cell-O Corp.
Lear Inc
Parker-Hannifin Corp
Simmonds Aerocessories, Inc.
Southwest Research Institute

INJECTION SYSTEMS, WATER

Agricultural Aviation Engineering Co. Inc
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp
Bowser Inc
Delavan Mfg. Co
Hydra-Power Corp.
Lear Inc
Tapco Group Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.

INSPECTION EQUIPMENT

a. Fluorescent
b. Lighting
c. Magnetic
d. Optical
e. X-Ray

Acme Industrial Co., **d.**
Advance Industrial X-Ray Labs., Inc., **a, c, e.**
American Cystoscope Makers Inc., **d.**
American Electronics, Inc., Nuclear Div.
American Optical Co., **d.**
American Optical Co., Instrument Div., **d.**
American Research & Mfg. Corp., **d.**
Automation Industries, Inc., **e.**
Baird-Atomic, Inc., **d.**
Bar-Ray Products, Inc., **e.**
Bausch & Lomb Optical Co., **d.**
Bendix Aviation Corp., **d, e.**
E. W. Bliss Co., **c, d, e.**
Blowers Inc. **b, d.**
Branson Instruments, Inc.,
Cleveland Instrument Co.,
Curtiss-Wright Corp., Metals Processing Div., **a, c, d, e.**
Curtiss-Wright Corp., Princeton Div., **a, e.**
Joe Davidson & Associates, **e.**
Davidson Optronics, Inc., **d.**
Daystrom Inc., Weston Instruments Div., **d, e.**
Delta Corp., **e.**
J. W. Dice Co., **c.**
Eastman Kodak Co., **d.**
Eder Instrument Co., Inc., **b, d.**
Edgerton, Germeshausen & Grier, Inc., **b.**
Engelhard Industries, Inc., National Electric Instrument Div., **d.**
Engrg. Developments, Inc., **a, d.**
***ENGIS EQUIPMENT CO., d.**
J. W. Fecker Div., American Optical Co., **d.**
General Electric Co., X-Ray Dept., **e.**
Gordon Enterprises, **d.**
Hammett-Mercury Rex Div., **d, e.**
High Voltage Engrg. Corp., **e.**
Holophane Co., Inc., **b.**
Image Instruments, Inc., **b, d, e.**
Instrument Div., The Budd Co., **c, e.**
Kollmorgen Optical Corp., **d.**
Lear, Inc., **d, e.**
Lenox Instrument Co., **d.**
Magnaflux Corp., Sub.-General Mills, Inc., **a, c.**
Marquardt Corp., The, **c, d.**
***MARTIN CO., THE, DENVER DIV., e.**
NUMEC-Nuclear Materials & Equipment Corp.,
Nuclear Development Corp. of America, **e.**
Optical Gaging Products, Inc., **d.**
Optomechanisms Inc., **d.**
Opto-Metric Tools, Inc., **d.**
Parker-Hartford Corp., The, **d.**
Pennsylvania Tool & Mfg. Co., The
Philips Electronic Instruments, **e.**
Photobell Co., Inc., **b.**
Pioneer Industries Div., Almar-York Co. Inc., **e.**
***RADIO CORP. OF AMERICA, c, e.**
Recony Div.,-Vinco Corp.
Resistron Labs., Inc., **e.**
Rimak, Inc., **a thru d.**
Rototest Labs., Inc., **e.**
St. John X-Ray Laboratory, **e.**
Shannon Luminous Mat., Affiliate-Curtiss-Wright, Princeton Div., **a thru d.**
Sperry Products Co., Div.-Howe Sound Co., **c, e.**
State Testing Laboratory Inc., **e.**
Sterling Glass Corp., **d.**
Strat-O-Seal Mfg. Co., **a, d.**
Sunshine Scientific Instrument, **c.**
Tinsley Labs., Inc., **d.**
Tracerlab Inc., **e.**
Turco Products, Inc., **a.**
Ultra-Violet Products, Inc., **a.**
United States Testing Co., Inc.,
Van Wagner Co., **b, c.**
Vapor Blast Mfg. Co.
Vinco Corp., **d.**
Westinghouse Electric Corp., **e.**
Wollensak Optical Co., **d.**

INSTRUMENTS, ELECTRICAL MEASURING

a. Ammeters
b. Audiometers
c. Bridges
d. Calibrators
e. Circuit Linearity
f. Comparators
g. Comparators Voltage
h. Galvanometers

i. Magnetometers
j. Megohmmeters
k. Microammeters
l. Microfaradmeters
m. Micromicroammeters
n. Milliammeters
o. Millivoltmeters
p. Ohmmeters
q. Panel
r. Ratiometers
s. Recorders
t. Standards
u. Tracers, Signal
v. Ultrasonic
w. Voltmeters
x. Volt-Ohm-Milliammeters
y. Wattmeters

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, a.
Adage, Inc., w.
Aero Instrument Co., q.
Aeronca Mfg. Corp.-Aerospace Div., f, g, s.
Aeroscience, Inc., d.
Air Logistics Corp., r.
Airpax Electronics Inc., Cambridge Div., a, k, n, o, w.
Airpax Electronics Inc. Seminole Div., a, k, n, o, w.
Allegany Instrument Co., Inc., c, d, r, s.
Allen Electric & Equipment Co., a, q, w, x,y.
Amco Engrg. Co., q.
American Machine & Foundry Co., Government Products Group, w.
American Machine & Foundry Co., Government Products, N. Y., s, w.
American Research & Mfg. Corp., f.
R. B. Annis Co., i.
Antlab Inc., s.
Arkay Engrg., Inc., g, t.
Assembly Products, Inc., a, k, n, o, q, w, y.
Associated Engineers, Inc., a, c, n, o, w, y.
Associated Research, Inc., j, k, n, p, q.
Atlantic Research Corp.
Automatic Timing & Controls, Inc., q.
Avien, Inc., g.
Avo Ltd., w.
B & H Instrument Co., Inc., c, d, h, n, o, w.
B & K Instruments, Inc., f, j, k, m, s, w.
Baird-Atomic, Inc.
Barnes Development Co., c, s.
E. Bauches S. A., Freeport Engrg. Co., t.
Beckman Instruments, Inc., Berkeley Div., s, w.
Belleville-Hexem Corp., k, m thru p, w, x.
Belmar Wheel & Machine Co., Inc., q.
Bendix Aviation Corp., g, i, s.
Bendix Aviation Corp., Cincinnati Div., a, k, m, w, y.
Benson-Lehner Corp., s.
James G. Biddle Co., h, j, k, p.
Boonton Electronics Corp., c, k, m, n, o, w.
Branson Instruments, Inc., v.
*BRISTOL CO., THE, a, c, n, o, s, w.
Bruno-New York Industries Corp., x, y.
Brunswick Instruments, r.
Brush Instruments, Div.-Clevite Corp., s, u.
Burr-Brown Research Corp., s, v, w.
Bytrex Corp., t.
CBS Laboratories, Div.-Columbia Broadcasting System, b, s, v.
Calvert Electronics Inc., a thru e, g thru u, w, x, y.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., s.
Century Electronics & Instruments, Inc., s.
Chemalloy Electronics Corp., y.
Circo Equipment Co., v.
Circo Ultrasonic Corp., v.
Clegg Labs., Div.-Clegg, Inc., c, f.
G. L. Collins Corp., g, r.
Consolidated Airborne Systems, Inc., f.
*CONSOLIDATED ELECTRODYNAMICS CORP., h, s, w.
Covel Mfg. Co., f.
Crescent Engrg. & Research Co., e.
Crosby-Teletronics Corp., k.
Cubic Corp., j, p, r, u, w, y.
Curtiss-Wright Corp., Princeton Div., a, c, e, f, n, o, p, s, v, x.
Datascan Inc., f, g.
Datex Corp., f.
Daven Co., The, c, w, x.
Davenport Mfg. Co., d, g, j, t.
Joe Davidson & Associates, c, j, o, p, w.
Daystrom Inc., Weston Instruments Div., a, d, g, h, j, k, n thru q, s, t, w, x, y.
Decker Corp., The, f.
Dejur-Amsco Corp., Electronic Sales Div., a, k, n thru q, w, x.
Djeco, Div.-Djordjevic Engrg. Co., g.
Dmeter Mfg. Co., c, f.
Allen B. Du Mont Labs., Inc., s.
Dynamics Instrumentation Co., o, w.
Dynatronics, Inc., d, f, g.
Dytronics Co., c, f, t.
Elcor. Inc., m.
Electric Autolite Co., The, s.
Electric Design & Mfg. Co., a, k, n, o, q, w.
Electro Impulse Lab., Inc., y.
Electro Instruments, Inc., a, c, d, f, g, j thru p, r, s, w, x.
Electro Scientific Industries, c, d, g, t.
Electronic Applications, Inc., c, p.
Elin Div., International Electronic Research Corp., d.
Eljay Corp., q.
Emertron, Sub.-Emerson Radio & Phonograph Corp., s.
Empire Products Sales Corp., d, t.
*ENGIS EQUIPMENT CO., h.
Epic, Inc., a, c, h, n, o, q, s, w, x, y.
Epsco Inc., w.
*EQUIPMENT DIV., RATYHEON CO., v.
Erdco Engrg. Corp., p.
Easterline-Angus Co., The, a, k, n, o, s, w, y.
FXR, Inc., r.
Federal Products Corp., f.
Fischer & Porter Co., d.
Fisher Scientific Co., Maryland, c, h, s.
Flight Support, Inc., q.
Flow Corp., w.
John Fluke Mfg. Co., Inc., d, o, w, y.
Franklin Electronics Inc., w.
Freed Transformer Co., Inc., c, f, j.
Garwin, Inc., a.
General Controls Co., s.
General Electric Co., Apparatus Sales Div., a, h, k, n, o, q, s, w, y.
General Electric Co., Instrument Dept., a, c, h, n thru s, w, x, y.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense* & Engrg. Products Group, c, v.
General Radio Co., c, d, f, j, k, m, o, s, t, w.
Gilmore Industries, Inc., s.
Gordon Enterprises, s.
Gray Instrument Co., c, f, g, p, t.
Greibach Instruments Corp., a, h, j, k, n thru q, w, x.
Gulton Industries, Inc., d, s, v.
Hallamore Electronics Co., Div.-Siegler Corp., d, o.
Hammett-Mercury-Rex Div., a, k thru o, q, w, x, y.
Hathaway Instruments, Inc., h, s.
Helipot Div.-Beckman Instruments, Inc., a, k, n, w.
Hewlett-Packard Co., a, c, d, j, k, m thru t, w, x, y.
Hickok Electrical Instrument Co., The, a, b, d, e, h, j thru q, w, x.
A. F. Holden Co., The, q.
Honeywell, Marion Instruments Div., a, k, n thru q.
Hoyt Electrical Instrument Works, Inc., Burton Rogers Co., a, k, n, o, q, w.
ITI Electronics, Inc., x.
Illionois Testing Laboratories, Inc., h.
Industrial Control Co., m, o.
Industrial Devices, Inc., w.
Industrial Instruments Inc., c, f, p.
Industrial Test Equipment Co., c, f, y.
Instrument Labs., x.
International Instruments Inc., a, k, n, o, q, w, x.
Interstate Electronics Corp., r.
Kahn & Co., Inc., c, d.
Kay Electric Co., d, s, w.
*KEARFOTT DIV., GENERAL PRECISION, INC., c, e, f.
Keithley Instruments, Inc., a, c, j, k, m thru p, w.
Wayne Kerr Corp., b, c, d, f, j, o, w, y.
Kin Tel Div.-Cohu Electronics, Inc., a, d, g, h, k, m, n, o, w.
Knopp Inc., t.
Lavoie Labs., Inc., f, t.
Lear, Inc., f, s.
Leeds & Northrup Co., c, h, k, m, p, s, t.
*WALLACE O. LEONARD, INC., r.
*LEWIS ENGRG. CO., THE, k, r.
Liquidometer Corp., The, j.
MB Electronics
Magnaflux Corp., Sub.-General Mills, Inc., i, v.
Maico Electronics, Inc., b, s.
Marconi Instruments, c, l, o, w, x, y.
Marion Instrument Div.,-Minneapolis-Honeywell Regulator Co., a, k, n, o, q, w.
*MARTIN CO., THE, DENVER DIV., d thru g, q, r, t.
Martindale Electric Co., a, j, w, x.
Massa Div.-Cohu Electronics, Inc., h, s, v.
Mc Millan Companies, The, f.
Meters Inc., a, h, j, k, n thru q, w, x.
Metronix, Inc., Sub.-Assembly Products, Inc., d, n, o, q, w.
Micrometrical Mfg. Co.,
Midwestern Instruments, Inc., c, h, s.
James Millen Mfg. Co. Inc., c, d, f.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., m, s.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., d.
Molded Insulation Co., o.
Motorola, Inc., d, w.
Muirhead Instruments Inc., c, t.
National Co., Inc., y.
National Electronics, a, h, j, k, n thru q, w, x, y.
New England Scientific Instruments Co., a, c, h, j, k, n, o, p, s, w, y.
New London Instrument Co. Inc., d, r.
Nilsson Electrical Lab., Inc., a, b, d, h, j, k, m thru t, w, x, y.
Non-Linear Systems, Inc., f, g, o, r, w.
Ernest Norrman Laboratories, d.
Northrop Corp.
Paul Nurches Co., o.
Orbitran Co., Inc., r.
Pace Electrical Instruments Co., Inc., a, h, k, n thru q, w, x.
Packard Bell Computer Corp., g, w.
Paco Electronics Co., Inc., a, c, k, n thru q, u, w, x.
Panoramic Radio Products, Inc., v.
Performance Measurements Co., r, s.
Phaostron Instrument & Electronic Co., a, k, n, o, w.
Photocon Research Products, d.
Photron Instrument Co., h, s.
Pimex, Inc., c, h, x.
Pioneer Industries Div., Almar-York Co. Inc., v.
Polarad Electronics Corp., r.
Potter Instrument Co., Inc., s.
Probescope Co. Inc., d, v.
Q. V. S. Inc., a, h, k, n thru q, w, x.
Quan-Tech Labs., Inc., a, k.
Radalab Inc., a, c, d, l thru p.
*RADIO CORP. OF AMERICA, w, x.
Rawson Electrical Instrument Co., k, n, o, t, w, y.
Reed Instrument Co., y.
Reed Research Inc., y.
Research Indsl. Lab. of Electronics, m.
Rinco, Inc., c.
Rochester Mfg. Co. Inc., a.
Sangamo Electric Co., a, q, s, w, y.
Scientific & Process Instruments Div.-Beckman Instruments, Inc., k.
H. M. Scott Co., The, q.
Sensitive Research Instrument Corp., a, d, f, g, h, k, n, o, q, r, t, w, y.
Servo Consultants Ltd., t.
Servo-Tek Products Co., d, p, w, x.
Shallcross Mfg. Co., c, h, j, k, n, o, w, x.
Sierra Electronic Corp., Div.-Philco Corp., y.
Simpson Electric Co., a, d, h, j, k, n thru q, t, w, x, y.
Slaughter Co., Inc., e, f, g, j.
Southwest Research Institute, v.
Southwestern Industrial Electronics Co., b, c, h, j, o, p, w.
Special Products Dept., Melpar, Inc., e, r.
Specialty Electronics Development Corp., w.
Herman H. Sticht Co., Inc., c, j, p, x.
H. W. Sullivan Ltd., c.
Sun Electric Corp., Aeronautical Div., a, b, k, n, o, q, w, y.
Sunshine Scientific Instrument, a, d, f, j, k, m thru q, t, w, x, y.
Superior Electric Co., The, v.
B. K Sweeney Mfg. Co., j, l, w.
Systron Corp., j, k, n, o, p, r, w, x.
TRG, Inc., t.
Taffet Electronics, Inc., c, d, e.
Technique Associates Div., Duncan Electric Co., Inc., a, w.
Technology Instrument Corp., c, d, h, n, o, p, s, t, w, x.
Tektronix, Inc., l, m.
Telechrome Mfg. Corp., r.
Telectro Industries Corp., a, f, g, p, s.
Texas Instruments Inc., n, p, s.
Thermo Electric Co., Inc., o, q, s.
Theta Instrument Corp., c, r.
Transformers, Inc., c, g, r.
Trepac Corp. of America, f, s, w.
Trio Laboratories, Inc., f, g, o, q, w.
United States Testing Co., Inc.
Universal Mfg. Co., Inc., f.
Varo Mfg. Co., Inc., t.
Victoreen Instrument Co., m.
Virginia Electronics Co., Inc., c.
Wacline, Inc., a, k, n, o, q, w, x, y.
Waters Mfg. Inc., c.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., a, h, i, k, n thru q, w, y.
Westinghouse Electric Corp., a, k, n, o, q, s, t, w, x, y.
Winder Aircraft Corp. of Florida, c.
Yellow Springs Instrument Co., The., s.

INSTRUMENTS, GRAPHIC RECORDING

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Allegany Instrument Co., Inc.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
R. B. Annis Co.
Antlab Inc.
Automatic Timing & Controls, Inc.
B & K Instruments, Inc.
Bendix Aviation Corp.
Benson-Lehner Corp.
*BRISTOL CO., THE

Brush Instruments Div -Clevite Corp
CBS Laboratories Div -Columbia Broadcasting System
Calvert Electronics Inc
Century Electronics & Instruments Inc
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Curtiss Wright Corp. Princeton Div
Daystrom In Weston Instruments Div
Electric Autolite Co., The
Electro Instruments, Inc
Epic Inc
Esterline-Angus Co. The
Fenske, Fedrick & Miller Inc.
Fischer & Porter Co
General Controls Co
General Electric Co., Missile & Space Vehicle Dept., Pa
General Radio Co
Hathaway Instruments Inc
Impact-O-Graph Corp., The
Kay Electric Co
Lear, Inc.
Leeds & Northrup Co.
Librascope Div., General Precision, Inc.
Loral Electronics Corp.
Mason-Neilan
Micrometrical Mfg. Co
Midwestern Instruments, Inc
Minneapolis-Honeywell, Heiland Div
Minneapolis-Honeywell Regulator Co., Industrial Div
Minneapolis-Honeywell Regulator Co., Missile Equipment Div
Motorola, Inc
National Electronics
New England Scientific Instruments Co.
Optomechanisms Inc
Panoramic Radio Products, Inc.
Photron Instrument Co
Research, Inc
Sangamo Electric Co
Scientific-Atlanta, Inc.
Servo Consultants Ltd.
Systron Corp
Tally Register Corp
Technology Instrument Corp.
Texas Instruments Inc
Westinghouse Electric Corp.
Yellow Springs Instrument Co., The

INSULATING COMPOUNDS

Acme Wire Co
Allied Plastics Supply Corp
American Latex Products Corp
Biwax Corp.
Delta Chemical Works, Inc
Dow Corning Corp.
Dyna-Therm Chemical Corp.
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics , Inc
B. F. Goodrich Chemical Co
Goodyear Tire & Rubber Co., The, Aviation Products Div
Hastings Plastics, Inc
Insulation Mfrs. Corp.
Isocyanate Products, Inc
Johns-Manville Sales Corp
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Mitchell Rand Mfg Corp
Monsanto Chemical Co
National Engrg. Products, Inc.
Norrich Plastics Corp
Permacel
Raybestos-Manhattan, Inc
Sauereisen Cements Co
Schenectady Varnish Co., Inc
Silicone Products Dept., General Precision Co., Dept C
Standard-Toch Chemicals, Inc
Stevenson Bro & Co
Thiokol Chemical Corp., Hunter-Bristol Div
Topper Mfg Co., Inc
United States Rubber Co
Wesrep Corp.
Zophar Mills Inc

INSULATION MATERIALS

a. Aluminum Oxide
b. Asbestos
c. Ceramic
d. Fabric
e. Fibre
f. Glass
g. Glass Fibre
h. Nylon
i. Paper
j. Silicone Compounds

ACF Industries Inc.
Acme Wire Co., **d, e, f, h, i.**
Actioncraft Products
Aero Leather Products Co., **d, g.**
Aircraft Porous Media, Inc., **g.**
Alite Div., U. S. Stoneware Co., **a, c.**
Allied Plastics Supply Corp., **b thru j.**
Aluminum Co of America, **a.**
American Feldmuehle Corp., **a.**
American Felt Co., **d, e, h.**
American Latex Products Corp.
American Lava Corp., **a, c.**
Armstrong Cork Co., **g.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **b thru j.**
Auburn Mfg. Co., The, **b, d, e, g thru j.**
Semon Bache & Co., **f.**
Bar-Ray Products, Inc., **g.**
L. J. Barwood Mfg. Co. Inc., **b, d, e, g thru j.**
Bemis Bro. Bag Co., **i.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., c.**
Bentley, Harris Mfg. Co., **g.**
Birma Mfg. Co. Inc., **c thru f, h, i.**
Birnbach Radio Co., Inc., **c, g.**
Biwax Corp.
W. H. Brady Co., **d, g.**
Brunswick Balke Collender Co., The, Defense Products Div., **a, b, c, f, g, i.**
Budd Co., The, **d, e, i, j.**
Carborundum Co., The, **a, c, d, e, i.**
Carborundum Co., Latrobe Plant, Refractories Div., **a, c.**
Carborundum Co., Refractories Div., **a, c, e.**
Carmer Industries Inc., **h.**
Centralab, Div.-Globe-Union, Inc., **c.**
Chemplast, Inc., **h.**
Comco Plastics Inc., **d thru j.**
Connecticut Hard Rubber Co., The, **j.**
Continental Rubber Works, **j.**
Coors Porcelain Co., **c.**
Corning Glass Works, **a, c, f.**
Cryogenic Engrg. Co., **g.**
R. E. Darling Co., Inc., **j.**
Dell Optics Co., Ltd., **f.**
Diamonite Products Mfg. Co., **a.**
Dow Corning Corp., **j.**
Du-Co Ceramics Co., **c.**
E. I. Du Pont de Nemours & Co. Inc., **c, d, g.**
Dura Plastics of N. Y., Inc., **h.**
Duramic Products, Inc., **c.**
Eagle-Picher Co., The, **b, e, g.**
Electrical Insulation Co., Inc., **b, d, e, g thru j.**
Electro Technical Products Div., Sun Chemical Corp., **d, f, i.**
Electronic Mechanics, Inc., **c, f.**
Eljay Corp., **g, h.**
Emerson & Cuming, Inc., **a, c, j.**
Emerson Plastics Corp., **e, g, h, j.**
Enfab Inc., **g.**
Erie Resistor Corp., **c.**
Falge Engrg. Div -Pen Mac Nye Co., **h.**
Fibercraft, Inc., **g.**
Fisher & Crome, **d, e, g thru j.**
Flightex Fabrics Inc., **f.**
Flock Process Co. Inc., **e.**
Franklin Fibre-Lamitex Corp., **e, g thru j.**
Frenchtown Porcelain Co., **a, c.**
Garlock Packing Co., The-Electronic Products, **h.**
General Ceramics Div., Indiana General Corp., **c.**
General Electric Co., Missile & Space Vehicle Dept., Pa., **c, h.**
General Plastics Corp., **d, h.**
Gladding, McBean & Co., **c.**
Gulton Industries, Inc., **a, c.**
Gustin-Bacon Mfg. Co., **g.**
Harco Labs., Inc., **b.**
Hastings Plastics, Inc., **a thru e, g.**
Hays Mfg Co., **g.**
Hughes Tool Co., Aircraft Div., **c.**
Illumitronic Engrg Co., **h.**
Insulation Mfrs Corp., **b, d thru j.**
Isolantite Mfg Corp., **c, j.**
Johns-Manville Sales Corp., **b, d thru g.**
Kaiser Aluminum & Chemical Sales, Inc., **a.**
M. Kirchberger & Co., Inc., **a, c.**
Lamtex Industries Inc., **g, h.**
Lapp Insulator Co., Inc., Radio Specialties Div., **a, c.**
Thomas J. Long, Inc., **d thru j.**
M & Q Plastic Products, **h.**
McMillan Companies, The, **d, g.**
Mechanical Felt & Textiles Co., **g.**
Mechanical Rubber Products Co., **j.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co., **b, d, f thru i.**
***MICROWAVE & POWER TUBE DIV., RAYTHEON CO., c.**
James Millen Mfg Co Inc., **c.**
***MINNESOTA MINING & MFG. CO., a, c, d, g, i, j.**
Minnesota Rubber Co., **j.**
Mitronics Inc. **c.**
Monsanto Chemical Co., **a.**
NUMEC-Nuclear Materials & Equipment Corp., **c.**
National Beryllia Corp., **a, c.**
National Ceramic Co., **c.**
National Vulcanized Fibre Co., **d, e, g, h, i.**
Natvar Corp., **d, g, i.**
Nopco Chemical Co., Plastics Div.
Norton Co., New Products Dept., **a, c.**
Ohlson Empire Inc., **c.**
Olympic Plastics Co., Inc., **g.**
Owens-Corning Fiberglas Corp., **f, g.**
Penn Fibre & Specialty Co., Inc., **e, h, i.**
Permacel, **j.**
Pittsburgh Corning Corp., **f.**
Plastic Age Sales, Inc., **b, f, j.**
Polymer Corp., The, **h.**
Products Research Co., **j.**
Quartzite Processing Inc., **a, c.**
Raybestos-Manhattan, Inc., **b, d, e, j.**
Reeves Brothers, Inc. **d.**
Reeves Bros Inc., Vulcan Rubber Div., **d.**
Refractories Div., The, Ferro Corp., Louthan Plant, **c.**
Ren Plastics, Inc., **g.**
Reynolds Metals Co., **a.**
J. R. Robbins Co., **g, i.**
Robins Industries Corp., **g.**
Rogers Corp., **c, e, i.**
Milton Ross Metals Co., The, **h.**
Russell Mfg. Co., **b.**
St. Regis Paper Co., Panelyte Div., **b, d, g, h, i.**
Saxonburg Ceramics, Inc., **c.**
Saylor Electric Products Corp., **b, e.**
Seaman Products, Div.-Seaman Paper Co., **d thru g, j.**
Semi-Elements, Inc., **a.**
W. S. Shamban & Co., **g, h.**
Sheridan-Gray, Inc.
Silicone Products Dept., General Electric Co., Dept. C, **j.**
Silicones Div.-Union Carbide Corp., **j.**
Spaceatomics Div., The Budd Co., **e, i.**
Spaulding Fibre Co., Inc.
Special Products Dept , Melpar, Inc., **c, j.**
Star Porcelain Co., The, **c.**
Stevens Products, Inc., **g, j.**
F. M. Stevenson Co., Inc., **d, e, g, h.**
Superior Steatite & Ceramic Corp., **a, c.**
Swedlow Inc., **g, j.**
Synthane Corp., **b thru j.**
TRG, Inc., **a, c, e, g, j.**
Taylor Fibre Co., **b, d, e, f, h, i, j.**
Tetrafluor, Inc., **h.**
Thermal American Fused Quartz Co., Inc., **c.**
Thermoid Div.-H. K. Porter Co., Inc., **b.**
H. I. Thompson Fiber Glass Co., **d, f, g.**
Thor Ceramics, Inc., **a, c.**
Topper Mfg. Co., Inc., **a, b, c, f, h, j.**
Union Asbestos & Rubber Co., **b, e, f, g.**
United Mineral & Chemical Corp., **a.**
United States Rubber Co., **b, d.**
Wenztau Engrg. Co., **g.**
Westinghouse Electric Corp., **f.**
Westinghouse Electric Corp., Micarta Div., **b, d, g thru j.**
Wilmington Fibre Specialty Co., **e, i.**
Young Development Div., Hercules Powder Co., **g.**
Zippertubing Co., The, **b, d, f, g, h, j.**
Zirconium Corp. of America, **c.**

INSULATION PARTS

a. Bead
b. Ceramic
c. Insulating Sleeves
d. Rods
e. Sheets
f. Silicone Rubber
g. Stampings & Punchings

Actioncraft Products, **f.**
Acushnet Process Co., **f.**
Aero Gasket Corp., **f, g.**
Alite Div., U. S. Stoneware Co., **b.**
Allied Plastics Supply Corp., **a thru g.**
Alloys Unlimited Inc., **g.**
Amatom Electronic Hardware Co. Inc., **b, c.**
Amco Engrg. Co., **g.**
American Feldmuehle Corp., **b.**
American Felt Co., **g.**
American Latex Products Corp.
American Lava Corp., **b.**
American Super-Temperature Wires, Inc., **c, f.**
Apahouser Corp. of N. E., **e.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **c, e, f.**
Associated Engineers, Inc., **c, e.**
Auburn Mfg Co , The, **c, e, f, g.**
Bacon Industries, Inc., **f.**
L. J. Barwood Mfg Co. Inc., **c thru g.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., b.**
Bentley, Harris Mfg Co., **c, f.**
Bergen Carbide Co., **b, g.**
Bestcraft Products Co. Inc., **g.**
Birma Mfg Co. Inc., **c, g.**
Birnbach Radio Co., Inc., **b thru f.**
Bonny Mfg. Corp., **g.**
Borden Chemical Co. **c.**

Milton H. Brooks & Son Engraving & Mfg. Co., Inc., **d, e, g.**
Brush Beryllium Co., The, **b.**
Carborundum Co., The, **a thru e.**
Carborundum Co., Latrobe Plant, Refractories Div., **a thru d.**
Carborundum Co., Refractories Div., **a, b, e.**
Centralab, Div.-Globe-Union, Inc., **b.**
Chemplast, Inc., **c, d, e, g.**
Chicago Gasket Co., **d, e.**
Comco Plastics Inc., **d thru g.**
Connecticut Hard Rubber Co., The, **f.**
Continental Diamond Fibre Corp., **c thru f.**
Continental Rubber Works, **f.**
Coors Porcelain Co., **b.**
Corning Glass Works, **a, b, d, e.**
Crystal-X Corp., **d, e.**
R. E. Darling Co., Inc., **f.**
Diamonite Products Mfg. Co., **b.**
John L. Dore Co., **c, d, e.**
Dow-Elco, Inc., **f.**
Du-Co Ceramics Co., **a thru d.**
Duramic Products, Inc., **a thru e.**
Hugh H. Eby Co., **g.**
Edwards High Vacuum Ltd., **f.**
Electric Autolite Co., The, **b.**
Electrical Insulation Co., Inc., **c, d, e, g.**
Electrical Refractories Co., The, **a, b, c.**
Electronic Mechanics, Inc., **a thru e, g.**
Eljay Corp., **c, d, e, g.**
Emerson Plastics Corp., **a thru e, g.**
Enfab Inc., **c, e, g.**
Engineered Plastics, Inc., **g.**
Erie Resistor Corp., **b.**
Falge Engrg. Div.-Pen Mac Nye Co., **c, g.**
Federal Tool & Mfg. Co., **g.**
Fisher & Crome, **d, e.**
Flexible Tubing Corp., **f.**
Forsberg Mfg., Co., The, **g.**
Franklin Fibre-Lamitex Corp., **c thru g.**
Frenchtown Porcelain Co., **b.**
Furane Plastics, Inc., **d, e.**
G-C Electronics Co., **c.**
Garlock Packing Co., **c, e, f, g.**
Garlock Packing Co., The-Electronic Products, **c, d, e, g.**
Gasket Mfg. Co. Inc., **g.**
General Ceramics Div., Indiana General Corp., **b.**
General Electric Co., Missile & Space Vehicle Dept., Pa., **b.**
General Gasket Inc., **g.**
Goe Engrg. Co., **b.**
B. F. Goodrich Sponge Products, **f.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **f.**
Gordon Rubber & Packing Co. Inc., **f.**
Goshen Rubber Co., Inc., **f.**
Gries Reproducer Corp.
Gulton Industries, Inc., **b.**
Hastings Plastics, Inc., **a, d, e.**
Hays Mfg. Co., **e.**
Hermetic Seal Corp., **a, b, c.**
Insulation Mfrs. Corp., **c thru g.**
Isolantite Mfg. Corp., **a thru d.**
Joclin Mfg. Co., The, **c, d, e, g.**
Johns-Manville Sales Corp., **c, e.**
Keystone Electronics Corp., **g.**
M. Kirchberger & Co., Inc., **a, b.**
Lamtex Industries Inc., **c.**
Lapp Insulator Co., Inc., Radio Specialties Div., **b, d.**
Thomas J. Long, Inc., **c, d, e.**
M & Q Plastic Products, **c, d, e.**
Mechanical Rubber Products Co., **f, g.**
J. E. Menaugh Co., **c.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co., **d, e, f.**
Mico Instrument Co., **d.**
***MICROWAVE & POWER TUBE DIV., RAYTHEON CO., b.**
James Millen Mfg. Co. Inc., **a, b.**
***MINNESOTA MINING & MFG. CO., a thru e.**
Minnesota Rubber Co., **f.**
Mitronics Inc., **b.**
Motorola, Inc., **b.**
Mycalex Corp. of America, **c, d, e.**
NUMEC-Nuclear Materials & Equipment Corp., **b.**
National Beryllia Corp., **a thru d.**
National Ceramic Co., **b.**
National Moldite Co., **a.**
National Vulcanized Fibre Co., **c, d, e, g.**
Natvar Corp., **c, e, f.**
New England Spring Mfg. Co., Inc., **g.**
New England Tape Co., Div.-United-Carr Fastener Corp., **c, d.**
M. M. Newman Corp., **c.**
Norrich Plastics Corp., **a thru e.**
Norton Co., New Products Dept., **b.**
Ohlson Empire Inc., **b, c.**
Olympic Plastics Co., Inc., **c.**
Owens-Corning Fiberglas Corp., **c.**
Penn Fibre & Specialty Co., Inc., **c, d, e, g.**
Permacel, **f.**
Polymer Corp., The, **c, d, e, g.**
Precision Metal Products Co. Inc., **g.**
Prewitt Aircraft Co., **c.**
Raybestos-Manhattan, Inc., **c thru f.**
Reeves Bros. Inc., Vulcan Rubber Div., **f.**
Refractories Div., The, Ferro Corp., Louthan Plant, **b.**
Resistoflex Corp., **d, e.**
J. R. Robbins Co., **e, g.**
Roberts Toledo Rubber Co., The, **f.**
Rogers Corp., **b, c, f.**
Milton Ross Metals Co., The, **c, d, g.**
Rubbercraft Corp. of California, **d thru g.**
St. Regis Paper Co., Panelyte Div., **d, e.**
Saxonburg Ceramics, Inc., **b.**
D. A. Schultz Co., **e, f, g.**
Seaman Products, Div.-Seaman Paper Co., **c, e.**
Servicair Co., **c.**
W. S. Shamban & Co., **d, e.**
Sheridan-Gray, Inc., **g.**
Sillcocks-Miller Co., **c, e, g.**
Spaulding Fibre Co., Inc., **d, e, g.**
Star Porcelain Co., The, **a thru e, g.**
Stevens Products, Inc., **c, g.**
Stillman Rubber Co., **f.**
Superior Steatite & Ceramic Corp., **a, b.**
Surprenant Mfg. Co., **c.**
Synthane Corp., **c, d, e, g.**
Taylor Fibre Co., **c, d, e, g.**
Tetrafluor, Inc., **c, d, e.**
Thermal American Fused Quartz Co., Inc., **b.**
Thermoid Div.-H. K. Porter Co., Inc., **f.**
H. I. Thompson Fiber Glass Co., **c.**
Thor Ceramics, Inc., **a thru e, g.**
Topper Mfg. Co., Inc., **b.**
Tri-Point Plastics Inc., **a, d.**
Union Asbestos & Rubber Co., **c.**
United Mineral & Chemical Corp., **d.**
United States Rubber Co., **c.**
Varflex Corp., **c, f.**
Victor Tool & Mfg., Inc., **g.**
Western Gold & Platinum Co., **a, b.**
Westinghouse Electric Corp., **d, e.**
Westinghouse Electric Corp., Micarta Div., **c, d, e, g.**
Wilmington Fibre Specialty Co., **c, d, e, g.**
Young Development Div., Hercules Powder Co., **c.**
Zippertubing Co., The, **c.**
Zirconium Corp. of America, **b, c, d.**

INSULATORS

a. Antenna Insulators & Spring Assemblies
b. Bead
c. Bearing
d. Can Liner
e. Ceramic
f. Cord
g. Electric
h. Fabricated
i. Feed Through
j. Feeder Spreader
k. Fused Quartz
l. Glass Bonded Mica
m. High Dielectric Paper
n. HV Power Line
o. Laminated
p. Metallized Bushing
q. Mica
r. Molded
s. Plastic
t. Rods
u. Sheets
v. Shock
w. Shock & Vibration
x. Sleeve
y. Standoff
z. Strain
a-1. Test Clip
b-1. Thermal
c-1. Thermocouple
d-1. Tower
e-1. Transmitting Antenna

Aeroscience, Inc., **z.**
Alite Div., U. S. Stoneware Co., **b, c, e, g, i, n, p, x, y, c-1, e-1.**
Allied Plastics Supply Corp., **h, l, o, q thru u, x.**
Alpine Electronic Components, Inc., **i, y.**
Amatom Electronic Hardware Co. Inc., **e, i, s, x, y.**
American Agile Corp., **s.**
American Feldmuehle Corp., **e.**
American Felt Co., **v, w.**
American Latex Products Corp., **a, d, h, r thru z, a-1 thru e-1.**
American Lava Corp., **e, g, i, y, z, c-1.**
Apahouser Corp. of N. E., **a, h, o, s, t, u.**
Aries Laboratories, Inc., **r, s.**
Armel Electronics Inc., **i, r, s, y.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings Inc. **h, o.**
Asheville Schoonmaker Mica Co., **q.**
Associated Engineers, Inc., **i.**
Auburn Mfg. Co. The, **h, s, u, v, w, b-1.**
B G Corp., The, **e, i.**
L. J. Barwood Mfg. Co. Inc., **c, f thru i, o, q, s thru x.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., e.**
Bentley, Harris Mfg. Co., **x.**
Bergen Carbide Co., **e.**
Bestcraft Products Co. Inc., **h, m.**
Carl H. Biggs Co., **r, s, t, b-1.**
Birma Mfg. Co. Inc., **e, r, u, v, w.**
Birnbach Radio Co., Inc., **e, i, j, s, t, u, x, y, z, a-1, e-1.**
Bonny Mfg. Corp., **r thru u, x.**
Braun-Knecht-Heimann Co., Industrial Div., **k.**
Brook Molding Corp., **r, s.**
Milton H. Brooks & Son Engraving & Mfg. Co., Inc., **s, t, u.**
Brunswick Balke Collender Co., The, Defense Products Div., **o, r, s.**
Budd Co., The, **g, r, s.**
Cambridge Thermionic Corp., **e, r, y.**
Carborundum Co., The, **b, e, g, m, t, u, x, b-1, c-1.**
Carborundum Co., Latrobe Plant, Refractories Div., **b, e, i, j, n, p, t, x, y, z, b-1, c-1.**
Carborundum Co., Refractories Div., **e, b-1, c-1.**
Carmer Industries Inc., **s, t, u.**
Centralab, Div.-Globe-Union, Inc., **b, e, i, j, y, z.**
Ceramaseal, Inc., **i, p, y, c-1.**
Champion Spark Plug Co., **e.**
Chemplast, Inc., **h, r thru u.**
Chicago Gasket Co., **s.**
Colonial Rubber Co., **r.**
Comco Plastics Inc., **h, o, s, t, u.**
***CONSOLIDATED ELECTRODYNAMICS CORP., e.**
Continental Diamond Fibre Corp., **h, l, o, q thru u, b-1.**
Continental Rubber Works, **r.**
Coors Porcelain Co., **e, i, y, e-1.**
Corning Glass Works, **b, e, i, r, t, u, x, y, b-1.**
Crystal-X Corp., **s, t, u.**
Dayton Aircraft Products, Inc., **a, e, h, i, r, s, z, e-1.**
Dell Optics Co., Ltd., **k.**
Deutsch Co., The, Electronic Components Div., **r.**
Diamonite Products Mfg. Co., **e.**
Dixon Corp., **s.**
John L. Dore Co., **r thru u.**
Dow-Elco, Inc., **w.**
Du-Co Ceramics Co., **b, e, f, g, i, p, t, x, y, z, b-1, c-1.**
Dura Plastics of N. Y., Inc., **s.**
Duramic Products, Inc., **e, h, t, u, x.**
E-Z Way Towers, Inc., **d-1.**
Electrical Insulation Co., Inc., **r thru u.**
Electrical Refractories Co., The, **e, c-1.**
Electronic Mechanics, Inc., **l, o, q.**
Eljay Corp., **g, h, m, o, r thru u.**
Emeloid Co., Inc., The, **r, s.**
Emerson & Cuming, Inc., **t, u.**
Emerson Plastics Corp., **b, c, e, h, i, l, o, q thru u, y.**
Engelhard Industries, Inc., **g.**
Engineered Plastics, Inc., **h.**
Epoxy Products, Inc., Div.-Joseph Waldman & Sons, **s.**
Erie Resistor Corp., **e.**
Falge Engrg. Div.-Pen Mac Nye Co., **h, s.**
Fisher & Crome, **h, m, s, t, u, y.**
Fluorocarbon Co., The, **s, t, u.**
Ford Radio & Mica Corp., **q.**
Form-It Products, Inc., **h, r, s.**
Franklin Fibre-Lamitex Corp., **g, h, o, r thru u.**
Frenchtown Porcelain Co., **e, i, p.**
G-C Electronics Co., **a.**
Garde Mfg. Co., **i, q, r, s.**
Garlock Packing Co., **d, o, r thru u.**
Garlock Packing Co., The-Electronic Products, **g, h, i, r thru u, y.**
General Ceramics Div., Indiana General Corp., **e.**
General Electric Co., Insulator Dept., **e, g, n, y, z, d-1, e-1.**
General Radio Co., **r.**
Gladding, McBean & Co., **e, p, b-1, e-1.**
Goe Engrg. Co., **e, i, y.**
Claud S. Gordon Co., **b, c-1.**
Goshen Rubber Co., Inc., **w.**
Gries Reproducer Corp., **c, r.**
Gulton Industries, Inc., **e.**
Hays Mfg. Co., **r, s, y.**
Hermetic Seal Corp., **b, e, i, y.**
Heyman Mfg. Co. **f, i, s.**
Hobson Brothers Inc., **i, r.**
Holub Industries Inc. **s, z.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., r, s**
Walter J. Hyatt Co. The **s**
Industrial Acoustics Co. Inc **w.**
Industrial Devices Inc **r, s**
Industrial Mica Corp. **q**
Insulation Mfrs. Corp. **g, h, l, m, o, q thru u, x.**
Isocyanate Products Inc **s**
Isolantite Mfg. Corp. **a, b, e, i, j, y, z, e-1.**
Jan Hardware Mfg. Co. Inc **n, y.**
Johns-Manville Sales Corp **g, m, r, s**
E. F. Johnson Co. **a, e, i, y, e-1.**
K. W. Johnson & Co. Inc. **w**

Kentucky Metal Products Co., **b-1.**
Keystone Electronics Corp., **h, y.**
M. Kirchberger & Co., Inc., **b, e, g, r, y.**
Lamtex Industries Inc., **g, h, o, r, s, x, y, e-1.**
Lapp Insulator Co., Inc., Radio Specialties Div., **a, e, g thru j, n, p, t, y, z, d-1, e-1.**
Lone Star Plastics Co. Inc., **s.**
Thomas J. Long, Inc., **s.**
Lord Mfg. Co., **w.**
MB Electronics, **v, w.**
M & Q Plastic Products, **r thru u, y.**
Martin Machine Works, Inc., **s.**
McMillan Companies, The, **q.**
Mechanical Rubber Products Co., **r.**
J. E. Menaugh Co., **x.**
Mica Fabricating Co., **e, h, l, q thru u.**
Mica Industry Association, Inc., **q.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co., **q, s, t, u.**
Micacraft Products Inc., **h, l, q.**
***MICROWAVE & POWER TUBE DIV., RAYTHEON CO., e.**
James Millen Mfg. Co. Inc., **a, b, e, i, j, r, y.**
***MINNESOTA MINING & MFG. CO., a, b, e, g, h, i, l, m, o, q thru u, x, b-1.**

***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV., s, b-1.**
Minnesota Rubber Co., **h, r.**
Mitronics Inc., **e, i, p.**
Molded Insulation Co., **r, z.**
Molding Corp. of America, **h, i, r, s, y.**
Motorola, Inc., **e.**
Mueller Electric Co., **a-1.**
Mycalex Corp. of America, **g, l, q thru u, x, y.**
Narmco Mfg. Co., **o, r, s.**
National Beryllia Corp., **b, e, g, h, t, x, c-1.**
National Ceramic Co., **b, e, g, i, y, z, b-1.**
National Moldite Co., **b.**
National Vulcanized Fibre Co., **g, h, m, o, r thru u.**
Natvar Corp., **s.**
Nevada Air Products Co., **i, e-1.**
New England Tape Co., Div.-United-Carr Fastener Corp., **s.**
M. M. Newman Corp., **s.**
Norrich Plastics Corp., **a, b, c, e, i, j, o thru z, a-1, d-1.**
Norrich Screw Machine Products, **a, b, c, f, h, i, o, r thru u, x, y, z, b-1, d-1, e-1.**
Northern Plastics Corp., **h, o, s, u.**
Norton Co., New Products Dept., **e, c-1.**
Ohlson Empire Inc., **e.**
Olympic Plastics Co., Inc., **s.**
Owens-Corning Fiberglas Corp., **g, h, o, r, v, w, b-1.**
Penn Fibre & Specialty Co., Inc., **h, m, s thru w.**
Permax Products Div., Chisholm-Ryder Co., Inc., **a, v, w, y, e-1.**
Pittsburgh Corning Corp., **b-1.**
Plastic Age Sales, Inc., **o, r, s.**
Polymer Corp., The, **c, g, h, s thru y.**
Precision Metal Products Co. Inc., **e, h, i, r, y.**
Prewitt Aircraft Co., **s.**
Raybestos-Manhattan, Inc., **r thru u, x, b-1.**
Refractories Div., The, Ferro Corp., Louthan Plant, **e.**
Resistoflex Corp., **s, t, u.**
J. R. Robbins Co., **m, u.**
Rogers Corp., **c, e, g, o, r, s.**
Rohn Mfg. Co., **z, d-1.**
Milton Ross Metals Co., The, **d, r, s, t, y, z.**
Rubbercraft Corp. of California, **r, w.**
St. Regis Paper Co., Panelyte Div., **o, s, t, u.**
Sanford Plastics Corp., **r thru u.**
Saxonburg Ceramics, Inc., **e, c-1.**
Saylor Electric Products Corp., **s, w.**
D. A. Schultz Co., **s, u.**
Sealectro Corp., **s.**
Seaman Products, Div.-Seaman Paper Co., **o, r, u, w, b-1.**
Semi-Elements, Inc., **k.**
W. S. Shamban & Co., **i, r, s, u.**
Sheridan-Gray, Inc., **k.**
Sinclair Mfg. Co., **h, o, s.**
E. C. Smith Mfg. Co., Inc., **c-1.**
Smooth-On Mfg. Co., **s.**
Solar Mfg. Corp., **e, i, y.**
Southern Plastics Co., **r thru u.**
Spaceatomics Div., The Budd Co., **b-1.**
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co., **r thru u.**
Spaulding Fibre Co., Inc., **h, o, s, t, u, b-1.**
Sphere Co. Inc., The, **e.**
Spruce Pine Mica Co., **h, q, s.**
Star Porcelain Co., The, **b, e, g, h, i, r, t, u, x, y, z, c-1.**
A. T. Stevens Co., **w.**
Stevens Products, Inc., **o, r.**
Superior Steatite & Ceramic Corp., **b, e, g, r, y.**
Surprenant Mfg. Co., **x.**
Swedlow Inc., **s.**
Synthane Corp., **h, o, r thru u.**
Taurus Corp., **i, s, y.**
Taylor Fibre Co., **h, s, t, u, x.**
Tetrafluor, Inc., **r, s.**
Thermal American Fused Quartz Co., Inc., **e, k.**
Thermo Electric Co., Inc., **c-1.**
Thermon Mfg. Co., **g.**
Thor Ceramics, Inc., **a, b, e, g thru j, p, s, t, u, x, y, z, b-1 thru e-1.**
Torwico Electronics, Inc., **e.**
Tri-Ex Tower Corp., **z.**
Trinity Equipment Corp., **c-1.**
Tri-Point Plastics Inc., **b, c, h, i, t, y.**
Twix Mfg. Co., Inc., **q, s.**
U. E. Electronics Corp., **r, s.**
Union Asbestos & Rubber Co., **f.**
United Mineral & Chemical Corp., **t.**
U. S. Plastic Molding Corp., **s.**
United States Rubber Co., **h, o, r, s, w, x, b-1.**
Universal Moulded Products Corp., **r, s.**
Universal Unlimited, Inc., **s, u.**
Varflex Corp., **s, x.**
Veeco Vacuum Corp., **i.**
Victor R. F. & Microwave Co., **s.**
Waterbury Companies, Inc., **s.**
Westinghouse Electric Corp., **e, g.**
Westinghouse Electric Corp., Micarta Div., **m, o, r thru u, b-1.**
Whitso, Inc., **i, r, s, y.**
Wind Turbine Co., **i, j, y, z, d-1, e-1.**
Yardley Plastics Co., **d.**
Young Development Div., Hercules Powder Co., **g, h, o, r thru u, x, b-1.**
Zippertubing Co., The, **v thru y, b-1.**
Zirconium Corp. of America, **e, b-1, c-1.**

INTEGRATORS, ELECTRONIC

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
***AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP.**
Allegany Instrument Co., Inc.
Andersen Labs., Inc.
Antlab Inc
Beckman Instruments, Inc., Berkeley Div.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
***BRISTOL CO., THE**
Bruno-New York Industries Corp.
Budd Lewyt Electronics, Inc.
Burton-Rodgers, Inc.
Chance Vought Aircraft, Inc.
Daystrom, Inc., Military Electronics Div.
Daystrom Inc., Pacific Div.
Daystrom Inc., Weston Instruments Div.
Djeco, Div.-Djordjevic Engrg. Co.
Dynamics Instrumentation Co.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Elcor, Inc.
Electro Instruments, Inc.
Electronic Tube Corp.
Ensco, Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
Fischer & Porter Co.
Flight Support, Inc.
General Devices, Inc.
General Electric Co., Missile & Space Vehicle Dept., Pa
Hamilton Watch Co., Military Products Div.
Hoover Electronics Co.
Huyck Systems Co.
I-L-S Instrument Div., The Meriam Instrument Co.
Industrial Control Co.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Lear, Inc.
Librascope Div., General Precision, Inc.
Madigan Corp.
W. L. Maxson Corp., The
Micro Gee Products, Inc.
Motorola, Inc.
Northrop Corp.
Packard Bell Computer Corp.
Philco Corp.-Govt. & Industrial Group
Reeves Instrument Corp.
Scientific-Atlanta, Inc.
Servomechanisms, Inc.
Servo-Tek Products Co.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Sun Electric Corp., Aeronautical Div.
Telechrome Mfg. Corp.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.

INTERCOMMUNICATION SYSTEMS

Bendix Aviation Corp.
Broadview Research Corp.
Bruno-New York Industries Corp.
Chance Vought Aircraft, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Designers for Industry, Inc
Diamond Antenna & Microwave Corp.
Du Kane Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Executone, Inc.
Fla. Aircraft Radio & Marine
Flush Wall Radio Co.
GPL Div.-General Precision, Inc.
Gates Radio Co.
General Devices, Inc.
General Instrument Corp., Defense & Engrg. Products Group
Gonset Div.-Young Spring & Wire Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Hammarlund Mfg. Co., The
ITT Federal Div., International Telephone & Telegraph Corp.
E. F. Johnson Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc.
Lenkurt Electric Co., Inc.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
M. V. Palmer, Inc
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Remler Co.
Rimak Inc.
Seiscor, Div.-Seismograph Service Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Talk-A-Phone Co.
United States Instrument Corp.
Vocaline Co. of America Inc.
Western Union Telegraph Co., The
Wickes Engrg. & Contruction Co.
Winder Aircraft Corp. of Florida

INTERFERENCE EQUIPMENT RF

Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
General Instrument Corp., Defense & Engrg. Products Group
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hallett Mfg. Co.
Lear, Inc.
Miller Associates
Motorola, Inc.
Panoramic Radio Products, Inc.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Southwest Research Institute
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Sprague Electric Co.
Telechrome Mfg. Corp.

INTERFEROMETERS

Bausch & Lomb Optical Co.
Davidson Optronics, Inc.
Diamond Antenna & Microwave Corp.
Eastman Kodak Co.
Edgerton, Germeshausen & Grier, Inc.
***ENGIS EQUIPMENT CO.**
J. W. Fecker Div., American Optical Co.
Gulton Industries, Inc.
Jarrell-Ash Co.
Mc Millan Companies, The
Omega Labs., Inc.
Optomechanisms Inc.
Tinsley Labs., Inc.

INTERVALOMETERS

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
***ABRAMS INSTRUMENT CORP.**
Beckman Instruments, Inc., Berkeley Div.
Courier Products, Div.-Model Engrg. & Mfg., Inc.
Joe Davidson & Associates
Designers for Industry, Inc.
Eagle Signal Co.
Elgin Micronics, West Coast Div.-Elgin National Watch Co.
Flight Research, Inc.
Gordon Enterprises
Greenleaf Mfg. Div., The, Mandrel Ind. Inc.
Hamilton Watch Co., Military Products Div.
A. W. Haydon Co., The
Jordan Electronics, Div.-Victoreen Instrument Co.
Lear, Inc.
Lundy Mfg. Corp.
Optomechanisms Inc.

Patterson Moos Research, Div.-Leesona Corp.
Revere Corp. of America, Sub.-Neptune Meter Co.
Servomechanisms, Inc.
Southwest Research Institute
Spectrol Electronics Corp.
Traid Corp.
Trio Laboratories, Inc.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.

INVERTERS

ACF Industries Inc.
Airborne Accessories Corp.
*AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP.
American Missile Products Co., Inc.
American Research & Mfg. Corp.
*ARNOUX CORP.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Carter Motor Co.
Chatham Electronics Div.-Tung-Sol Electric Inc.
Collins Radio Co.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Communication Measurements Lab., Inc.
Cornell-Dubilier Electric Corp.
Cubic Corp.
Joe Davidson & Associates
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Delco Radio Div.-General Motors Corp.
Djeco, Div.-Djordjevic Engrg. Co.
Eicor Div.-Scranton
Electrosolids Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Devices, Inc.
General Electric Co., Apparatus Sales Div.
Georator Corp.
Paul E. Gerst & Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Gulton Industries, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
George E. Harris & Co., Inc.
Hathaway Instruments, Inc.
Hoover Electric Co.
I-L-S Instrument Div., The Meriam Instrument Co.
Industrial Test Equipment Co.
Johnson Electronics Inc.
Jordan Electronics, Div.-Victoreen Instrument Co.
Lear, Inc.
Leece-Neville Co., The
Leland Airborne Products, Div.-American Machine & Foundry Co.
Lockheed Aircraft Corp. Missiles & Space Div.
MEG Products, Div.-Mandrel Industries, Inc.
Magnetic Controls Co.
W. L. Maxson Corp., The
Micro Gee Products, Inc.
Motor Generator Corp.
Motorola, Inc.
Networks Electronic Corp.
D. W. Onan & Sons Inc.
Opad Electric Co.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Perkin Engrg. Corp.
Pesco Products Div.-Borg-Warner Corp.
Pesco Products Div., Borg-Warner Corp., Calif.
Power Supplies Inc.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Riverbank Labs., Dept.-Engrg.
Sangamo Electric Co.
Small Motors Inc.
Sonotone Corp.
Southwestern Industrial Electronics Co.
Spectrol Electronics Corp.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Talley Corp., The
Telkor, Inc.
Terado Co.
Torwico Electronics, Inc.
U. S Industries, Inc.
Varo Mfg. Co., Inc.
Voi-Shan Electronics
Wesrep Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Wickes Engrg. & Construction Co.
Wincharger Corp., Sub.-Zenith Radio Corp.

ION TRAPS

Bendix Aviation Corp., Cincinnati Div.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General American Transportation Corp.
*RADIO CORP. OF AMERICA

IRON

Amtara Chemicals, Div.-General Aniline & Film Corp.
Crucible Steel Co. of America
Custom Tool & Mfg. Co.
Lapham Hickey Steel Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

ISOLATORS, MICROWAVE

Airtron, Div.-Litton Industries
American Lava Corp.
Bendix Aviation Corp.-
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Demornay-Bonardi
FXR, Inc.
Hammett-Mercury-Rex Div.
*KEARFOTT DIV., GENERAL PRECISION, INC.
*KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS
Kentucky Metal Products Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Microphase Corp.
Microwave Associates, Inc.
*MICROWAVE & POWER TUBE DIV., RAYTHEON CO.
Motorola, Inc.
*RADIO CORP. OF AMERICA
Rantec Corp.
Sage Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Sylvania Electric Products Inc., Special Tube Operations
TRG, Inc.
Victor R. F. & Microwave Co.

JACK PANEL ASSEMBLIES

ADC Inc.
Accurate Electronics Corp.
Aerolite Electronics Corp.
Anchor Specialty Mfg. Co. Inc.
Apahouser Corp. of N.E.
Bernco Engrg. Corp.
Bud Radio, Inc.
California Plasteck Inc.
Croname Inc.
Dage Television Div., Thompson Ramo Wooldridge, Inc.
Falstrom Co.
Gates Radio Co.
Harco Labs., Inc.
Interstate Electronics Inc.
Jan Hardware Mfg. Co., Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Keystone Electronics Corp.
Kings Electronics Co., Inc.
Lab-Tronics, Inc.
Thomas J. Long, Inc.
Lycoming Div., Avco Corp.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Chester Morton Electronics Corp.
Panoramic Radio Products, Inc.
Piasecki Aircraft Corp.
Projects Unlimited, Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Rimak, Inc.
Sheltered Workshops
Sonex, Inc.
Standard Electric Time Co., The
Standard Electronics Div.-Reeves Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Switchcraft, Inc.
Technical Material Corp., The
Thermo Electric Co., Inc.
Unlimited States Instrument Corp.
Virginia Electronics Co., Inc.

JACKS

ADC Inc.
Accurate Electronics Corp.
Aerolite Electronics Corp.
Alden Products Co.
Amatom Electronic Hardware Co. Inc.
American Machine & Foundry Co., Greenwich Engrg. Div.
Beacon Steel Corp.
Bead Chain Mfg. Co., The
Beaver Precision Products Inc.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Birnbach Radio Co., Inc.
A. M. Byers Co.
Cable Electric Products Inc.
Cambridge Thermionic Corp.
G-C Electronics Co.
General Radio Co.
Harco Labs., Inc.
Hein-Werner Corp.
Carl Hirschmann Co., Inc.
Hoover Electric Co.
Interstate Electronics Inc.
Jan Hardware Mfg. Co., Inc.
E. F. Johnson Co
Howard B. Jones Div.-Cinch Mfg. Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Keystone Electronics Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kings Electronics Co., Inc.
James Millen Mfg. Co. Inc.
Norrich Screw Machine Products
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.
Reed Instrument Co.
Reed Research Inc
Regent Jack Mfg. Co., Inc.
Milton Ross Metals Co., The
Sancor Corp.
Sealectro Corp.
Standard Electric Time Co., The
Standard Electronicss Div.-Reeves Instrument Corp.
Swithcraft Inc.
Taurus Corp.
Technical Materiel Corp., The
Telex, Inc.
Templeton, Kenly & Co.
United States Instrument Corp.
Waste King Corp., Technical Products Div.
Weaver Mfg. Co., Div.-Dura Corp.
Whitso, Inc.

JET ENGINES

Allison Div., General Motors Corp.
Bermite Powder Co.
A. M. Byers Co.
Delta Corp.
Falcon Machine & Tool Co.
Fischer & Porter Co.
Lycoming Div., Avco Corp
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pratt & Whitney Aircraft Div., United Aircraft Corp.

JEWELS

Moser Jewel Co.
Swiss Jewel Co.

JEWELS, GLASS

Corning Glass Works
General Electric Co., Apparatus Sales Div.
E. F. Johnson Co.
Manhattan Lighting Equipment Co., Inc.
Moser Jewel Co.

JOINT ASSEMBLIES

Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Barco Mfg. Co., Inc.
California Stamping & Mfg. Co.
Chiksan Co., Sub.-Food Machinery & Chemical Corp.
FAE Instrument Corp.
Flight Refueling, Inc.
Walter K. Jaros Aircrafters
Langley Corp.
Piasecki Aircraft Corp.
Uni-Flex Mfg. & Engrg. Inc.
Weatherhead Co., The

JOINTS

a. Ball
b. Swivel
c. Torsion
d. Universal

Aeroquip Corp., Jackson Div., **b.**
Allegany Instrument Co., The, **a.**
Apex Machine & Tool Co., The, **d.**
Arkwin Industries, Inc., **a, b.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **a thru d.**
Barco Mfg. Co., Inc., **a, b.**
Bendix Aviation Corp., **a.**
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., **a, b, d.**
Bendix Utica Div., Bendix Aviation Corp., **d.**
Boston Gear Works, **d.**
A. M. Byers Co., **a thru d.**
California Stamping & Mfg. Co., **a, b.**
Chiksan Co., Sub.-Food Machinery & Chemical Corp., **b.**
Cobra Metal Hose Div. DK Mfg. Co., **d.**
Components Corp., **b.**
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co., **b.**
Curtis Universal Joint Co., Inc., **a, d.**
Dumont Engrg. Co., **b, d.**
FAE Instrument Corp., **b, d.**
Falcon Machine & Tool Co., **a, b, d.**
Flight Refueling, Inc., **a thru d.**
B. H. Hadley, Inc., **a, b.**

Hallett Mfg. Co.
Walter K. Jaros Aircrafters, **a thru d.**
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., **a.**
Langley Corp., **a, b.**
Lovejoy Flexible Coupling Co., **d.**
Norrich Plastics Corp., **a, b, d.**
Norrich Screw Machine Products, **a, d.**
OPW-Jordon, **b.**
Ohlson Empire Inc., **a, d.**
Richard Philip Co., **a, d.**
Phoenix Products Co., **a.**
Recony Div.,-Vinco Corp., **a thru d.**
Resistoflex Corp., **a, b.**
Sealol Corp., **b.**
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., **b.**
Solar Aircraft Co., **a.**
Southwest Products Co., **a, b, c.**
Uni-Flex Mfg. & Engrg. Inc., **a.**
Vibration Isolation Products, **c.**
Vinson Mfg Co. Inc., **b.**
Vlier Engrg. Corp., **b.**
Waste King Corp., Technical Products Div., **b.**
Weatherhead Co., The, **a, b.**
Western Div., Aeroquip Corp., **b.**

JUMPERS, BONDING

All Specs Corp.
Allen Electric & Equipment Co.
Bernco Engrg. Corp.
Janco Corp.
Walter K. Jaros Aircrafters
Kulka Electric Corp.

JUNCTION BOXES & PANELS

A & E Metal Specialties Inc.
A&P Metal Products Mfg. Corp.
Abalon Precision Mfg. Corp.
Accurate Electronics Corp.
Aerotest Laboratories, Inc.
American Aluminum Co.
Associated Co., Inc.
Bendix Aviation Corp., Cincinnati Div.
Bernco Engrg. Corp.
Breeze Corporations, Inc.
Brooks & Perkins, Inc.
Bud Radio, Inc.
Budd Lewyt Electronics, Inc.
CG Electronics Corp.
Chance Vought Aircraft, Inc.
Conrad & Moser
***DEL MAR ENGRG. LABS.**
Falstrom Co.
Farwell Metal Fabricating
Flight Refueling, Inc.
Grimes Mfg. Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Indiana Gear Works, Inc.
International Electric Industries, Inc.
Javex Electronics
Kellogg Switchboard & Supply Co., Communications Div. IT&T Corp.
Kirk & Blum Mfg. Co., The
Kolton Electric Mfg. Co.
***LAVELLE AIRCRAFT CORP.**
***MARTIN CO., THE, DENVER DIV.**
Nelson Electric Mfg. Co
Richard Philip Co.
Piasecki Aircraft Corp.
Pneumatil Corp.
Prewitt Aircraft Co.
REF Mfg. Corp.
Radio Condenser Co.
Skyline Products, Inc
Sonex, Inc.
Specialty Electronics Development Corp.
Telkor, Inc
Thermo Electric Co., Inc.
Victor Tool & Mfg., Inc.
Virginia Electronics Co., Inc.

JUNCTIONS, HYBRID, MICROWAVE

Aircom Inc
Artisan Metal Works Co.
Bendix Aviation Corp.
Bogart Mfg. Corp
Dalmo Victor Co., Div.-Textron, Inc
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
FXR, Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lieco, Inc.
Meridian Metalcraft, Inc.
Microwave Associates, Inc.
Motorola, Inc.
Narda Microwave Corp., The
Omega Labs., Inc.
Specialty Electronics Development Corp.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc
Transco Products, Inc.
Victor R. F. & Microwave Co.
Wheeler Laboratories, Inc.

KEYERS

ACF Industries Inc.
ASCOP Div., Electro-Mechanical Research, Inc.
Applied Electronics Corp. of N. J.
Barker Sales Co.
Bruno-New York Industries Corp.
Dorsett Electronics Labs., Inc.
Dynatronics, Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
GPL Div.-General Precision, Inc.,
Gates Radio Co.
General Devices, Inc.
General Instrument Corp., Defense & Engrg. Products Group.
Jordan Electronics, Div.-Victoreen Instrument Co.
L & R Mfg. Co.
Litton Industries, Maryland Div.
Motorola, Inc.
National Co., Inc.
Northrop Corp.
Production Research Corp., Sub.-Radio Condenser Co.
Radalab Inc.
Radar Relay, Inc.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Small Motors Inc.
Technical Materiel Corp., The
Telechrome Mfg. Corp.
Telectro Industries Corp.
Texas Instruments Inc.
Trepac Corp. of America
United Control Corp.
Virginia Electronics Co., Inc.
Winder Aircraft Corp. of Florida

KEYERS & COUPLERS

Electromation Co., Div.-Del Mar Engrg. Labs.
GPL Div.-General Precision, Inc.
Litton Industries, Maryland Div.
National Co., Inc.
Northrop Corp.
Technical Materiel Corp., The
Telectro Industries Corp.
Trepac Corp. of America
Winder Aircraft Corp. of Florida

KEYS & CODING EQUIPMENT

Alden Products Co.
Applied Electronics Corp. of N. J.
Barker Sales Co.
GPL Div.-General Precision, Inc.
Gates Radio Co.
Molded Insulation Co.
Motorola Inc.
National Co., Inc.
Production Research Corp., Sub.-Radio Condenser Co.
Radalab Inc.
Soroban Engrg., Inc.
Telechrome Mfg. Corp.

KILOVOLTMETERS

Associated Research, Inc.
Calvert Electronics Inc.
Davenport Mfg. Co.
Daystrom Inc., Weston Instruments Div.
Del Electronics Corp.
Electro Instruments, Inc.
Esterline-Angus Co., The
General Electric Co., Apparatus Sales Div.
Greibach Instruments Corp.
Hammett-Mercury-Rex Div.
Meters Inc.
National Electronics
New England Scientific Instruments Co.
Nilsson Electrical Lab., Inc.
Peschel Electronics, Inc.
Q. V. S. Inc.
Radalab Inc
Rawson Electrical Instrument Co.
Shallcross Mfg. Co.
Wacline, Inc.

KITS

a. Geiger Counter
b. Modification
c. Portable Lighting
d. Test Equipment

Accessory Controls & Equipment Corp., **d.**
Accessory Products Co., Div.-Textron Inc., **d.**
Aeroflex Labs. Div., Aeroflex Corp., **d.**
Aero-Test Equipment Co., Inc., **d.**
Allied International Corp., **c, d.**
Anchor Metal Spinning Co., The., **c.**
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., **d.**
Baird-Atomic, Inc., **a, d.**
Bendix Aviation Corp., Cincinnati Div., **a, b, d.**
Benson Mfg. Co., **b.**
Bernco Engrg. Corp., **d.**
A. Biederman, Inc., **d.**
Bruno-New York Industries Corp., **d.**
Budd Lewyt Electronics, Inc., **b.**
Carborundum Co., Refractories Div., **d.**
Chance Vought Aircraft, Inc., **b, d.**
Cornelius Co., The, Aero Div., **b.**
Custom Component Switches Inc., **d.**
Dejur-Amsco Corp., Electronic Sales Div., **a.**
Eastern Specialty Co., The, **d.**
Electro Products Labs., Inc., **d.**
Electronic Measurements Corp., **d.**
***ENGIS EQUIPMENT CO., d.**
FXR, Inc., **d.**
Flight Refueling, Inc., **b, d.**
General Electric Co., **d.**
General Instrument Corp., Defense & Engrg. Products Group, **b.**
Good Electronic Corp., **b.**
Gordon Enterprises, **c, d.**
Grimes Mfg. Co., **c.**
Hammett-Mercury-Rex Div., **c, d.**
Herlo Corp., **d.**
E. Vernon Hill & Co., **d.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., d.**
Interstate Electronics Corp., **a.**
Kahn & Co., Inc., **d.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **b.**
Lofstrand Co., The, **c.**
Lycoming Div., Avco Corp., **d.**
Madigan Corp., **b, d.**
Magnaflux Corp., Sub.-General Mills, Inc., **d.**
***MARTIN CO., THE, DENVER DIV., d.**
W. L. Maxson Corp., The, **b.**
Millipore Filter Corp., **d.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **d.**
George L. Nankervis Co., **d.**
Paco Electronics Co., Inc., **d.**
Piasecki Aircraft Corp., **a.**
Pioneer Industries Div., Almar-York Co. Inc., **b, d.**
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp., **d.**
REF Mfg. Corp., **d.**
Radalab Inc., **d.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **b.**
Republic Mfg. Co., **d.**
Revere Corp. of America, Sub., Neptune Meter Co., **d.**
Richmont, Inc., **d.**
Solar Aircraft Co., **d.**
Specialties, Inc., **b.**
Specialty Electronics Development Corp., **b, c.**
State Testing Laboratory Inc., **d.**
Sun Electric Corp., Aeronautical Div., **d.**
TRG, Inc., **a.**
Telechrome Mfg. Corp., **a, b.**
Telectro Industries Corp., **a.**
Telkor, Inc., **b.**
Tober Electronic Corp., **b.**
Unified Industries, Inc., **a.**
United Mfg. Co., Div., The W. L. Maxson Corp., **d.**
U. S. Science Corp., Div.-Topp Industries, Inc., **d.**
Winder Aircraft Corp. of Florida, **b, c, d.**
Wolverine Diesel Power Co., **c.**

LACQUERS

American Products Mfg. Co.
Arco Co., The
Avondale Co., The
Better Finishes & Coatings Inc.
Borden Chemical Co.
Dennis Chemical Co.
E. I. Du Pont de Nemours & Co. Inc.
Felton-Sibley & Co., Inc.
Hastings Plastics, Inc.
Krylon, Inc.
Maas & Waldstein Co.
Marblette Corp., The
Metal & Thermit Corp.
Micro-Circuits Co.
Midland Industrial Finishes Co.
C. P. Moyen Co.
Naz-Dar Co.
Raffi & Swanson, Inc.
Silicones Div.-Union Carbide Corp.
Spraylat Corp.
Standard-Toch Chemicals, Inc.
Thompson & Co.

United States Plywood Corp.
Vorac Co., The
Wasley Products, Inc.

LADDERS, FUELING

Alad Aluminum Ladder Corp.
Atlas Industrial Corp.
Beacon Steel Corp.
Bil-Jax Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Kellett Aircraft Corp.
Pry Welding & Mfg., Inc.
South River Metal Products Co., Inc.
Waco Aircraft Co.
Wells Industries Corp.

LAMINATES

Agricultural Aviation Engineering Co. Inc.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
American Printed Circuits Co., Inc.
Atkins & Merrill, Inc.
L. J. Barwood Mfg. Co. Inc.
Bjorksten Research Labs. for Industry, Inc.
Bridgeport Brass Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Clevite Ordnance, Div.-Clevite Corp.
Continental Diamond Fibre Corp.
E. I. Du Pont de Nemours & Co. Inc.
Duralith Corp.
Eljay Corp.
Emerson Plastics Corp.
Fibercraft, Inc.
Food Machinery & Chemical Corp.-Dapon Dept.
Food Machinery & Chemical Corp.-Epoxy Dept.
Formica Corp.
Franklin Fibre-Lamitex Corp.
General American Transportation Corp.
General Plastics Corp.
Goodyear Aircraft Corp.
Grant-Lehr Corp.
Haskelite Mfg. Div.-Evans Products Co.
Hays Mfg. Co.
Heil Process Equipment Corp.
Insulation Mfrs. Corp.
Laminated Shim Co., Inc.
Lamtex Industries Inc.
Lunn Laminates, Inc.
Met-L-Wood Corp.
Mica Corp.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Mico Instrument Co
***MINNESOTA MINING & MFG. CO.**
Narmco Mfg. Co.
Narmco Materials Div., Narmco Industries, Inc.
National Vulcanized Fibre Co.
Olin Mathieson Chemical Corp., N. Y.
Olympic Plastics Co., Inc.
Owens-Corning Fiberglas Corp.
Penn Fibre & Specialty Co., Inc.
Plastic Age Sales, Inc.
Prewitt Aircraft Co.
Raybestos-Manhattan Inc.
Rogers Corp.
St. Regis Paper Co., Panelyte Div.
Sierracin Corp., The
Sillcocks-Miller Co.
Swedlow Inc.
Synthane Corp.
Taylor Fibre Co.
H. I. Thompson Fiber Glass Co.
Tingstol Co.
E. F. Twomey Co., Inc.
United States Plywood Corp.
United States Rubber Co.
Virginia Plak Co.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micarta Div.
Young Development Div., Hercules Powder Co.

LAMINATIONS, TRANSFORMER

Allen Electric & Equipment Co.
American Printed Circuits Co., Inc.
Communication Accessories Co.
G-L Electronics Co., Inc.
Industrial Equipment Div., Baldwin Lima Hamilton Corp
Magnetic Metals Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Squiers Gage Co.
Standard Electronics Div.-Reeves Instrument Corp.

LAMINATORS, PLASTIC HIGH PRESSURE

Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
American Printed Circuits Co., Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings Inc.
L. J. Barwood Mfg. Co. Inc.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
California Plasteck Inc.
Continental Diamond Fibre Corp.
Dayton Aircraft Products, Inc.
Emeloid Co., Inc., The
Emerson Plastics Corp
Eubanks Industries, Inc
Fabricon Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Farley & Loetscher Mfg. Co., Plastics Div.
Fibercraft, Inc.
Formica Corp.
Franklin Fibre-Lamitex Corp.
General Plastics Corp.
Grant-Lehr Corp.
Hays Mfg. Co.
Insulation Mfrs. Corp.
Lam-Ply, Inc.
Lamtex Industries Inc.
Lone Star Plastics Co. Inc.
Mica Corp.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
C. P Moyen Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Olympic Plastics Co., Inc.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Prewitt Aircraft Co
Raybestos-Manhattan, Inc.
Rogers Corp.
Russell Mfg. Co.
St. Regis Paper Co., Panelyte Div.
H. M. Scott Co., The
Sierracin Corp., The
Sillcocks-Miller Co.
Spaulding Fibre Co., Inc.
Stevens Products, Inc,
Swedlow Inc.
Synthane Corp.
Taylor Fibre Co.
Tetrafluor, Inc.
H. I. Thompson Fiber Glass Co.
United States Chemical Milling Corp.
United States Plywood Corp.
Virginia Plak Co.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micata Div.

LAMPS, INFRARED

Aerolux Light Corp
Eagle Electric Mfg. Co. Inc.
Engelhard Industries Inc
Miskella Infra-Red Co., The
Pioneer Industries Div., Almor-York Co. Inc.
Radiant Lamp Corp.
Research, Inc.
Tober Electronic Corp.
Westinghouse Electric Corp.

LAMPS, INSPECTION

Art Specialty Co.
Blowers Inc.
Cartriseal Corp.
Chicago Miniature Lamp Works
Eagle Electric Mfg. Co. Inc.
Engelhard Industries, Inc.
International Electric Industries, Inc
Magnaflux Corp., Sub.-General Mills, Inc.
Manhattan Lighting Equipment Co., Inc.
National Ultrasonic Corp.
Research, Inc.
Shannon Luminous Mat., Affiliate-Curtiss-Wright, Princeton Div
Strat-O-Seal Mfg. Co.
Westinghouse Electric Corp.

LAMPS, PROJECTION

***ENGIS EQUIPMENT CO.**
Gordon Enterprises
Manhattan Lighting Equipment Co., Inc.
Radiant Lamp Corp.
Westinghouse Electric Corp.

LANDING AIDS, ELECTRONIC

Aeronca Mfg. Corp.-Aerospace Div.
Bendix Aviation Corp.
Blonder-Tongue Labs. Inc., Special Products Div.
Collins Radio Co.
Decker Corp., The
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Fairfield Engrg. Corp.
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Intercontinental Electronics Corp.
Lear, Inc.
Litton Industries, Maryland Div.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
*Servomechanisms, Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.
Western Gear Corp.-Precision Products Div.
Wickes Engrg. & Construction Co.

LANDING GEAR ASSEMBLIES

***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Binkley Co., The
A. M. Byers Co.
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Eastern Rotorcraft Corp.
Electrol Inc.
Fenn Mfg. Co., The
Hydra-Power Corp.
Kanarr Corp.
Kemp Aero Products
Lycoming Div., Avco Corp.
Menasco Mfg. Co.
Ozone Metal Products Corp.
Peacock Engrg. & Mfg. Co.
Pryor Mfg. Co.
Sargent Engrg. Corp.
Simmonds Aerocessories, Inc.
Superior Industrial Machine Co.

LANDING SYSTEMS, INSTRUMENT

Allied International Corp.
Bendix Aviation Corp.
A. Biederman, Inc.
Broadview Research Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Collins Radio Co.
Consolidated Controls Corp.
Daystrom Inc., Transicoil Div.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Instrument Corp., Defense & Engrg. Products Group
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Litton Industries, Maryland Div.
Madigan Corp.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Motorola, Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.
Western Gear Corp.-Precision Products Div.

LATCHES

Burklyn Co.
Camloc Fastener Corp.
Components Corp.
George E. Harris & Co., Inc.
Hartwell Aviation Supply Co.
Henry & Miller Industries, Inc.
Walter K. Jaros Aircrafters
Langley Corp.
REF Mfg. Corp.
Richards-Wilcox Mfg. Co.
Simmonds Aerocessories, Inc.
Southco Div., South Chester Corp.
United States Chemical Milling Corp.
United Supply Co.
Vlier Engrg. Corp.
Waldick Engrg. Co

LATHES, BENCH

Clausing Div.-Atlas Press Co.
Dennis Chemical Co.
Hanson-Van Winkle-Munning Co.
Carl Hirschmann Co., Inc.
R. K. Leblond Machine Tool Co.
Louis Levin & Son, Inc.
Miller Falls Co.
Rivett Lathe & Grinder Inc.
Joseph T. Ryerson & Son, Inc.
Stark Tool Co.
U. S. Industries, Inc

LAUNCHERS, AIRBORNE ROCKET

American Machine & Foundry Co.

American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
Armament Div.-Universal Match Corp.
Beacon Steel Corp
Beckman & Whitley, Inc., Missile Products Div.
Beech Aircraft Corp.
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bermite Powder Co.
Breeze Corporations, Inc.
Broadview Research Corp.
A. M. Byers Co.
Calcor Corp.
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Columbia Research & Development Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cromer Mfg. & Engrg., Inc.
Dayton Aircraft Products, Inc.
Delta Corp.
Douglas Aircraft Co., Inc.
Edo Corp.
Food Machinery & Chemical Corp., Ordnance Div.
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard
Intercontinental Mfg. Co., Inc.
Interstate Engrg. Corp.
Jack & Heintz, Inc.
Link-Belt Co.
Mechanics Research Div., American Machine & Foundry Co.
Narmco Mfg. Co.
Northeast Metals Industries, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pastushin Industries, Inc.
Portland Copper & Tank Works Inc.
Rimak, Inc.
Royal Jet, Div.-Royal Industries, Inc.
Stamping Div.-Rockwell Standard Corp.
Standard Armament Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Talley Corp., The
Temco Aircraft Corp.
Transco Products, Inc.
Twin Coach Co., Aircraft-Missiles
U. S. Industries, Inc.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Welded Construction Inc.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Young Development Div., Hercules Powder Co.

LAUNCHERS, GROUND BASED MISSILES

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Aero-Test Equipment Co., Inc.
American Machine & Foundry Co.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Arde-Portland, Inc.
Armament Div.-Universal Match Corp.
Baker Industrial Trucks, Div.-Otis Elevator Co.
Basic Tool Industries, Inc.
Beacon Steel Corp.
*BEAVER PRECISION PRODUCTS INC.
Beckman & Whitley, Inc., Missile Products Div.
Beech Aircraft Corp.
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bermite Powder Co.
Bethlehem Steel Co.
Blaw-Knox Equipment, Div.-Blaw-Knox Co.
E. W. Bliss Co.
Broadview Research Corp.
Budd Co., The
A. M. Byers Co.
Calcor Corp.
Caterpillar Tractor Co., Defense Products Dept.
Chance Vought Aircraft, Inc
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Crane Co., Special Products Div.
Cromer Mfg. & Engrg., Inc.
Delta Corp.
Douglas Aircraft Co., Inc.
FWD Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
Gar Wood Industries Inc.
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Electric Co., Ordnance Dept.
Goodyear Aircraft Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard
George E. Harris & Co., Inc.
Hoefner Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Jack & Heintz, Inc.
Jonco Aircraft Corp., Sub.-Fairchild Engine & Airplane Corp.
Kellett Aircraft Corp.
Link-Belt Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Lofstrand Co., The
Lyncoach & Truck Co. Inc.
W. L. Maxson Corp., The
McCathron Boiler Works Co., Inc.
McDowell-Wellman Companies, The
McGregor Mfg. Corp.
Napier Engines Inc.
Narmco Mfg. Co.
Neway Equipment Co.
Northeast Metals Industries, Inc.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Otis Elevator Co., Defense & Industrial Div.
Portland Copper & Tank Works Inc.
*RADIO CORP. OF AMERICA
Republic Aviation Corp., Missile Systems Div.
Rimak, Inc.
Sancor Corp.
Stainless Inc.
Stamping Div.-Rockwell Standard Corp.
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
Trailmobile Inc.
Twin Coach Co., Aircraft-Missiles
U. S. Industries, Inc.
United States Steel Corp.
Vickers, Inc., Mich.
Ward Lafrance Truck Corp.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Welded Construction Inc.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Wickfield, Inc.
Winder Aircraft Corp. of Florida
Young Development Div., Hercules Powder Co.

LAUNCHING PLATFORMS

Aero-Test Equipment Co., Inc.
American Machine & Foundry Co.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Armament Div.-Universal Match Corp.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bethlehem Steel Co.
Bil-Jax Inc.
Broadview Research Corp.
Budd Co., The
A. M. Byers Co.
Calcor Corp.
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Crane Co., Special Products Div.
Curtiss-Wright Corp., Metals Processing Div.
Douglas Aircraft Co., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
Gar Wood Industries Inc.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard
Harbison-Walker Refractories Co.
George E. Harris & Co., Inc.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Kellett Aircraft Corp.
Link-Belt Co.
Lofstrand Co., The
Lyncoach & Truck Co. Inc.
McCathron Boiler Works Co., Inc.
Napier Engines Inc.
Northeast Metals Industries, Inc.
Nortronics, Div.-Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Pacific Coast Engrg. Co.
Portland Copper & Tank Works Inc.
Regent Jack Mfg. Co., Inc.
Republic Aviation Corp., Missile Systems Div.
Rimak, Inc.
Sancor Corp.
Stainless Inc.
Twin Coach Co., Aircraft-Missiles
U. S. Pipe & Foundry Co., Steel & Tubes Div.
Waco Aircraft Co.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Wickfield, Inc.

LEAD & ALLOYS

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Alpha Metals, Inc.
American Smelting & Refining Co.
Bar-Ray Products, Inc.
Belmont Smelting & Refining Works, Inc.
Bow Solder Products Co., Inc.
Custom Tool & Mfg. Co.
Division Lead Co.
Eagle-Picher Co., The
Eutectic Welding Alloys Corp.
Harmon, Lichtenstein & Co.
Morris P. Kirk & Son, Inc.
Nuclear Development Corp. of America
Pacific Coast Engrg. Co.
Plastics Distributor of New England
Portland Copper & Tank Works Inc.
Ray Proof Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

LEADS, TEST

Aerolite Electronics Corp.
Amatom Electronic Hardware Co. Inc.
American Smelting & Refining Co.
Anchor Specialty Mfg. Co. Inc.
Associated Engrg. Corp.
J. T. Baker Chemical Co.
Bendix Aviation Corp., Cincinnati Div.
Birnbach Radio Co., Inc.
Bud Radio, Inc.
Eastern Specialty Co., The
G-C Electronics Co.
General Radio Co.
Hallett Mfg. Co.
JFD Electronics Corp.
Keystone Electronics Corp.
Lab-Tronics, Inc.
Chester Morton Electronics Corp.
Paul Nurches Co.
Pomona Electronics Co., Inc.
Schaffer Air Industries, Inc.
Simpson Electric Co.
Skytronics, Inc.
Sunshine Scientific Instrument

LENSES

a. Infrared
b. Inspection
c. Motion Picture
d. Optical
e. RF
f. Zoom

*AEROJET-GENERAL CORP., **a.**
Ainslie Corp., **e.**
Allegheny Electronic Chemicals Co., **a.**
American Optical Co., **a thru f.**
American Optical Co., Instrument Div., **a, d.**

*ASKANIA-WERKE, U. S. BRANCH OFFICE, d.
Semon Bache & Co., b, c, d.
Bausch & Lomb Optical Co., a thru d, f.
Broadview Research Corp., a, d, e.
CBS Laboratories, Div.-Columbia Broadcasting System, d.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.,
*CONSOLIDATED ELECTRODYNAMICS CORP., a, d.
Corning Glass Works, a, d.
Davidson Optronics, Inc., a, d.
Decker Corp., The, d.
Dell Optics Co., Ltd., d.
Diamond Antenna & Microwave Corp., e.
Don-Lan Electronics Inc., e.
Eastman Kodak Co., a, c, d, f.
Elgeet Optical Co., Inc., c, f.
Emerson & Cuming, Inc., e.
Engelhard Industries, Inc., d.
*ENGIS EQUIPMENT CO., d.
J. W. Fecker Div., American Optical Co., a, b, d.
Fenske, Fedrick & Miller Inc., d.
Gordon Enterprises, a, c, d, f.
W. & L. E. Gurley, d.
Hammett-Mercury-Rex Div., d.
Infrared Industries, Inc., a.
Jarrell-Ash Co., d.
Hugo P. Keller, Jr., a.
Kollmorgen Optical Corp., a thru d.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., a, d.
Kopp Glass, Inc., a, b, f.
Lancaster Glass Corp., b, d.
Lear, Inc., a.
D. B. Milliken Co., c.
Mitchell Camera Corp., c.
Networks Electronic Corp., a.
Northrop Corp., a, d.
Nortronics, Div.-Northrop Corp., d.
Pacific Optical Corp., Div.-Chicago Aerial Industries, a, c, d.
Patterson Moos Research, Div.-Leesona Corp., a.
Perkin-Elmer Corp., a, d, f.
Precision Lapping Co. Inc., a, d.
*RADIO CORP. OF AMERICA, a, e.
Rantec Corp., e.
Republic Lens Co., Inc., a thru f.
Santa Barbara Research Center, a.
Scientific-Atlanta, Inc., e.
Sellstrom Mfg. Co., a, d.
Semimetals, Inc., a.
Singer Military Products Div.-The Singer Mfg. Co., a.
Spectracoat, Inc., a.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., e.
Sterling Glass Corp., b.
Tamar Electronics, Inc., e.
Texas Instruments Inc., a, d.
Texstar Plastics, Div.-The Texstar Corp.
Thermal American Fused Quartz Co., Inc., a, d.
Tinsley Labs., Inc., a thru d.
Traid Corp., c, f.
U. S. Industries, Inc., a.
United Supply Co.
Valpey Crystal Corp., a, d.
Vicon Corp. Sub.-Insul-8-Corp., d, f.
Viewlex, Inc., d, f.
Waterbury Companies, Inc., d.
Wollensak Optical Co., a thru f.
Zenith Optical Laboratory, a, d.
Zoomar Inc., a thru d, f.

LENSES, PRISMS, MIRRORS

American Optical Co.
American Optical Co., Instrument Div.
American Optical Co., Safety Products Div.
Semon Bache & Co.
Bausch & Lomb Optical Co.
*CONSOLIDATED ELECTRODYNAMICS CORP.
Davidson Optronics, Inc.
Dell Optics Co., Ltd.
Eastman Kodak Co.
Edmund Scientific Co.
*ENGIS EQUIPMENT CO.
J. W. Fecker Div., American Optical Co.
Fenske, Fedrick & Miller Inc.
Fish-Schurman Corp.
Gordon Enterprises
W. & L. E. Gurley
Hammett-Mercury-Rex Div.
Jarrell-Ash Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Kopp Glass, Inc.
Lancaster Glass Corp.
D. B. Milliken Co.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Pacific Optical Corp., Div.-Chicago Aerial Industries
Pacific Universal Products Corp.
Perkin-Elmer Corp.
Precision Lapping Co. Inc.
*RADIO CORP. OF AMERICA
Republic Lens Co., Inc.
Seiscor, Div.-Seismograph Service Corp.
Sterling Glass Corp.
TRG, Inc.
Texas Instruments Inc.
Thermal American Fused Quartz Co., Inc.
Tinsley Labs., Inc.
U. S. Industries, Inc.
United Supply Co.
Valpey Crystal Corp.
Wollensak Optical Co.
Zenith Optical Laboratory

LIGHT SUPPLIES

Aviation Textile Associates
*ENGIS EQUIPMENT CO.
Fenske, Fedrick & Miller Inc.
Hammett-Mercury-Rex Div.
Lear, Inc.
Manhattan Lighting Equipment Co., Inc.
Merix Chemical Co.
Pyle-National Co., The

LIGHTING, COLD CATHODE

Acme Electric Corp.
American Speedlight Corp.
*ENGIS EQUIPMENT CO.
Hammett-Mercury-Rex Div.
Lear, Inc.
Manhattan Lighting Equipment Co., Inc.
Julian A. Mc Dermott Corp.

LIGHTING EQUIPMENT, EMERGENCY

Acme Electric Corp.
American Optical Co., Safety Products Div.
Anchor Metal Spinning Co., The
Automatic Switch Co.
Blowers Inc.
Bogue Electric Mfg. Co.
Consolidated Diesel Electric Corp.
General Scientific Equipment Co.
Grimes Mfg. Co.
Hammett-Mercury-Rex Div.
Homelite, Div.-Textron Inc.
International Fermont Machinery Co., Inc.
Jeta, Inc.
Lincoln Electric Co., The
Lofstrand Co., The
Manhattan Lighting Equipment Co., Inc.
Julian A. Mc Dermott Corp.
Pesco Products Div.-Borg-Warner Corp.
Phoenix Products Co.
Pyle-National Co., The
Ready-Power Co., The
Thermal Dynamic Products Div.-Waltham Precision Instrument Co.
United States Radium Corp.
Winpower Mfg. Co.
Wolverine Diesel Power Co.

LIGHTING EQUIPMENT, PRESET PANELS

Acme Electric Corp.
American Machine & Foundry Co., Government Products Group
Bendix Aviation Corp.
California Plasteck Inc.
Fouch Electric Mfg. Co., Inc.
Kolton Electric Mfg. Co.
Lear, Inc.
Simmonds Aerocessories, Inc.
Superior Electric Co., The
United States Radium Corp.
Westinghouse Electric Corp.

LIGHTING EQUIPMENT, TOWER

Allied International Corp.
Automatic Switch Co.
Hammett-Mercury-Rex Div.
Hughey & Phillips, Inc.
Joy Mfg. Co.
Manhattan Lighting Equipment Co., Inc.
Julian A.-Mc Dermott Corp.
Pyle-National Co., The
Tabet Mfg. Co., Inc.
Tucson Instrument Corp.
Wind Turbine Co.
Wolverine Diesel Power Co.

LIGHTNING ARRESTERS

Airtron, Div.-Litton Industries
American Missile Products Co., Inc.
Brach Mfg. Corp.
Corning Glass Works
Garde Mfg. Co.
General Electric Co., Apparatus Sales Div.
Lehigh Structural Steel Co.
Line Material Industries-Mc Graw-Edison Co.
Manhattan Lighting Equipment Co., Inc.
*RADIO CORP. OF AMERICA
Westinghouse Electric Corp.

LIGHTS

a. Arc
b. Black
c. Dial, Panel & Pilot
d. Flood
e. Fluorescent
f. Glow
g. Incandescent
h. Indicator
i. Jewel Pilot
j. Miniature
k. Neon Test
l. Photoelectric Source
m. Signal
n. Spot
o. Stroboscopic Source

Aerolite Electronics Corp., c, i.
Aerolux Light Corp., b, f, k, n, o.
Alden Products Co., c, f thru j.
Amatom Electronic Hardware Co. Inc., c.
American Speedlight Corp., o.
Anglo Corp., e, m, o.
Anchor Metal Spinning Co., The, g, n.
Associated Engineers, Inc., c, h, i.
Aviation Textile Associates, c, h, j, m, n.
Bendix Aviation Corp., e.
Brunswick Instruments, k.
Cable Electric Products Inc., j, m, n.
California Plasteck Inc., c, f.
Carling Electric, Inc., c, h thru k.
Chadwick-Helmuth Co., o.
Chicago Miniature Lamp Works, c, f, g, h, j, k, m, n.
Circo Equipment Co., b.
Circo Ultrasonic Corp., b.
Control Sw. Div. Controls Co. of America, c, e, h, j, k, m.
Joe Davidson & Associates, o.
Dejur-Amsco Corp., Electronic Sales Div., l.
Dialight Corp., c, f thru k, m.
Dmeter Mfg. Co., l.
Dura Plastics of N. Y., Inc., c.
Eagle Electric Mfg. Co. Inc., c, k.
Edgerton, Germeshausen & Grier, Inc., o.
Edmund Scientific Co., o.
Eldema Corp., c, f, h.
Electronic Brazing Co., o.
Electronic Control Corp., l.
*ENGIS EQUIPMENT CO., l.
Federal Screw Products Inc., c, i.
G-C Electronics Co., i, k, m.
General Electric Co., Apparatus Sales Div., d, l.
General Radio Co., o.
Glar-Ban Corp., c, g thru j.
Gordon Enterprises, a, b, d, f, k, l, n.
Grimes Mfg. Co., c, d, e, g thru j, m, n.
Hammett-Mercury-Rex Div., d, e, g.
Holophane Co., Inc., e, g, n.
Industrial Devices, inc., c, f, h, i, j.
Industrial Electronic Engineers, Inc., h.
E. F. Johnson Co., c, i, j.
Joy Mfg. Co., d.
Kay Electric Co., c, h, j.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., c, l.
Kopp Glass, Inc., a thru d, g, h, i, m, n.
Lear, Inc., e, f, m.
Leecraft Mfg. Co., Inc., c, h, j, k, m.
Line Material Industries-Mc Graw-Edison Co., d, e, g, l.
Magnaflux Corp., Sub.-General Mills, Inc., b.
Manhattan Lighting Equipment Co., Inc., a thru k, m, n.
Marco Industries Co., c, f thru k.
Master Specialties Co., c, h, j.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., o.
National Ultrasonic Corp., b.
Phoenix Products Co., d, n.
Photobell Co., Inc., l.
Radar Relay, Inc., h.
Radiant Lamp Corp., d, g, n.
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., c, h.
Shannon Luminous Mat., Affiliate-Curtiss-Wright, Princeton Div., b.
Simmonds Aerocessories, Inc., c.
Specialties, Inc., h.
Sun Electric Corp., Aeronautical Div., o.
Thermal Dynamic Products Div.-Waltham Precision Instrument Co., a, d.
Transistor Electronics Corp., c, h thru k, m.
Tung-Sol Electric, Inc., c, f, h, j, l.
Ultra-Violet Products, Inc., b.
United States Radium Corp., c.
Van Wagner Co., j.
Vemaline Products Co., c, g thru j.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., a.

Wells Industries Corp., **l.**
Western Coil & Electrical Co., **a.**
Westinghouse Electric Corp., **a thru j, l, m, n.**
Wollensak Optical Co., **d, n.**

LINERS

a. Can
b. Combustion Chamber
c. Combustion Chamber, Gas
d. Metal
e. Rocket Engine
f. Turbine Engine

A & E Metal Specialties Inc., **d.**
Aerocal Div., Aeronca Mfg. Corp., **d.**
***AEROJET-GENERAL CORP., e.**
Allison Div., General Motors Corp., **a, b, c, f.**
American Aluminum Co., **a.**
American Potash & Chemical Corp., National Northern Div., **e.**
American Rocket Co., **e.**
Ampco Metal, Inc., **a.**
Anchor Metal Spinning Co., The, **d.**
Arde-Portland, Inc., **a thru f.**
Associated Co., Inc., **d.**
Beacon Steel Corp., **d.**
Bemis Bro. Bag Co., **a.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., e.**
Bestcraft Products Co. Inc., **a.**
Bethlehem Steel Co., **b, c, d.**
J. Bishop & Co., Platinum Works, **d.**
S. Blickman, Inc., **b thru f.**
Brunswick Balke Collender Co., The, Defense Products Div., **e.**
A. M. Byers Co., **e, f.**
Carborundum Co., The, **b, c, e, f.**
Carborundum Co., Refractories Div., **b, c.**
Carborundum Metals Co., The, **d.**
Crane Co., Special Products Div., **b, c, d, f.**
Crystal-X Corp., **a.**
Custom Tool & Mfg. Co., **d.**
Delta Corp., **b, c, e, f.**
Fansteel Metallurgical Corp., **d.**
Farwell Metal Fabricating, **d.**
Fenn Mfg. Co., The, **f.**
Flight Refueling, Inc., **d.**
Garlock Packing Co., **e.**
General Electric Co., Missile & Space Vehicle Dept., Pa., **d.**
B. F. Goodrich Aviation Products, **a, e.**
Grand Central Rocket Co., **e.**
Guided Missile Div., The Firestone Tire & Rubber Co., **e.**
Hahn & Clay, **d, e.**
Henry & Miller Industries, Inc., **d.**
Hughes Tool Co., Aircraft Div., **b, d, e.**
Janitrol Aircraft Div.-Midland-Ross Corp., **a, b, d, f.**
Kaiser Fleetwings, Inc., **d.**
C. B. Koupp & Sons, Inc., **a, c, d.**
Kelsey-Hayes Co., **d, e, f.**
Kentucky Metal Products Co., **b, c, e, f.**
***LAVELLE AIRCRAFT CORP., b, d, f.**
Lockheed Aircraft Corp., Missiles & Space Div., **e.**
Lofstrand Co., The, **d.**
Lone Star Plastics Co. Inc., **e.**
Lycoming Div., Avco Corp., **c, e, f.**
McGregor Mfg. Corp., **a thru f.**
Napier Engines Inc., **a, b, c, f.**
Naugatuck Chemical Div.-U. S. Rubber Co., **e.**
Nooter Corp., **d.**
Norton Co., New Products Dept., **b, e.**
Olin Mathieson Chemical Corp., N. Y., **d.**
Olympic Plastics Co., Inc., **b, e.**
Phoenix Products Co., **a, d, e, f.**
Plastic Age Sales, Inc., **e.**
Portland Copper & Tank Works Inc., **a thru f.**
Pressed Steel Tank Co., **b thru e.**
Raybestos-Manhattan, Inc., **b, e.**
Edw. Renneburg & Sons Co., **d.**
Royal Jet, Div.-Royal Industries, Inc., **d.**
Sillcocks-Miller Co., **a.**
Solar Aircraft Co., **b, d, f.**
South Wind Div., Stewart Warner Corp., **b.**
Southwest Research Institute, **b.**
Structural Fibers, Inc., **e, f.**
Synthane Corp., **e.**
T. O. D Mfg. Co. Inc., **d.**
Thermionic Aeronautical Div., **b thru f.**
Thiokol Chemical Corp. Hunter-Bristol Div., **e.**
H. I. Thompson Fiber Glass Co., **b, e.**
United States Rubber Co., **b, c, e.**
Western Pneumatic Tube Co., **d.**
Westinghouse Electric Corp., Micarta Div., **b, e.**
Yardley Plastics Co. **e**
Young Development Div., Hercules Powder Co., **b, e.**

LINES, SLOTTED

Bendix Aviation Corp
Demornay-Bonardi
Diamond Antenna & Microwave Corp
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Radio Co
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co.
ITE Circuit Breaker Co., Special Products Div.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Litton Industries, Maryland Div.
Narda Microwave Corp., The
Omega Labs., Inc.
Polytechnic Research & Development Co., Inc.
***RADIO CORP. OF AMERICA**
Sage Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
TRG, Inc.
Tober Electronic Corp.
Victor R. F. & Microwave Co.
Wacline, Inc.
Waveline, Inc.

LINKS, ANTENNA

***ANDREW CORP.**
Bendix Aviation Corp.
Chance Vought Aircraft, Inc.
Daystrom, Inc., Military Electronics Div.
Diamond Antenna & Microwave Corp
Dorne & Margolin, Inc.
Dynatronics, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Gabriel Co., The, Gabriel Electronics Div.
ITE Circuit Breaker Co., Special Products Div.
Litton Industries, Maryland Div
***MARTIN CO., THE, DENVER DIV.**
Norrich Screw Machine Products
Radalab Inc.
***RADIO CORP. OF AMERICA**
Stanley-Judd Div.-The Stanley Works
Tamar Electronics, Inc.
Telerad Mfg. Corp.
Waveline, Inc.

LIQUID FUELS

Air Products, Inc.
Allied Chemical Corp., General Chemical Div.
American Rocket Co.
Callery Chemical Co.
Chlor-Alkali Div.-Food Machinery & Chemical Corp.
Esso Standard, Div.-Humble Oil & Refining Co.
Food Machinery & Chemical Corp., Ordnance Div.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
Monsanto Chemical Co.
National Cylinder Gas, Div.-Chemetron Corp.
Olin Mathieson Chemical Corp., N. Y.
Shell Chemical Co., Indsl. Chemical Div.
Southwest Research Institute

LIQUID LEVEL MEASURING DEVICES

Aerotec Industries Inc., Aircraft Equipment Div.
Airaterra
Aircraft Instruments Co.
Automation Products, Inc.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
Consolidated Vacuum Corp.
Deltron Inc.
Dynamic Controls Corp.
Flight Refueling, Inc.
General Electric Co., Apparatus Sales Div.
General Electric Co., Rocket Engine Section
General Radio Co.
Hagan Chemicals & Controls Inc.
Hays Corp., The
Hughes Tool Co., Aircraft Div.
Industrial Instruments Inc.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
Kieley & Mueller, Inc.
Lear, Inc.
***WALLACE O. LEONARD, INC.**
Liquidometer Corp., The
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Narda Ultrasonics Corp., The
Oil-Rite Corp
Photobell Co., Inc.
Pyrotector Inc.
Radio Development & Research Corp.
Revere Corp. of America, Sub., Neptune Meter Co
Robertshaw-Fulton Controls Co., A & I Div
Rosemount Engrg. Co.
Milton Roy Co.
Roylyn Inc.
Servomechanisms, Inc
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Simmonds Aerocessories Inc
E. C. Smith Mfg. Co., Inc
Southwest Research Institute
Texas Instruments Inc.
Trans-Sonics, Inc.
Trimount Instrument Co.
United Control Corp.
U. S. Sonics Corp.
Vickers, Inc., Mich.
Vinson Mfg. Co. Inc.
Wells Industries Corp.
Young Development Div., Hercules Powder Co.

LIQUID NITROGEN

Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Cryogenerators, Inc.
Hofman Labs., Inc.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
National Cylinder Gas, Div.-Chemetron Corp.

LIQUID OXYGEN

Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Consolidated Airborne Systems, Inc.
Cryogenerators, Inc.
Hofman Labs., Inc.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
National Cylinder Gas, Div.-Chemetron Corp.

LITHIUM

Alloys Unlimited Inc.
American Potash & Chemical Corp.
Bios Labs., Inc
Bram Metallurgical Chemical Co.
***ENGIS EQUIPMENT CO.**
Foote Mineral Co.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Olin Mathieson Chemical Corp., N. Y.
Semi-Elements, Inc.
TRG, Inc.
United Mineral & Chemical Corp.

LOAD CELLS

Aeroscience, Inc.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs.
Beacon Steel Corp.
Budd Co., The
Gilmore Industries, Inc.
Instrument Div., The Budd Co.
Kistler Instrument Corp.
Leach Corp.
Martin-Decker Corp.
Morehouse Machine Co
Piasecki Aircraft Corp.
Revere Corp. of America, Sub., Neptune Meter Co.
Statham Instruments, Inc.

LOCATORS

a. Cable & Line Fault
b. Metal Flaw
c. Non-Metal Flaw
d. Open-Short

Associated Research, Inc., **a.**
James G. Biddle Co., **a.**
Branson Instruments, Inc., **b, c.**
Calvert Electronics Inc., **a, d.**
Delsen Corp., **c.**
J. W. Dice Co., **b.**
Dit-Mco, Inc., **d.**
Dytronics Co.
Industrial Instruments Inc., **a.**
Instrument Div., The Budd Co., **b, c.**
Leeds & Northrup Co., **a, d.**
Mechanics Research Div., American Machine & Foundry Co., **b.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **a, d.**
Muirhead Instruments Inc., **a.**
Nilsson Electrical Lab., Inc., **a.**
Peschel Electronics, Inc., **a, d.**
Philco Corp.-Govt. & Industrial Group, **a.**
Shallcross Mfg. Co., **a.**
Sierra Electronic Corp., Div.-Philco Corp., **a.**

LOCKNUTS

Abbott Screw & Mfg. Co.
Aero Spares, Inc
Airhardware, Inc.
All Specs Corp.
American Standard Products, Inc.
Associated Engineers, Inc
Autoscrew Co., Inc.
Aviation Textile Associates
Best Aircraft Corp
Capital City Mfg. Co., Inc
Carr Fastener Co., Div.-United-Carr Fastener Corp.
Collins Mfg. Corp
R. C. Dudek & Co

Eaton Mfg. Co., Reliance Div.
Eljay Corp.
George K. Garrett Co., Inc.
Hammett-Mercury-Rex Div.
Hi-Shear Rivet Tool Co.
Jan Hardware Mfg. Co., Inc.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
Klincher Locknut Corp.
Link-Belt Co.
Mercury Air Ports Co., Inc.
National Screw & Mfg. Co., The
Norrich Screw Machine Products
Ohlson Empire Inc.
Precision Metal Products Co. Inc.
Ratton Mfg. Co., The
Republic Steel Corp.
SKF Industries, Inc.
Shur-Lok Corp.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Thomas & Betts Co., Inc., The
Tinnerman Products, Inc.
Townsend Co., Cherry Rivet Div.
Vector Electronic Co., Inc.
Vlier Engrg. Corp.

LOCKS

a. Dial
b. General
c. Hydraulic
d. Shaft

Adams Rite Mfg. Co., **b.**
Adel Precision Products of Calif., Div.-General Metals Corp., **c.**

Amatom Electronic Hardware Co. Inc., **a.**
Birnbach Radio Co., Inc., **a, d.**
Bud Radio, Inc., **a.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., a, d.**
Hydra-Power Corp., **c.**
Jan Hardware Mfg. Co., Inc., **a, d.**
Haskel Engrg. & Supply Co., **c.**
Kemp Aero Products, **c.**
Keystone Electronics Corp., **a.**
Kilo Engrg. Co., **a, d.**
Lear, Inc., **d.**
James Millen Mfg. Co. Inc., **a, d.**
Precision Metal Products Co. Inc., **d.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., d.**
Reed Mfg. Co., **a.**
J. R. Robbins Co., **c.**
Ronson Hydraulic Units Corp., **c.**
Waters Mfg., Inc., **d.**

LORAN SYSTEMS

Allied International Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Broadview Research Corp.
Collins Radio Co.
Edo Corp.
Fla. Aircraft Radio & Marine
General Instrument Corp., Defense & Engrg. Products Group
ITT Federal Div., International Telephone & Telegraph Corp.
Motorola, Inc.
Philco Corp.-Govt. & Industrial Group
Piasecki Aircraft Corp.
Production Research Corp., Sub.-Radio Condenser Co.
Radalab Inc.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Southwest Research Institute
Sperry Gyroscope Co., Div.-Sperry Rand Corp.

LUBRICANTS

ACF Industries Inc.
Acheson Colloids Co., Div.-Acheson Industries, Inc.
Alpha Molykote Corp., The
American Grease Stick Co.
American Oil & Supply Co.
Anderson Oil & Chemical Co., Inc.
Ashland Oil & Refining Co.
George Basch Co., The
Chemplast, Inc.
Delta Chemical Works, Inc.
Delta-Desco Companies
Dow Corning Corp.
Drilube Co.
Eastern Chemical Div., Hooker Chemical Corp.
Ed-Berl Products, Inc.
Electrofilm, Inc.
Esso Standard, Div.-Humble Oil & Refining Co.
Fluoro-Chem Corp.
Food Machinery & Chemical Corp.-Chemical & Plastics Div.
Grafo Colloids Corp.
Gulf Oil Corp., Dept. DM
Halocarbon Products Corp.
R. M. Hollingshead Corp.
Imperial Oil & Grease Co., Inc.
Kano Labs.
Lockrey Co., The, Lubricants Div.
Magnus Chemical Co., Inc.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
New York & New Jersey Lubricant Co.
Olin Mathieson Chemical Corp., N. Y.
Parker Rust Proof Co.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Protective Coatings, Inc.
Quietrole Co.
Silicone Products Dept., General Electric Co., Dept. C.
Sinclair Refining Co.
Southwest Research Institute
Standard Oil Co. of Indiana
Var-Lac-Oid Chemical Co.
White & Bagley Co., The

LUBRICATING DEVICES

Bearing Inspection, Inc.
Bellows-Valvair Divs.
Bennett-Feragen
Ed-Berl Products, Inc.
Gits Brothers Mfg. Co.
Gray Co., Inc.
C. A. Morgren Co.
Oil-Rite Corp.
Superior Pneumatic & Mfg., Inc.
Technical Development Co.
Waldick Engrg. Co.
Wesrep Corp.

LUGS

Amatom Electronic Hardware Co. Inc.
American Brass Co., The
Associated Engineers, Inc.
Bead Chain Mfg. Co., The
Bergen Carbide Co.
Birnbach Radio Co., Inc.
Burndy Corp., Omaton Div.
Hobson Brothers, Inc.
Walter K. Jaros Aircrafters
Kellett Aircraft Corp.
Keystone Electronics Corp.
Kulka Electric Corp.
Malco Mfg. Co.
Norrich Screw Machine Products
Precision Metal Products Co. Inc.
Rye Sound Corp.
Sinclair Mfg. Co.
C. Sjoberg & Son
Stanley-Judd Div.-The Stanley Works

LUGS, CABLE-ELECTRIC

AMP Inc.
Amatom Electronic Hardware Co. Inc.
American Brass Co., The
Associated Engineers, Inc.
Birnbach Radio Co., Inc.
Burndy Corp., Omaton Div.
Hallett Mfg. Co.
Kolton Electric Mfg. Co.
Kulka Electric Corp.
Manhattan Lighting Equipment Co., Inc.
C. Sjoberg & Son.
Stanley-Judd Div.-The Stanley Works
Whitaker Cable Corp.

MACHINES

a. Abrasive Cutting
b. Air Conditioning
c. Balancing
d. Bending
e. Blueprint
f. Capacitor Manufacturing
g. Cleaning
h. Coil Winding
i. Counting
j. Crystal Manufacturing & Finishing
k. Cutting
l. Diecasting
m. Electric Soldering
n. Electron Tube
o. Electronic Balancing
p. Electronic Transcribing
q. Engraving & Profiling
r. Forming
s. Glass Working
t. Hermetic Sealing
u. Impregnating
v. Lamination Stacking
w. Marking
x. Metal Forming
y. Modular & Automatic Assembly
z. Photocopy & Whiteprint
a-1. Plastic Press
b-1. Riveting
c-1. Shock Testing
d-1. Soldering
e-1. Tube Manufacturing
f-1. Vibration Fatigue Testing
g-1. Weighing
h-1. Wire Stripping

ABA Tool & Die Co., **j, l.**
ACF Electronics Div., ACF Industries Inc., **x, b-1, g-1.**
ACF Industries Inc., **x, b-1.**
Abbott Screw & Mfg. Co., **x, b-1.**
Ackerman-Gould Co., Inc., **w.**
Acromark Co., The, **w.**
Aeroflex Labs. Div., Aeroflex Corp., **f-1.**
Aeroil Products Co., Inc., **w.**
Aeroprojects Inc., **d-1.**
Aeroscience, Inc., **f-1, g-1.**
Aero-Test Equipment Co., Inc., **g.**
Aircraft Tools, Inc., **b-1.**
All American Tool & Mfg. Co., **f-1.**
All Specs Corp., **d-1.**
Allison-Campbell Div., American Chain & Cable Co., Inc., **a.**
American Instrument Co., Inc., **a.**
American Machine & Foundry Co., Greenwich Engrg. Div., **h, y.**
Anchor Specialty Mfg. Co. Inc., **c-1, f-1.**
R. B. Annis Co., **c.**
Apex Machine Co., **w.**
Arnold Magnetics Corp., **h.**
Associated American Winding Machinery Inc., **f, h.**
Associated Engrg. & Mfg. Corp., **n, s, t, e-1.**
Associated Testing Labs., Inc., **c-1, f-1.**
Avco Corp.-Research & Advanced Development Div., **c-1.**
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., **f-1, g-1.**
Banthin Engrg. Co., **z.**
Leon J. Barrett Co., The, **f, g, u.**
Barry Controls Inc., **c-1.**
Rex Bassett, Inc., **j.**
Cyril Bath Co., The, **d, r, x.**
Bearing Inspection, Inc., **g.**
Bendix Aviation Corp., **c, k.**
Blackstone Corp., **g.**
E. W. Bliss Co., **d, x, e-1.**
Bo Myte Co., Inc., The, **u.**
W. H. Brady Co., **w.**
Branson Instruments, Inc., **g.**
Brown & Sharpe Mfg. Co., **k.**
Bruce Engrg. Co., **q.**
Budd Co., The, **a, e, k, l, r, u, v, x, f-1.**
Budd Lewyt Electronics, Inc., **b.**
Bulova Research & Development Labs., Inc., **j, m, q, t, y, d-1, h-1.**
Burklyn Co., **x.**
A. M. Byers Co., **r.**
Calcar Corp., **x.**
California Stamping & Mfg. Co., **x.**
Carborundum Co., The, **a, k.**
Chambersburg Engrg. Co., **x.**
Cherry Rivet Div.-Townsend Co., **b-1.**
Chicago Rivet & Machine Co., **b-1.**
Cincinnati Cleaning & Finishing Machinery, **g.**
Cincinnati Milling Machine Co., The, **a, k, q, r, x.**
Cincinnati Shaper Co., The, **d, x.**
Cincinnati Sub Zero Products, **c-1.**
Circo Equipment Co., **g.**
Circo Ultrasonic Corp., **g.**
Cleveland Automatic Machine Co., The, **l.**
Coast Pro-Seal & Mfg. Co., **x.**
Cobehn, Inc., **g.**
Coil Winding Equipment Co., **h.**
Coleman Electronics, Inc., **g-1.**
Compudyne Corp., **c-1, f-1.**
***CONSOLIDATED ELECTRODYNAMICS CORP., c-1.**
Consolidated Vacuum Corp., **c-1.**
Copymation, Inc., **e, z.**
Cosa Corp., **c, o, q, x, f-1.**
Covel Mfg. Co., **a.**
Cryogenerators, Inc.
Dallons Semiconductors, Div.-Dallons Labs., **j.**
Joe Davidson & Associates, **b.**
J. H. Day Co., The, Div.-The Cleveland Automatic Machine Co., **l.**
Decker Corp., The, **c, o.**
Delsen Corp., **g-1.**
Desomatic Products, Inc.-Anders-Driline, **b.**
Detrex Chemical Industries, Inc., **g.**
W. C. Dillon & Co., Inc., **g-1.**
Drill Mfg. Co., **g.**
Edwards High Vacuum Ltd., **s.**
Eisler Engrg. Co., Inc., **a, h, j, k, m, n, r thru u, d-1, e-1.**
Electromark Corp., The, **w.**
Ellis & Watts Products, Inc., **b.**

*ENGIS EQUIPMENT CO., a, q.
Ex-Cell-O Corp., k, q.
Falstrom Co., x.
Federal Electronic Products Inc., s.
Fenn Mfg. Co., The, x, e-1.
Finnell System, Inc., g.
Fish-Schurman Corp., s.
Flight Refueling, Inc., c-1, f-1.
Foredom Electric Co., Inc., a, k, q, w, b-1.
Gardner-Denver Co., b-1.
General Electro-Mechanical Corp., b-1.
Giddings & Lewis Machine Tool Co., k.
Duncan M. Gillies Co. Inc., w.
Gleason Works, a, k.
Gordon Enterprises, w, z, f-1, h-1.
George Gorton Machine Co., q, w.
Grant Mfg & Machine Co., The, b-1.
Green Instrument Co., q.
Grotnes Machine Works, Inc., r.
Gulton Industries, Inc., g, h, m, c-1.
Haloid Xerox Inc., z.
Hamilton Watch Co., Military Products Div., h.
Hammett-Mercury-Rex Div., a, c, d, h, j, m.
Heidor Mfg. Co., Inc., x.
High Speed Hammer Co., Inc., The, w, b-1, h-1.
High Vacuum Equipment Corp., Sub.-Robinson Tech Products, Inc., u.
Highland Engrg. Co., b.
Carl Hirschmann Co., Inc., h, q, c-1, f-1.
Hobbs Mfg. Co., k.
P. R. Hoffman Co., j.
Hopkins Engrg. Co., f.
Howe Scale Co., The, g-1.
Hunter Spring Co., Div.-American Machine & Metals, Inc., f-1.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., l, r, x, a-1.
Impact-O-Graph Corp., The, c-1.
Imperial Brass Mfg Co., The, d, k.
Industrial Systems Co., g.
Instrument Div., The Budd Co., f-1.
Invincible Vacuum Cleaner Mfg. Co., g.
*ITEMCO, INC., b.
Jan Hardware Mfg. Co., Inc., c-1.
Walter K. Jaros Aircrafters, b-1.
Jennings Machine Corp., h-1.
L. A. B. Corp., f-1.
L & R Mfg. Co., g.
Lear, Inc., g-1.
Lemert Engrg. Co., Inc., r, b-1.
Lennox Tool & Machine Builders, d, k, r, x.
Lepel High Frequency Labs. Inc., j, m, t, d-1.
Litton Engrg. Labs., s, e-1.
Livingston Electronic Corp., d-1.
MB Electronics, f-1.
Magnus Chemical Co., Inc., g.
R. C. Mahon Co., The, g.
Marchant Machining Corp., r, x, b-1.
Markem Machine Co., w.
Martindale Electric Co., h-1.
Jas. H. Matthews & Co., w.
Mc Kenna Labs., g.
Mechanics Research Div., American Machine & Foundry Co., y, g-1.
Miami Engrg., Div.-Miami Shipbuilding Corp., s.
Mico Instrument Co., q, s.
Milman Engrg. Co.
*MINNESOTA MINING & MFG. CO., z.
Molding Corp. of America, t.
Robert E. Morris Co., The, a, j, k.
NUMEC-Nuclear Materials & Equipment Corp., g-1.
National Cylinder Gas, Div.-Chemetron Corp., d-1.
New England Machine & Tool Co., The, q.
Niagara Machine & Tool Works, d, r, x.
Noble & Westbrook Mfg. Co., The, w.
Northrop Corp., h, f-1.
Norton Co., New Products Dept., a.
Paul Nurches Co., h-1.
Nureco, Inc., u.
Onsrud Machine Works, Inc., k, q.
Optomechanisms Inc., i, w.
Orbitran Co., Inc., g-1.
Palmer Instruments, j.
Paragon-Revolute, Div.-Charles Bruning Co., Inc., e, z.
Parsons Diamond Products, Inc., k, s.
Patterson Moos Research, Div.-Leesona Corp., h.
Peerless Photo Products Inc., z.
Pegasus Labs., Inc., c-1, f-1.
Penetone Co., The, g.
Pennsalt Chemicals Corp., g.
Richard Philip Co., d, h, r, x, h-1.
Pines Engrg. Co. Inc., d, x.
Pioneer Industries Div., Almar-York Co. Inc., b.
Precision Lapping Co. Inc., s.
H. P. Preis Engraving Machine Co., q, w.
Pryor Marking Products, w.
*RADIO CORP. OF AMERICA, h, j, n, p, v, y, e-1.
Ransohoff Co., g.
Rea Magnet Wire Co., Inc., Div.-Aluminum Co. of America, h.
Recony Div.-Vinco Corp., a, b, c, k.
Reed-Prentice, Div.-Package Machinery Co., l.
Revere Corp. of America, Sub., Neptune Meter Co., g-1.
Roovers-Lotsch Corp., w.
Rotex Punch Co., Inc., x.
Roto Finish-Ransohoff, g.
Joseph T. Ryerson & Son, Inc., a, d, k, r, x.
St. Regis Paper Co., Panelyte Div., u.
Salas Corp. of America, d-1.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., y.
Sheridan-Gray, Inc., d, r, x, a-1.
Southwest Research Institute, a, b, c-1, f-1.
Special Products Dept., Melpar, Inc., y.
Specialties, Inc., z.
Sphere Co. Inc., The, b-1.
Stanley-Judd Div.-The Stanley Works, x.
Geo. Stevens Mfg. Co., Inc., h.
F. J. Stokes Corp., u, a-1.
W. Whitney Stueck, Inc., d, x.
Swift Textile Metalizing & Laminating Corp., w.
TRG, Inc., j, s.
Taylor-Winfield Corp., d.
Technical Design & Development Co., Inc., v, y.
Telechrome Mfg. Corp., y, g-1.
Telectro Industries Corp., y.
Thayer Scale Corp., g-1.
Thiokol Chemical Corp., Hunter-Bristol Div., g-1.
Thomas Instrument Co., h-1.
Thomson, Judson L., y, b-1.
Thor Power Tool Co., a, w, b-1.
Tinius Olsen Testing Machine Co., c.
Torrington Co., The, x.
Trane Co., The, b.
United Shoe Machinery Corp., k, w, b-1.
U. S. Industries, Inc., r, x, b-1.
United States Testing Co., Inc., c-1, f-1.
Universal Mfg. Co., Inc., h.
Vapor Blast Mfg. Co., a, g.
Veeco Vacuum Corp., j, t.
Veet Industries, a-1.
Vemaline Products Co., d.
Vilter Mfg. Co., The, b.
Virginia Electronics Co., Inc., m, d-1.
Wells Industries Corp., i.
Western Electronic Products Co., h-1.
Western Sealant of Conn., u.
Westinghouse Electric Corp., b, c-1.
Westline Products Div.-Western Lithograph Co., w.
Wheelabrator Corp., g.
S. S. White Industrial Div., a, g, j.
Whitney Metal Tool Co., d, k, b-1.
Worthington Corp., b.
Zippertubing Co., The, e-1.

MACHMETERS

*AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div.
Bendix Aviation Corp
A. Biederman, Inc.
Daystrom Inc., Pacific Div
George E. Harris & Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
*WALLACE O. LEONARD, INC.
Madigan Corp
Rosemount Engrg. Co.
Servomechanisms, Inc.
Specialties, Inc.
Trans-Sonics, Inc.

MAGNESIUM & ALLOYS

Alloys Unlimited Inc
Aluminum Co. of America
American Smelting & Refining Co.
Artra Aluminum Foundry & Mfg Co. Inc
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
Brooks & Perkins, Inc
Budd Co., The
Delta Chemical Works, Inc.
Dow Chemical Co., The
Kaiser Aluminum & Chemical Sales, Inc.
Light Metals, Inc.
Magline Inc
Nelco Metals, Inc.
R. H. Osbrink Mfg. Co.
Semi-Elements, Inc
South River Metal Products Co., Inc.
United Mineral & Chemical Corp.
Vanadium Corp. of America
Var-Lac-Oid Chemical Co.
Wyman-Gordon Co.

MAGNETIC ANALYSIS EQUIPMENT

Budd Co., The
Coil Co. of America
General Kinetics Inc.
Hays Corp., The
Magnaflux Corp., Sub.-General Mills, Inc.
Mincom Div., Minnesota Mining & Mfg. Co.
Sensitive Research Instrument Corp.

MAGNETIZERS & DEMAGNETIZERS

R. B. Annis Co.
Bearing Inspection, Inc.
Coltron Products Co.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Crucible Steel Co. of America
Davenport Mfg. Co.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Electromation Co., Div.-Del Mar Engrg. Labs.
Electronic Brazing Co.
General Electric Co., Apparatus Sales Div.
Indiana Steel Products, Div.-Indiana General Corp.
Leo Klein Electronics Co.
L & R Mfg. Co.
Magnaflux Corp., Sub.-General Mills, Inc.
Robins Industries Corp.

MAGNETOMETERS

R. B. Annis Co
*ARNOUX CORP.
*ASKANIA-WERKE, U. S. BRANCH OFFICE
Bendix Aviation Corp.
Dalmo Victor Co., Div.-Textron, Inc.
Device Development Corp.
Eclipse-Pioneer Div., Bendix Aviation Corp.
General Electric Co., Missile & Space Vehicle Dept., Pa
Lear, Inc.
Magnaflux Corp., Sub.-General Mills, Inc.
Northrop Corp.
Rawson Electrical Instrument Co
Sun Electric Corp., Aeronautical Div.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

MAGNETOS & PARTS

Bendix Aviation Corp.
Hallett Mfg. Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc
Scintilla Div., Bendix Aviation Corp.
Skytronics, Inc.

MAGNETS

Arnold Engrg. Co., The
Cosmic Instruments Inc.
Crucible Steel Co. of America
Edmund Scientific Co.
Ferroxcube Corp. of America
Fisher Scientific Co., Maryland
General Magnetic Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc
J. E. Menaugh Co.
National Moldite Co.
Permanent Magnet Co., Inc., The
Stackpole Carbon Co.
Ullman Devices Corp.
Westinghouse Electric Corp.

MAGNETS, ELECTRO

Allied Control Co., Inc.
J. Bishop & Co., Platinum Works
Device Development Corp.
Ferroxcube Corp. of America
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc.
Litton Industries, Inc.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Process & Instruments
Sunshine Scientific Instrument
Talley Corp., The
Westinghouse Electric Corp.

MAGNETS, FOCUSING

Applied Radiation Corp.
Crucible Steel Co. of America
Ferroxcube Corp. of America
General Magnetic Corp
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Litton Industries, Inc.
National Moldite Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

MAGNETS, PERMANENT

Arnold Engrg. Co., The
Barker Sales Co.

J. Bishop & Co., Platinum Works
Cosmic Instruments Inc.
Crucible Steel Co. of America
Eriez Mfg. Co.
Ferroxcube Corp. of America
General Magnetic Corp.
Hoskins Mfg. Co.
Indiana Steel Products, Div.-Indiana General Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Magnaflux Corp., Sub.-General Mills, Inc.
J. E. Menaugh Co.
National Moldite Co.
Permanent Magnet Co., Inc., The
Stackpole Carbon Co.
Westinghouse Electric Corp.

MANGANESE

American Nickel Alloy Mfg. Corp.
American Smelting & Refining Co.
Bethlehem Steel Co.
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
Delta Chemical Works, Inc.
Foote Mineral Co.
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Vanadium Corp. of America
Var-Lac-Oid Chemical Co.

MANIFOLDS

a. Air System
b. Fuel
c. Ignition
d. Intake & Exhaust
e. Nitrogen
f. Oxygen
g. Primer

Accessory Products Co., Div.-Textron Inc., **a, b.**
***AEROJET-GENERAL CORP., a, b, e, f.**
Aerotec Industries Inc., Aircraft Equipment Div., **f.**
Air Products, Inc., **f.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **e, f.**
Allison Div., General Motors Corp., **a, b.**
American Tube Bending Co., Inc., **d.**
Arde-Portland, Inc., **a, b, d.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **a, b, d.**
B. H. Aircraft Co., Inc., **a, b, d.**
Beaton & Corbin Mfg. Co., The, **b, c.**
***BENDIX AVIATION CORP., HAMILTON DIV. b.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., b.**
Breeze Corporations, Inc., **c.**
Calcor Corp., **a thru f.**
California Stamping & Mfg. Co., **b, d, f.**
Captive Seal Corp., **a thru g.**
Carleton Aviation Co., Inc., **b, e, f.**
Colonial Aircraft Corp., **a, b, d.**
Curtiss-Wright Corp.-Wright Aeronautical Div., **a thru d, g.**
George W. Dahl Co., Inc., **a, f.**
***DEL MAR ENGRG. LABS., b, e.**
Douglas Aircraft Co., Inc., **b, f.**
Dunbar-Kapple Inc.-Aircraft Components Div., **a, d.**
Flexonics Corp., **a, b.**
Futurecraft Corp., **a, b, e, f.**
General Laboratory Associates, Inc., **c.**
Guided Missile Div., The Firestone Tire & Rubber Co., **b.**
B.H. Hadley, Inc., **a, b, e, f, g.**
Hallett Mfg. Co., **c.**
Hofman Labs., Inc., **e, f.**
Hydra-Power Corp.
C. B. Kaupp & Sons, Inc.
Kelsey-Hayes Co., **d.**
***LAVELLE AIRCRAFT CORP., a, b.**
Linde Co., Div.-Union Carbide Corp., **e, f.**
Lone Star Plastics Co. Inc. **a.**
McGregor Mfg. Corp., **a, d, e, f.**
Mead Specialties Co., Inc., **a.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **a, b, c, e, f.**
National Cylinder Gas, Div.,-Chemetron Corp., **a, e, f.**
National Welding Equipment Co., **e, f.**
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc., **a, b.**
Opelika Welding, Machine & Supply Inc., **d.**
Oxygen Equipment & Service Co., **e, f.**
Parts Engrg. Co., Inc., **a, b.**
Penn-Michigan Mfg. Corp., **d.**
Republic Mfg. Co., **a.**
Robbins Aviation, Inc., **a.**
Sargent Engrg. Corp., **a, e, f.**
Scintilla Div., Bendix Aviation Corp., **c.**
Servicair Co., **c.**
Sierra Engrg. Co., **a, f.**
Skytronics, Inc., **c.**
Solar Aircraft Co., **d.**
Southwest Research Institute, **a, b, d.**
Specialty Electronics Development Corp., **c.**
Standard Steel Corp., Cambridge Div., **e, f.**
A. U. Stone & Co., Inc., **a, b.**
Struthers Wells Corp., **b, e, f.**
Superior Air Products Co., **e, f.**
Weatherhead Co., The, **a, b.**
Weba, Inc.
Wells Industries Corp., **a, e, f.**
Woolf Aircraft Products, Inc., **a, b, f.**
Zep Aero, **f.**

MANIPULATORS, NUCLEAR

American Research & Mfg. Corp.
Bendix Aviation Corp.
E. W. Bliss Co.
A. M. Byers Co.
Central Research Labs., Inc.
Ex-Cell-O Corp.
Flight Refueling, Inc.
General Electric Co., Apparatus Sales Div.
General Mills, Inc
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
Mechanics Research Div., American Machine & Foundry Co.
Pacific Coast Engrg. Co.
Tracerlab Inc.
U. S Industries, Inc.

MANOMETERS

A. Biederman, Inc.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Dynametrics Corp.
Eclipse Fuel Engrg. Co.
Edwards High Vacuum Ltd.
Ellison Draft Gage Co., Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Hass Instrument Corp., The
E. Vernon Hill & Co.
Ideal-Aerosmith, Div.-Royal Industries, Inc.
Joseph Kaye & Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
***WALLACE O. LEONARD, INC.**
***MARTIN CO., THE, DENVER DIV.**
Southwest Research Institute
Thermal American Fused Quartz Co., Inc.
Trans-Sonics, Inc.
Trimount Instrument Co.
Uehling Instrument Co.
Wallace & Tierman Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

MASKS, APERTURE, TUBE

Acushnet Process Co.
Croname Inc.
Puritan Aerospace Div.-Puritan Compressed Gas Corp.

MATERIALS HANDLING EQUIPMENT

Air Logistics Corp.
American Car & Foundry Div., ACF Industries, Inc.
American Monorail Co., The
Arnolt Corp.
Associated Co., Inc.
Baker Industrial Trucks, Div.-Otis Elevator Co.
Barrett-Cravens Co.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
E. W. Bliss Co.
Brooks & Perkins, Inc.
Brown-Line Corp.
Budd Co., The
E. W. Buschman Co., The
Butler Mfg. Co.
Albert H. Cayne Equipment Corp.
Clark Equipment Corp.
Clark Equipment Co., Industrial Truck Div.
Colson Corp., The
Deluxe Metal Products Co.
Dempster Brothers, Inc.
FWD Corp.
Fairbanks Co., The
Flight Refueling, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
Garden City Fan & Blower Co.
General American Transportation Corp.
Gyrex Corp., The
George E. Harris & Co., Inc.
Herlo Corp.
Hughes Tool Co., Aircraft Div.
Jeffrey Mfg. Co., The
Joy Mfg. Co.
Lear, Inc.
Link-Belt Co.
Magnesium Co. of America
***MARTIN CO., THE, DENVER DIV.**
McDowell-Wellman Companies, The
Mechanical Handling Systems Inc.
Mechanics Research Div., American Machine & Foundry Co.
Mercury Mfg. Co.
National Vulcanized Fibre Co.
Nelson Labs., Inc.
Northrop Corp.
Nutting Truck & Caster Co.
Pacific Coast Engrg. Co.
Pegasus Labs., Inc.
Pettibone Mulliken Corp.
Richard Philip Co.
Pioneer Industries Div., Almar-York Co. Inc.
Rapids-Standard Co., Inc., The
Reed Research Inc.
Edw. Renneburg & Sons Co.
Revolvator Co.
Richards-Wilcox Mfg. Co.
Rimak, Inc.
Robbins & Myers, Inc., Hoist & Crane Div.
Sheridan-Gray, Inc.
Trailmobile Inc.
United States Rubber Co.
Waco Aircraft Co.
Wayne Pump Co., The, Div.-Symington Wayne Corp.
Wells Industries Corp.
Albert Wesling & Sons Inc.
Whiting Corp.

MATRIXES COMPUTER

Aeronca Mfg. Corp.-Aerospace Div.
Bendix Aviation Corp.
Broadview Research Corp.
Djeco, Div.-Djordjevic Engrg. Co.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
Navigation Computer Corp.
Northrop Corp.
Packard Bell Computer Corp.
Radiation, Inc.
***RADIO CORP. OF AMERICA**
Southwestern Industrial Electronics Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Tally Register Corp.
Telechrome Mfg. Corp.

MEGAPHONES, ELECTRONIC

Calvert Electronics Inc.
Du Kane Corp.
Gordon Enterprises
ITI Electronics, Inc.
Motorola, Inc.

MEMORY

a. Crystal
b. Drums
c. Multi-Core Magnetics
d. Systems
e. Tape Loop
f. Tubes

AMP Inc., **c.**
Alwac Computer, Div.-El-Tronics Inc., **b.**
Ampex Data Products Co., **d, e.**
Arrow Tool Co. Inc., **b, d, e.**
Audio Instrument Co., Inc., **e.**
Autonetics, Div.-North American Aviation, Inc., **b.**
Bendix Aviation Corp., **b, d.**
Bendix Aviation Corp., Cincinnati Div., **d.**
Broadview Research Corp., **a thru f.**
Bryant Computer Products Div., **b.**
Budd Lewyt Electronics, Inc., **c, d.**
Burroughs Corp., **c, d, e.**
CBS Laboratories, Div.-Columbia Broadcasting System, **d.**
C & K Components, Inc., **d.**
California Computer Products, Inc., **b.**
Chance Vought Aircraft, Inc., **b, d.**
Christie Machine Works, **b.**
Computer Control Co., Inc., **c, d.**
Computer Control Co., Inc., Western Div., **c, d.**
Consolidated Controls Corp., **b, d.**
***CONSOLIDATED ELECTRODYNAMICS CORP., d, e.**
Control Data Corp., **b, c, d.**
Daystrom, Inc., Control Systems Div., **c, d.**
Daystrom, Inc., Military Electronics Div., **c, d.**
Daystrom Inc., Transicoil Div., **d.**
Delco Radio Div.-General Motors Corp., **c, d.**
Designers for Industry, Inc., **b, c, d.**
Dynatronics, Inc., **d.**
Eastman Kodak Co., **d.**
Electromation Co., Div.-Del Mar Engrg. Labs., **e.**
Electronic Engrg. Co. of California, **d, e.**

Electronic Tube Corp., **f.**
Electronics Div.-The National Cash Register Co **b thru e.**
Ex-Cell-O Corp., **b.**
Ferroxcube Corp. of America, **c.**
Flight Support, Inc., **b, d.**
General Ceramics Div., Indiana General Corp., **c, d.**
General Electric Co., Heavy Military Electronics Dept., **d.**
Genisco, Inc., **b.**
Graflex Inc., **b.**
Hammett-Mercury-Rex Div., **a, b, d.**
ITT Federal Div., International Telephone & Telegraph Corp., **d.**
Image Instruments, Inc., **d.**
Intercontinental Electronics Corp., **f.**
Lab. for Electronics, Inc., **b, d.**
Leach Corp., **e.**
Lear, Inc., **a, d.**
Librascope Div., General Precision, Inc., **b, c, d.**
Madigan Corp., **d.**
Magnasync Corp., **d.**
Magne-Head Div., General Transistor Corp., **b, e.**
Maico Electronics, Inc., **b thru e.**
Midwestern Instruments, Inc., **b, e.**
Milgo Electronic Corp., **d.**
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., **b, e.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **c, d.**
***MINNESOTA MINING & MFG. CO., e.**
Motorola, Inc., **a, c, d.**
Northrop Corp., **b, c,**
Norton Associates, Inc., **b.**
Packard Bell Computer Corp., **c, d.**
Philco Corp.-Govt & Industrial Group, **d.**
Potter Instrument Co., Inc., **e.**
***RADIO CORP. OF AMERICA, b, c, d, f.**
Ramo-Wooldridge, Div.-Thompson Ramo Woodridge Inc., **b.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., f.**
J. B. Rea Co., **b.**
Rese Engrg., Inc., **c, d.**
Sangamo Electric Co., **e.**
Semi-Elements, Inc., **a.**
Servomechanisms, Inc., **c.**
Skiatron Electronics & Television Corp., **f.**
Southwestern Industrial Electronics Co., **d.**
Stromberg-Carlson Div.-General Dynamics Corp., **d, e.**
Sun Electric Corp., Aeronautical Div., **d.**
Tapco Group, Thompson Ramo Wooldridge Inc., **b.**
Telectro Industries Corp., **b, d, e.**
Telex, Inc., **c, d.**
Thompson Ramo Wooldridge Inc., **b.**
Wang Labs., Inc., **d.**
Westinghouse Electric Corp., **c.**

MERCURY

Alloys Unlimited Inc
Belmont Smelting & Refining Works, Inc.
A. Biederman, Inc.
Bram Metallurgical Chemical Co.
City Chemical Corp.
Eastern Smelting & Refining Corp
Engelhard Industries, Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General Electric Co., Lamp Metals & Components Dept
Goldsmith Bros. Div., National Lead Co.
Semi-Elements, Inc.
United Mineral & Chemical Corp.
Var-Loc-Oid Chemical Co

METAL CLAD SHEETS

Accurate Specialties Co. Inc.
Alloys Unlimited Inc
American Printed Circuits Co., Inc
Belmar Wheel & Machine Co., Inc.
Bethlehem Steel Co.
J. Bishop & Co., Platinum Works
Bo Myte Co., Inc., The
Bram Metallurgical Chemical Co.
Brooks & Perkins, Inc.
Continental Diamond Fibre Corp
Cordo Chemical Corp.
Engelhard Industries, Inc.
Franklin Fibre-Lamitex Corp.
General Electric Co., Lamp Metals & Components Dept.
General Plastics Corp.
Hydroforming Co. of America Inc.
Leach & Garner Co., Indsl. Div.
Met-L-Wood Corp.
Mica Insulator Div.-Minnesota Mining & Mfg. Co
***MINNESOTA MINING & MFG. CO.**
Nuclear Development Corp. of America
Olin Mathieson Chemical Corp.-Metals Div
St. Regis Paper Co., Panelyte Div.
Somers Brass Co. Inc.
Synthane Corp.
Taylor Fibre Co.
Texas Instruments Inc.
Tingstol Co
United Mineral & Chemical Corp.

METAL MACHINING

ACF Industries Inc.
Abalon Precision Mfg. Corp.
Aero Mfg & Mach. Co., Inc.
Aircraft Tools, Inc.
Airhardware, Inc.
All Specs Corp
Allied Products Corp.
Alloy Products Corp
American Beryllium Co.
American Tool Co
American Welding & Mfg Co., The
Ampco Metal, Inc
Anchor Specialty Mfg. Co. Inc.
B. H. Aircraft Co., Inc
Barnum Machine Works, Inc.
Basic Tool Industries, Inc
Belmar Wheel & Machine Co., Inc.
Bendix Filter Div., Bendix Aviation Corp.
Bergen Carbide Co.
Bernco Engrg. Corp.
Bethlehem Steel Co.
E. W. Bliss Co.
Bruce Engrg. Co.
Budd Co., The
Calcor Corp.
California Aircraft Products
Capital City Mfg. Co., Inc
Chance Vought Aircraft Inc.
Cincinnati Milling Machine Co., The
Clark-Aiken Co., The
Conrad & Moser
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
C. Lee Cook Co., Airtomic Products Div.
Cromer Mfg & Engrg., Inc.
Custom Tool & Mfg. Co.
Douglas Aircraft Co., Inc.
Eaton Mfg. Co., Valve Div.
Electronic Parts Mfg. Co., Inc.
Eljay Corp.
Elzee Metal Products Co., Inc.
Essex Mfg., Co., Inc.
Eureka Williams Corp.
***EXCELCO DEVELOPMENTS INC.**
Ex-Cell-O Corp.
Farwell Metal Fabricating
Federal Machine Co. Inc.
Fenn Mfg. Co., The
Forseberg Mfg., Co., The
Gar Products Corp.
George Gorton Machine Co.
Henry & Miller Industries, Inc.
Herlo Corp.
Hughes Tool Co., Aircraft Div
Walter K. Jaros Aircrafters
Kanarr Corp.
C. B. Kaupp & Sons, Inc.
Kellett Aircraft Corp.
Kelsey-Hayes Co.
Kemp Aero Products
Keystone Electronics Corp.
E. Konigslow Stamping & Tool Co
Ladish Co.
Langley Corp.
La Vezzi Machine Works
Le Fiell Mfg. Co.
Lycoming Div., Avco Corp.
Marchant Machining Corp.
Marquardt Corp. The
***MARTIN CO., THE, DENVER DIV.**
Meridian Metalcraft, Inc.
Miami Engrg., Div.-Miami Shipbuilding Corp.
Miller Dial & Nameplate Co.
Nordberg Mfg. Co.
Norris-Thermador Corp.
Omega Labs., Inc.
Onsrud Machine Works, Inc.
Opelika Welding, Machine & Supply Inc.
Panel Engrg. Corp.
Parts Engrg. Co., Inc.
Pennsylvania Tool & Mfg. Co., The
Richard Philip Co.
Piasecki Aircraft Corp
Precision Shapes, Inc.
Redco Corp.
Reed Mfg. Co.
Edw. Renneburg & Sons Co.
J. R. Robbins Co.
Sheffield Corp., The, Sub.-Bendix Aviation Corp
Sibley Machine & Foundry Corp.
Superior Industrial Machine Co.
Temco Aircraft Corp.
Arthur Tickle Engrg. Works, Inc.
Tucson Instrument Corp.
United States Chemical Milling Corp.
Universal Mfg. Co., Inc.
Victor Tool & Mfg., Inc.
Waco Aircraft Co
Weba, Inc.
Western Automatic Machine Screw Co., Div.-Standard Screw Co.
Western Design, Div.-U.S. Industries, Inc.
Westholt Mfg. Inc.

METAL PARTS

a. Bushings
b. Lead
c. Powdered
d. Screw Machine
e. Small Metal Stampings
f. Spinnings
g. Trimmings

ACF Industries Inc., **d, e.**
A & E Metal Specialties Inc., **e.**
A&P Metal Products Mfg. Corp., **e, f, g.**
Abalon Precision Mfg. Corp., **a, d, e.**
Abbot Screw & Mfg Co., **d, e.**
Accurate Electronics Corp., **e.**
Accurate Specialties Co., Inc., **b, c, e.**
Acme Industrial Co., **a, d.**
Aerial Machine & Tool Corp., **d, e.**
Aero Gasket Corp., **e.**
Aero Mfg. & Mach. Co., Inc., **a, d, e.**
Aero Spares, Inc., **a, d.**
Aerocal Div., Aeronca Mfg. Corp., **f.**
Aerolite Electronics Corp., **e.**
Aircraft Tools, Inc., **e.**
Airhardware, Inc., **a, d.**
All Specs Corp., **a, d.**
Allen Electric & Equipment Co., **e.**
Allied Products Corp., **d.**
Allmetal Screw Products Co., Inc., **d.**
Alloy Products Corp., **e.**
Alpha Metals, Inc., **b, e.**
Alpitec, Inc., **e.**
Aluminum Co. of America, **c, d, f.**
Amatom Electronic Hardware Co. Inc., **a, d, e, f.**
Amco Engrg. Co., **e.**
American Aluminum Co., **e, f.**
American Beryllium Co.
American Brake Shoe Co., **a, c.**
American Brass Co., The, **e.**
American Standard Products, Inc., **a, d, e.**
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV. a.**
Ampco Metal, Inc., **a, d, f.**
Anchor Metal Co. Inc., **b.**
Anchor Metal Spinning Co., The, **e, f.**
Anderson, Greenwood & Co., **d.**
Armament Div.-Universal Match Corp., **e.**
Arnolt Corp., **d, e.**
Art Wire & Stamping Co., **e.**
Associated Co., Inc., **e, f.**
Associated Engrg. & Mfg. Corp., **e, f.**
Associated Spring Corp., Ohio Div., **e.**
Atlantic Research Corp., **e.**
Auburn Mfg Co., The, **e.**
Augat Brothers, Inc.
Autoscrew Co., Inc., **a, d, e.**
B. H. Aircraft Co., Inc., **e.**
Babco Mfg Inc., **e.**
Wallace Barnes Div. Associated Spring Corp., **e.**
Barnum Machine Works, Inc.,
L. J. Barwood Mfg. Co. Inc., **b, e.**
Bearium Metals Corp., **a.**
Beemer Engrg. Co., **a, c.**
Belmar Wheel & Machine Co., Inc., **e.**
Belmont Smelting & Refining Works, Inc., **b.**
Bendix Filter Div., Bendix Aviation Corp., **a, c.**
Bennett-Feragen, **d, e.**
Benson Mfg. Co., **e, f.**
Bergen Carbide Co., **a, d, e.**
Bernco Engrg. Corp., **e.**
Best Aircraft Corp., **a, d.**
Birnbach Radio Co., Inc.
J. Bishop & Co., Platinum Works, **a.**
Bland Burner Co., The, **d.**
S. Blickman, Inc., **e, f.**
Bound Brook Oil-Less Bearing Co., **a, c.**
Milton H. Brooks & Son Engraving & Mfg. Co., Inc. **e.**
Brooks & Perkins, Inc., **e, f.**
Bruce Engrg. Co., **a.**
Budd Co., The, **e, g.**
Bunting Brass & Bronze Co., The, **a, c.**
Burklyn Co., **e.**
Calcor Corp., **d thru g.**
California Aircraft Products, **e, f.**
California Plasteck Inc., **e.**
California Stamping & Mfg. Co., **e.**
Cameraflex Div., The, Federal Mfg. & Engrg Corp., **e, f.**
Capital City Mfg. Co., Inc., **a thru d.**
Chance Vought Aircraft, Inc., **a, d thru g.**

Chemical Micro Milling Co., **e.**
Chicago Development Corp., **c.**
Chicago Screw Co., The, Div.-Standard Screw Co., **d.**
Collins Mfg. Corp., **d.**
Colorado Fuel & Iron Corp., The, **e, f.**
Commercial Shearing & Stamping Co., **f.**
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **e.**
Croname Inc., **e, g.**
Custom Products Corp., **a, d, e.**
Custom Tool & Mfg. Co., **b, c.**
Delta Corp., **f.**
Detroit Stamping Co., **e.**
Deutsch Co., The, Electronic Components Div., **d.**
Division Lead Co., **b.**
Doak Aircraft Co. Inc., **a, d, e, f.**
Douglas Aircraft Co., Inc., **e.**
Eaton Mfg. Co., **c.**
Eddington Metal Specialty Co., **d.**
Electric Steel Foundry Co., **a.**
Electronic Parts Mfg. Co., Inc., **d, e.**
Eljay Corp., **a, d, e.**
George D. Ellis & Sons, Inc., **e.**
Elzee Metal Products Co., Inc., **a, d, e, f.**
Engelhard Industries, Inc., **c.**
Erie Resistor Corp., **e.**
Essex Mfg. Co., Inc., **e.**
Eureka Williams Corp., **d, e.**
***EXCELCO DEVELOPMENTS INC., e.**
Ex-Cello-O Corp., **a, d.**
Fansteel Metallurgical Corp., **c.**
Farwell Metal Fabricating, **e.**
Federal Machine Co. Inc.,
Federal Tool & Mfg. Co., **e.**
Flight Refueling Inc., **a.**
Forsberg Mfg. Co., The, **d, e.**
Foursome Mfg. Co., Inc., **e.**
Freeman Co., The, **d.**
Gar Products Corp., **d.**
George K. Garrett Co., Inc., **e.**
Gasket Mfg. Co. Inc., **e.**
Gemex Corp., The, Indsl. Div., **e.**
General Aniline & Film Corp., Ansco Div., **d, e.**
General Electric Co., Lamp Metals & Components Dept., **e.**
General Findings & Supply Co., Industrial Div., **d, e, f.**
Globe Industries, Inc., Supermet Div.,**c.**
Fred Goat Co. Inc., The, **e.**
Graflex Inc., **d.**
Graphite Metallizing Corp., **a.**
Gries Reproducer Corp.,
Guarantee Specialty Mfg. Co., **e.**
HPL Mfg. Co., **e.**
Hamilton Watch Co., Industrial Div., **d, e.**
Hamilton Watch Co., Military Products Div., **d thru g.**
H. M. Harper Co., **d.**
Hartford Machine Screw Co., Div.-Standard Screw Co., **c.**
Harvey Aluminum, **d.**
Heldor Mfg. Co., Inc., **e.**
Henry & Miller Industries, Inc., **a, d, e, f.**
Herlo Corp.
Hobbs Mfg. Co., **d.**
Hobson Brothers, Inc., **e.**
Hughes Tool Co., Aircraft Div., **f.**
Hunter Spring Co., Div.-American Machine & Metals Inc., **e.**
Hydroforming Co. of America Inc., **f.**
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc., **e.**
Interlake Stamping Corp., **e.**
Jan Hardware Mfg. Co., Inc., **d, e, f.**
Walter K. Jaros Aircrafters, **a, d, e, f.**
Joma Inc., **e.**
Kaiser Aluminum & Chemical Sales, Inc., **c.**
Kanarr Corp., **e.**
C. B. Kaupp & Sons, Inc., **e, f.**
Kellett Aircraft Corp., **a.**
Kelsey-Hayes Co., **c thru g.**
Kennametal Inc., **a, c.**
Keystone Carbon Co., **a, c.**
Keystone Electronics Corp., **a, e.**
Kickhaefer Mfg. Co., **e.**
King Labs., Inc., **e.**
Kling Metal Spinning & Stamping Co., **b, e, f.**
Kohler Co., **d.**
E. Konigslow Stamping & Tool Co., **e.**
Kwikset Powdered Metal Products, **a, c.**
Laminated Shim Co., Inc., **e.**
Langley Corp., **d.**
La Vezzi Machine Works, **a, e.**
Le Fiell Mfg. Co., **f.**
Link-Belt Co., **d.**
Lycoming Div., Avco Corp., **a, f.**
Malco Mfg. Co., **e.**
P. R. Mallory & Co., Inc., **c.**
***MARTIN CO., THE, DENVER DIV.., a, d, g.**
Massachusetts Gear Div.-Geartronics Corp., **d.**
Maurer Artcraft Co., **f.**
Mc Dowell Mfg. Co., **f.**
Metal Forming Corp., Div.-Vanadium-Alloys Steel Corp., **e.**
Miami Engrg., Div.-Miami Shipbuilding Corp., **e, f.**
Monarch Governor Co., **e.**
NUMEC-Nuclear Materials & Equipment Corp., **c.**
National Automatic Products Co., The, **a, d.**
National Moldite Co., **c.**
National Screw & Mfg. Co., The, **d.**
Nevada Air Products Co., **a, e.**
New England Spring Mfg. Co., Inc., **d.**
Norrich Plastics Corp., **a, b, d, e.**
Norrich Screw Machine Products, **a, b, d, e.**
Norris-Thermador Corp., **e. f.**
Northeast Metals Industries, Inc.,
Nutmeg Screw Machine Products Co., **d**
Ohlson Empire Inc., **a, b, d, e.**
Omega Labs., Inc.
Opelika Welding, Machine & Supply Inc.
P. B. R. Mfg. Co., **e.**
Penn Fibre & Specialty Co., Inc., **b, e.**
Penn-Michigan Mfg. Corp., **e.**
Pennsylvania Tool & Mfg. Co., The
Richard Philip Co., **e.**
Phoenix Products Co., **e, f.**
Piasecki Aircraft Corp., **a, d, e, f.**
Precise Development Corp., **a, d, e, f.**
Precision Metal Products Co. Inc., **a, d, e.**
Precision Shapes, Inc.
Randall Graphite Bearings, Inc., **a.**
Red Devil Mfg. Co., **d.**
Edw. Renneburg & Sons Co., **a, g.**
Research Development Mfg. Inc., **a, d.**
Resistoflex Corp., **d.**
Rimak, Inc., **a, d thru g.**
J. R. Robbins Co., **a, d.**
Roll Formed Products Co., **g.**
St. Marys Carbon Co., **a, c, e.**
Scovill Mfg. Co., **d, e.**
J. H. Sessions & Son, **e.**
Seymour Products Corp., The, **e.**
Sheridan-Gray, Inc., **e.**
C. Sjorberg & Son, **e.**
C. M. Smillie & Co., **a, d, e.**
Solar Aircraft Co., **f.**
Southwest Products Co., **a.**
Spincraft, Inc., **e, f.**
Springfield Brass Co., Inc., **a.**
Stamping Div.,-Rockwell Standard Corp., **e.**
Standard Pressed Steel Co., **d.**
Stanley-Judd Div.-The Stanley Works, **d thru g.**
Herman D. Steel Co., **d.**
Stevens Co. Inc., **a, e.**
Stewart-Warner Electronics Div., **e.**
Stone City Products Co., **e.**
Superior Industrial Machine Co., **a.**
Superior Spinning & Stamping Co., **e, f.**
T. O. D. Mfg. Co. Inc., **c thru f.**
Taffet Electronics, Inc., **e.**
Roland Teiner Co. Inc., **e, f.**
Templet Industries Inc., **e.**
Thor Ceramics, Inc., **a, d, e.**
Tinnerman Products, Inc., **e.**
Titan Metal Mfg. Co., Div.-Cerro de Pasco Corp., **d.**
Torrington Co., The, **c, d.**
Transue & Williams Steel Forging Corp., **e.**
True Alloys Inc., **a.**
Twin Coach Co., Aircraft-Missiles
Twix Mfg. Co., Inc., **e.**
Unified Industries, Inc., **e, f, g.**
United Aircraft Products, Inc., **d, e.**
United Mineral & Chemical Corp., **c.**
United Shoe Machinery Corp., **e.**
United States Chemical Milling Corp., **e, f.**
Vector Electronic Co., Inc., **a, e.**
Victor Tool & Mfg., Inc., **a, d, e.**
Waco Aircraft Co., **a, d, e.**
Waldick Engrg. Co., **d.**
Wall Colmonoy Corp., Stainless Processing Div., **e.**
Wayne Foundry & Stamping Co., **e.**
Weber Aircraft Corp., **e.**
Western Automatic Machine Screw Co., Div. Standard Screw Co., **d.**
Western Gold & Platinum Co., **e.**
Westholt Mfg. Inc., **a, e, f, g.**
Westinghouse Electric Corp., **c.**
Whitehead Stamping Co., **e.**
William Whytock Co., **d.**
Winder Aircraft Corp. of Florida, **c, e, g.**
Woolf Aircraft Products, Inc., **e.**
Worcester Pressed Steel Co., **e.**
Wrought Washer Mfg. Co., **a, e.**

METAL STOCK, POROUS BEARING

Beemer Engrg. Co.
Bendix Filter Div., Bendix Aviation Corp.
Bound Brook Oil-Less Bearing Co.
Bunting Brass & Bronze Co., The
Utility Brass & Copper Corp.

METAL STOCK, THERMOSTATIC

American Silver Co., Inc.
Bram Metallurgical Chemical Co.
Fansteel Metallurgical Corp.

METAL TREATING

American Car & Foundry Div. ACF Industries, Inc.
Budd Co., The
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Cincinnati Milling Machine Co., The
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cowles Chemical Co.
Cromer Mfg. & Engrg., Inc.
Fenn Mfg. Co., The
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div.
C. I. Hayes, Inc.
A. F. Holden Co., The
Kanarr Corp.
Kelsey-Hayes Co.
Lepel High Frequency Labs. Inc.
Lycoming Div. Avco Corp.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Northeast Metals Industries, Inc.
Piasecki Aircraft Corp.
Pioneer Industries Div., Almar-York Co. Inc.
Ransohoff Co.
Rimak, Inc.
Sinclair Mfg. Co
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Vapor Blast Mfg. Co.
Wall Colmonoy Corp., Stainless Processing Div.

METEOROLOGICAL EQUIPMENT, ELECTRONIC

Advance Instrument Corp.
Barth Engrg. & Mfg. Co., Inc.
Beckman & Whitley, Inc., Instrument Div.
Bendix Aviation Corp.
Allen B. Du Mont Labs., Inc.
Ferrotran Electronics Co., Inc.
General Electric Co., Missile & Space Vehicle Dept., Pa.
ITT Federal Div., International Telephone & Telegraph Corp.
Madigan Corp.
Molded Insulation Co.
Motorola, Inc.
National Co., Inc.
National Scientific Labs., Inc.
Philco Corp.-Govt. & Industrial Group
Raven Industries Inc.
Specialty Electronics Development Corp.
M. C. Stewart
Swift Textile Metalizing & Laminating Corp.
Virginia Electronics Co., Inc.
Wang Labs., Inc.
Winder Aircraft Corp. of Florida

METEOROLOGICAL INSTRUMENTS

Advance Instrument Corp.
Aero Research Instrument Co. Inc.
Beckman & Whitley, Inc., Instrument Div.
Belfort Instrument Co.
Bell & Gossett Co.
Bendix Aviation Corp.
Allen B. Du Mont Labs., Inc.
General Electric Co., Missile & Space Vehicle Dept., Pa.
W. & L. E. Gurley
Molded Insulation Co.
Motorola, Inc.
Precision Thermometer & Instrument Co.
Specialty Electronics Development Corp.
M. C. Stewart
Virginia Plak Co.
Wallace & Tiernan Inc.
Wang Labs., Inc.
Weksler Instruments Corp.

METERS

- **a.** Acceleration
- **b.** Ammeter
- **c.** Ammeter RF
- **d.** Attenuation
- **e.** Audio
- **f.** Cable Testing
- **g.** Capacitance
- **h.** Conductance
- **i.** Counting Rate
- **j.** Counting Rate, Nuclear
- **k.** D'Arsonval
- **l.** Decibel
- **m.** Deflection
- **n.** Deviation
- **o.** Distortion & Noise
- **p.** Dosimeter
- **q.** Dosimeter, Nuclear
- **r.** Elapsed Time

s. Electrometer
t. Electronic Micrometer
u. Events-Per-Unit-Time
v. Exposure for Film
w. Field Strength
x. Flow
y. Flutter
z. Flux
a-1. FM Deviation
b-1. Footcandle
c-1. Frequency
d-1. Galvanometer
e-1. Goniometer
f-1. Grid Dip
g-1. Impedance
h-1. Industrial
i-1. Infrared
j-1. Intermodulation
k-1. Kilovolt
l-1. Kilowatt
m-1. Light
n-1. Megohm
o-1. Microfared
p-1. Microvolt
q-1. Microwave
r-1. Milliampere
s-1. Millivolt
t-1. Modulation
u-1. Moisture, Electronic
v-1. Multimeter
w-1. Multiplier
x-1. Noise, Electrical Measurement
y-1. Null
z-1. Ohm
a-2. Output, Electrical Measurement
b-2. Output, RF
c-2. Panel
d-2. Ph Meters, Recorders & Comparators
e-2. Phase
f-2. Photoelectric Reflection
g-2. Power Output
h-2. Pressure
i-2. Pyrometer
j-2. Q
k-2. Radiation, Nuclear
l-2. Rate
m-2. Ratio
n-2. Recording
o-2. RF Power
p-2. Snap Around
q-2. Sound Level
r-2. Spectral
s-2. Standing Wave Ratio
t-2. Tachometer
u-2. Tension
v-2. Thermocouple
w-2. Thermometer
x-2. Thrust
y-2. Time
z-2. Torque
a-3. Ultra-Violet
b-3. Vacuum Tube Volt
c-3. Vibrating Reed
d-3. Vibration
e-3. Viscosity, Electronic
f-3. Volt-Ohm, Electronic
g-3. Watt
h-3. Watt-Hour
i-3. Wave
j-3. Wow & Flutter
k-3. X-Ray Intensity

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, b, t-2.**
A.R.F. Products, Inc., n.
Acme Industrial Co., x.
Acton Laboratories Inc., g-1, e-2, b-3, f-3.
Actuator Products Div., Geartronics Corp., t-2.
Advance Instrument Corp., e-1.
Advanced Electronics, Inc., d-3.
Aero Instrument Co., r, c-1, y-2, c-3.
***AEROJET-GENERAL CORP., i-1.**
Aeronca Mfg. Corp.-Aerospace Div., t-2.
Aeroscience, Inc., a, m.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., x-1.
Aircom Inc., q-1, s-2.
Allen Electric & Equipment Co., b, h-1, k-1, l-1, r-1, s-1, z-1, c-2, t-2, g-3.
Allied International Corp., y-1.
Amerac Inc., c-1, q-1.
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., i, u.
American Instrument Co., Inc., d-2, i-2.
American Machine & Foundry Co., Government Products Group, n, p, c-1, t-2, f-3.
American Machine & Foundry Co., Government Products, N. Y., a, b, c-1, f-3.
American Missile Products Co., Inc., g, y-2.
American Speedlight Corp., m-1.
American Tradair Corp., i, j, c-3.
Amthor Testing Instrument Co., Inc., n-2, t-2.
Analytical Measurements, Inc., d-2.
R. B. Annis Co., r.
Applied Physics Corp., s.
Arcair Co., r, n-2, y-2.
Assembly Products, Inc., b, k, h-1, r-1, s-1, c-2, d-2, z-2, g-3.
Associated Engineers, Inc., r-1, s-1.
Associated Research, Inc., f, k-1, n-1, z-1.
Audio Instrument Co., Inc., j-1.
Automatic Timing & Controls, Inc., r.
Automation Products, Inc., e-3.
Avco Corp., Crosley Div., a.
Avo Ltd., v-1.
Avtron Mfg., Inc., a-1, t-1.
B & H Instrument Co., Inc., x, c-1, d-1, s-1, y-1, h-2, i-2, t-2, v-2.
B & K Instruments, Inc., w, n-1, t-1, q-2, d-3.
Baird-Atomic, Inc., j, p, r, k-2.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., z-2.
Barnes Development Co., g.
Rex Bassett, Inc., c-1.
E. Bauches S. A., Freeport Engrg. Co., y-2.
Bearing Inspection, Inc., x-1.
Beckman Instruments, Inc., Berkeley Div., r, u, x, c-1, t-2, y-2, f-3.
Belleville-Hexem Corp., s, n-1, s-1, y-1, z-1, b-3, f-3.
Bendix Aviation Corp., j, p, s, t, e-1, t-2, e-3.
Bendix Aviation Corp., Cincinnati Div., b, p, q, s, c-1, z-1, k-2, e-3.
Bergen Labs., Inc., r, z-2.
James G. Biddle Co., r, c-1, d-1, n-1, z-1, t-2, c-3.
A. Biederman, Inc., a, l, x, r-1, h-2, t-2, x-2.
Boonton Electronics Corp., o, f-1, y-1, b-3.
Boonton Radio Corp., j-2.
Arthur E. Booth Co., e-2.
Bowser Inc., Defense Div., x, h-1.
Briggs Associates, Inc., f.
***BRISTOL CO., THE, h-1, y-1, h-2, i-2, n-2, t-2, v-2, w-2.**
Bristol Motors Div.-Vocaline Co. of America, Inc., r.
Brooks Rotameter Co., x.
Bruno-New York Industries Corp., n-1, v-1.
Brunswick Instruments, o-2.
Brush Instruments, Div.-Clevite Corp., n-2.
Budd Co., The, x, g-1, h-1, u-2.
Budelman Electronics Corp., n, a-1.
Bulova Research & Development Labs., Inc., h-2, t-2, z-2.
Burr-Brown Research Corp., e, f-3.
Burton-Rogers Co., Sales Div.-Hoyt Electrical Instruments, b, d-1, r-1, s-1.
Bytrex Corp., s-1, u-2, x-2, z-2.
Calvert Electronics Inc., b thru i, k thru o, d-1, f-1, g-1, h-1, k-1, l-1, n-1 thru s-1, v-1, w-1, y-1, z-1, a-2, b-2, c-2, g-2, j-2, n-2 thru q-2, t-2, v-2, b-3, c-3, f-3 thru i-3.
Chemalloy Electronics Corp., q-1.
Clegg Labs., Div.-Clegg, Inc., f, g, g-1.
Coleman Instruments, Inc., d-2.
Consolidated Airborne Systems, Inc., u, c-1, n-1, y-1.
Consolidated Controls Corp., c-1, m-2.
***CONSOLIDATED ELECTRODYNAMICS CORP., d-1, u-1, h-2, d-3.**
Control Data Corp., a.
Control Electronics Co., Inc., e-2, g-2.
Convair Instruments, Convair Div.-General Dynamics Corp., m-1, w-2.
Cosa Corp., d-3.
Cox Instruments Div., George L. Nankervis Co., x, c-1, h-1, h-2, z-2.
Cramer Controls Corp., r.
Crescent Engrg. & Research Co., t, x, y-1, a-2, h-2, u-2.
Crosby-Teletronics Corp., c-1.
Cubic Corp., n-1, p-1, z-1, q-2, g-3.
Daven Co., The, e, o, c-1, x-1, z-1, a-2, b-2, b-3, g-3.
Davenport Mfg. Co., k-1.
Joe Davidson & Associates, b-3.
Daystrom Inc., Pacific Div., a.
Daystrom Inc., Weston Instruments Div., b, c, g, i, k, l, r, t, v, z, b-1, c-1, d-1, f-1, g-1, k-1 thru n-1, p-1, r-1 thru w-1, y-1, z-1, a-2, c-2, l-2, m-2, n-2, p-2, q-2, t-2, v-2, w-2, b-3, f-3, g-3.
Decker Corp., The, g, m, n, t, x, y, c-1, h-1, s-1, u-1, h-2, u-2, z-2.
De Havilland Aircraft of Canada, Ltd., Special Products Div., n, c-1, i-1.
Dejur-Amsco Corp., Electronic Sales Div., b, k, l, r, v, b-1, k-1, m-1, p-1, r-1, s-1, v-1, z-1, c-2, q-2, v-2.
Del Electronics Corp., k-1.
Delsen Corp., u-1.
Deltron Inc., y-1, e-2.
Demornay-Bonardi, c-1.
Diamond Antenna & Microwave Corp., q-1, i-3.
J. W. Dice Co., f, t.
Digital Sensors Inc., y-2.
W. C. Dillon & Co., Inc., u-2, w-2, z-2.
Dmeter Mfg. Co., w-1.
Douglas Microwave Co., Inc., q-1.
Allen B. Du Mont Labs., Inc., b-3.
Dynamics Instrumentation Co., p-1, s-1.
Dytronics Co., e-2.
Eagle Signal Co., r.
Eastern Specialty Co., The, e-2.
Eastman Kodak Co., a, m, n, v, i-1.
Eberline Instrument Corp., k-2.
Eclipse Fuel Engrg. Co., x.
Edgerton, Germeshausen & Grier, Inc., p, q.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., h-2, w-2, a-3.
Edwards High Vacuum Ltd., x.
Eisler Engrg. Co., Inc., i-2.
Elcor, Inc., s.
Eldorado Electronics, y-2.
Electric Autolite Co., The, h-2, w-2.
Electric Design & Mfg. Co., b, k, r-1, s-1, c-2.
Electro Impulse Lab., Inc., o-2, g-3.
Electro Instruments, Inc., b, g thru j, n, u, c-1, g-1, h-1, k-1, n-1, o-1, p-1, r-1, s-1, v-1, z-1, e-2, l-2, m-2, n-2, y-2, f-3.
Electro Scientific Industries, y-1.
Electronic Applications, Inc., g, h, l, y, c-1, g-1, j-1, x-1, z-1, b-2, n-2, s-2, b-3, j-3.
Electronic Measurements Corp., f-3.
Electronics of Clearfield, Inc., s, b-2, b-3, f-3, g-3.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., a, r.
Ellison Draft Gage Co., Inc., x, h-1, h-2.
Empire Products Sales Corp., d, o, p, w, j-1, q-1, t-1, x-1, b-2, o-2.
Engrg. Specialties, j, u-1, d-2.
***ENGIS EQUIPMENT CO., d-1, e-1.**
Epic, Inc., b, g, r, s, z, d-1, r-1, s-1, v-1, y-1, z-1, c-2, i-2, n-2, t-2, d-3, f-3, g-3.
Erdco Engrg. Corp., g, z-1.
Erie Instrumation, Div.-Erie Resistor Corp., i, u.
Erie Resistor Corp., i, u, x, c-1, y-2.
FXR, Inc., c-1, g-1, q-1, m-2, o-2, s-2, i-3.
Farwest Mfg. Div., Inc., e-2.
Federal Products Corp., t.
Fenske, Fedrick & Miller Inc., c-1.
Ferrotran Electronics Co., Inc., x-1.
Fischer & Porter Co., x, h-2, w-2, e-3.
Fisher Scientific Co., d-2, i-2, n-2.
Fisher Scientific Co., Maryland, d-2, i-2, w-2.
Flow Corp., b-3.
Flow Measurements Corp., x.
Food Machinery & Chemical Corp., Ordnance Div., x.
Foto-Video Labs., Inc., z-1.
Franklin Electronics Inc., v-1, b-3.
Freed Transformer Co., Inc., a, n-1, y-1, j-2.
Garwin, Inc., h-2, t-2, v-2, w-2.
General Communication Co., d, q-1, g-2, o-2.
General Controls Co., x, i-2.
General Electric Co., Apparatus Sales Div., b, k, r, v, x, c-1, d-1, h-1, k-1, l-1, m-1, r-1, s-1, a-2, b-2, c-2, g-2, h-2, i-2, j-2, n-2, t-2 thru z-2, g-3, h-3.
General Electric Co., Instrument Dept., b.
General Electric Co. Ltd. of England, b-3, f-3.
General Electric Co., Missile & Space Vehicle Dept., Pa
General Electric Co., X-Ray Dept., k-3.
General Radio Co., l, o, s, c-1, g-1, n-1, o-1, p-1, s-1, t-1, y-1, a-2, g-2, q-2, b-3, d-3, g-3.
Genisco, Inc., d-3.
Globe Electronics, Div.-Textron Electronics, Inc., s-2.
John Gombos Co., Inc., c-1.
Gordon Enterprises, u, v, b-1, m-1.
Gray Mfg. Co., The, c-1.
Greibach Instruments Corp., b, k, d-1, k-1, n-1, r-1, v-1, y-1, z-1, c-2, v-2.
Gulton Industries, Inc., g, w-2.
Hagan Chemicals & Controls Inc., x, d-2, h-2, m-2.
Hagen Mfg. Co., r.
Hallamore Electronics Co., Div.-Siegler Corp., s-1.
Hallikainen Instruments, s, a-3, e-3.
Hamilton Watch Co., Military Products Div., r, y-2.
Hammett-Mercury-Rex Div., b, k, s, t, c-1, d-1, k-1 thru s-1, z-1, b-2, o-2, f-3 thru i-3, k-3.
Hathaway Instruments, Inc., d-1.
A. W. Haydon Co., The, r, y-2.
Hays Corp., The, d-2, h-2, v-2.
Helipot Div.-Beckman Instruments, Inc., b, c-1, r-1, c-2.
Hewlett-Packard Co., b, o, a-1, c-1, p-1, r-1, s-1, x-1, z-1, a-2, c-2, g-2, m-2, o-2, p-2, s-2, b-3, f-3, g-3, i-3.
Hickok Electrical Instrument Co., The, b, h, k thru o, t, w, b-1, c-1, d-1, f-1, g-1, h-1, k-1 thru s-1, v-1, y-1, z-1, a-2, b-2, c-2, j-2, u-2, v-2, w-2, b-3, f-3, g-3.
Highland Engrg. Co., x, x-2.
E. Vernon Hill & Co., d-3.
Hoke Inc., x.
Honeywell, Marion Instruments Div., b, n, r, z, r-1, s-1, y-1, z-1, c-2, f-3.
Hoyt Electrical Instrument Works, Inc., Burton Rogers Co., b, k, l, r-1, s-1, c-2.
I-L-S Instrument Div., The Meriam Instrument Co., s.
ITI Electronics, Inc., v-1.
Iconix Inc., i, j, r, u, c-1, l-2, y-2.
Ideal Precision Meter Co., Inc., b, c, k, l, k-1, p-1, r-1,

s-1, c-2.
Illinois Testing Laboratories, Inc., d-1, i-2, v-2, w-2.
Image Instruments, inc., t, m-1.
Impact-O-Graph Corp., The, a.
Industrial Acoustics Co., Inc., p, q-2.
Industrial Control Co., d-1, p-1, s-1, v-2, b-3.
Industrial Instruments Inc., n-1, z-1.
Industrial Test Equipment Co., y-1, e-2, b-3.
Industrial Timer Corp., y-2.
Infrared Industries, Inc., i-1.
Ingraham Co., The, r.
Instrument Div., The W. L. Maxson Corp., e-2.
Instrument Electronics Corp., b-3.
Instrument Labs., a-2, b-3, f-3.
Instrument Div., The Budd Co., k-2, u-2, z-2.
Integrated Dynamics Div., Globe Industries, Inc., a, l-2, x-2.
International Electronic Research Corp., x, k-2.
International Instruments Inc., b, c, k, r-1, s-1, c-2.
Interstate Electronics Corp., f, i, j, p, q, r, i-1, k-2, l-2.
Isotopes Specialties Co., Div.-Nuclear Corp. of America, j, q, k-2.
Jennings Radio Mfg. Corp., k-1.
Jo-Line Tools, Inc., z-2.
Kahn & Co., Inc., g, w, x, c-1, t-2, d-3.
Kay Electric Co., f, o, y, c-1, x-1, b-2, j-2, q-2, b-3, d-3, j-3.
Keithley Instruments, Inc., s, z, k-1, n-1, p-1, y-1, z-1, b-3.
Wayne Kerr Corp., s, k-1, q-1, t-1, d-3, g-3.
Kin Tel Div.-Cohu Electronics, Inc., b, d-1, p-1, r-1, s-1, y-1.
Leo Klein Electronics Co., z.
James Knights Co., The, c-1.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., a, h-2, t-2, x-2.
Lab. for Electronics, Inc., q-1.
Lampkin Labs., Inc., M.R. Div., n, a-1, c-1, t-1.
Lavoie Labs., Inc., c-1.
Lear, Inc., x, e-1, i-1, u-1.
Leeds & Northrup Co., d-1, n-1, p-1, s-1, y-1, z-1, d-2, i-2, v-2, w-2.
Leland Airborne Products, Div.-American Machine & Foundry Co., r.

*WALLACE O. LEONARD, INC., a, x, h-2, m-2.
Lewis Engrg. Co., The, i-2, m-2, v-2, w-2.
Liquidometer Corp., The, g, n-1.
MB Electronics, a, x-1, d-3.
MSA Research Corp., x.
Mac Leod & Hanopol, Inc., g, n-1.
Magnetic Instrument Co. Inc., v-2, w-2.
Magtrol, Inc., t-2, z-2.
Maico Electronics, Inc., t-2.
Marconi Instruments, n, a-1, c-1, g-1, j-1, o-1, s-1, x-1, j-2, o-2, b-3, f-3, g-3, i-3.
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co., b, k, l, r, c-1, k-1, r-1, s-1, y-1, c-2, q-2.
Martindale Electric Co., p-2, t-2.
Mason-Neilan, x, n-2.
W. L. Maxson Corp., The, x.
Meters Inc., b, k, l, d-1, k-1, n-1, r-1, s-1, v-1, y-1, z-1, c-2, i-2, t-2.
Metron Instrument Co., t-2, z-2.
Metronix, Inc., Sub.-Assembly Products, Inc., s-1, c-2, b-3.
Mico Instrument Co., i-3.
Micrometrical Mfg. Co., n-2.
Microwave Associates, Inc., q-1, s-2.
James Millen Mfg. Co. Inc., f-1, g-1, s-2, i-3.
Minco Products, Inc., w-2.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., j, t.
J. J. Monaghan Co., Inc., x.
Motorola, Inc., a-1, j-1, q-1, t-1, o-2.
Muirhead Instruments Inc., f, y-1, e-2, b-3.
Narda Microwave Corp., The, c-1, g-1, q-1, i-3.
National Co., Inc., a-1, c-1, q-1, g-2, o-2, g-3.
National Electronics, b, c, k, l, b-1, c-1, d-1, h-1, k-1 thru n-1, r-1, s-1, v-1, z-1, c-2, e-2, g-2, n-2, t-2, w-2, c-3, g-3.
National Instrument Laboratories, Inc., x.
New England Scientific Instruments Co., b, g, s, d-1, k-1, l-1, n-1, r-1, s-1, u-1, d-2, n-2, g-3, h-3.
New London Instrument Co. Inc., n, a-1, c-1, t-1.
Nilsen Mfg. Co., e-2.
Nilsson Electrical Lab., Inc., a, b, c, k, r, b-1, d-1, j-1, l-1, m-1, o-1, p-1, r-1, s-1, z-1, c-2, t-2, v-2, b-3, g-3.
Non-Linear Systems, Inc., z-1, f-3.
Northeastern Engrg. Inc., c-1.
Nuclear Corp. of America, i, j, q, k-2.
Nuclear Development Corp. of America, r.
Nuclear Measurements Corp., j, q, k-2.
Nuclear-Chicago Corp., i, j, p thru s, u-1, k-2, l-2.
Paul Nurches Co., s-1, b-3.
Ohmart Corp., The, p, q, s, k-2, c-3.
Orbitran Co., Inc., x-2.
Overload Control Co., z-2.
Pace Electrical Instruments Co., Inc., b, e, k, l, d-1, r-1, s-1, v-1, z-1, c-2, b-3, f-3.
Paco Electronics Co., Inc., b, c, e, g, k, l, f-1, g-1, r-1, s-1, v-1, z-1, a-2, b-2, c-2, q-2, b-3, f-3.
Palmer Thermometers, Inc., n-2, w-2.
Panoramic Radio Products, Inc., n, o, a-1, c-1, j-1, q-1, t-1, x-1, e-2, n-2, r-2.
Parabam, Inc., r, y-2.
Patterson Moos Research, Div.-Leesona Corp., i-1.
Performance Measurements Co., t-2.
Peschel Electronics, Inc., f, k-1.
Phaostron Instrument & Electronic Co., b, k, r-1, s-1.
Philco Corp.-Govt. & Industrial Group
Richard Philip Co., u-1.
Philips Electronic Instruments, k-3.
Photovolt Corp., d-2, f-2.
Photron Instrument Co., u, d-1, x-1, n-2, d-3.
Piasecki Aircraft Corp., j, q, w, f-1, v-1, z-1, a-2, k-2.
Polarad Electronics Corp., w, q-1, g-2.
Potter Aeronautical Corp., u, x, c-1, l-2, m-2.
Powers Regulator Co., The, w-2.
Precise Development Corp., b-3.
Precision Radiation Instruments, Inc., j, k-2.
Production Research Corp., Sub.-Radio Condenser Co., c-1, i-1, r-2.
Projects Unlimited, Inc., f-1.
Pyrometer Instrument Co., Inc., i-2, v-2, w-2.
Q. V. S. Inc., b, l, d-1, k-1, n-1, r-1, s-1, v-1, y-1, z-1, c-2, i-2, w-2.
Quan-Tech Labs., Inc., b, o, e-2.
Radalab Inc., b thru i, f-1, g-1, n-1, o-1, q-1 thru t-1, v-1, x-1, a-2, b-2, n-2, o-2, r-2, s-2, v-2.
Radar Design Corp., q-1, i-3.
Radiation Instrument Development Lab., Inc., j, q, k-2.
*RADIO CORP. OF AMERICA., c, d, e, g thru j, a-1, c-1, f-1, f-3.
Radio Specialty Mfg. Co., a-1.
Rantec Corp., q-1.
Rawson Electrical Instrument Co., b, c, k, z, k-1, r-1, s-1, v-1, a-2, b-2, v-2, g-3.
Revere Corp. of America, Sub., Neptune Meter Co., x.
Rochester Mfg. Co. Inc., b, h-2.
Rochester Mfg. Co. Inc. of Calif., b, w-2.
Rosemount Engrg. Co., a.
Milton Roy Co., d-2, h-2.
Sangamo Electric Co., b, l-1, n-2, g-3, h-3.
Schaevitz Engrg., a, h-2, u-2, x-2, z-2.
Scientific & Process Instruments Div.-Beckman Instruments, Inc., d-2.
H. H. Scott, Inc., l, y-1, q-2, d-3.
Seco Mfg. Co., b-3.
Sensitive Research Instrument Corp., b, c, e, k, z, c-1, d-1, j-1, l-1, r-1, s-1, w-1, c-2, m-2, v-2, g-3.
Servo Consultants Ltd., g, h.
Servo-Tek Products Co., v-1, z-1, t-2, f-3.
Shallcross Mfg. Co., m, d-1, k-1, n-1.
Sierra Electronic Corp., Div.-Philco Corp., g-2, o-2, b-3.
Simmonds Aerocessories, Inc., x, h-2.
Simpson Electric Co., b, c, g, k, l, r, w, d-1, k-1, l-1, n-1, r-1, s-1, v-1, y-1, z-1, c-2, q-2, v-2, w-2, y-2, b-3, f-3, g-3.
Slaughter Co., Inc., f, n-1.
A. O. Smith Corp., Smith-Erie Div., x, h-1.
Solar Aircraft Co., c-1.
Sonotone Corp., e.
Southwest Research Institute, h, x, u-1, h-2.
Southwestern Industrial Electronics Co., g, s, d-1, n-1, p-1, s-1, v-1, z-1, q-2, d-3, f-3.
Specialty Electronics Development Corp., v-1, g-2, k-2, b-3, i-3.
Spectra Electronics Corp., b-1, f-2, a-3.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., c-1, q-1, g-2, s-2, g-3.
Sperry Piedmont Co., Div.-Sperry Rand Corp., e-2.
Statham Development Corp., a, e-2.
Statham Instruments, Inc., a, h-2, u-2, d-3.
Herman H. Sticht Co., Inc., r, s, c-1, n-1, z-1, i-2, y-2, c-3.
Stoddart Aircraft Radio Co., Inc., w, x-1.
Strand Engrg. Co., k-2.
Sun Electric Corp., Aeronautical Div., b thru e, k, l, r, x, c-1, k-1, r-1, s-1, t-1, a-2, b-2, c-2, o-2, d-3, g-3.
Sunshine Scientific Instrument, b, f, g, h, k, d-1, h-1, n-1, p-1, r-1, s-1, v-1, y-1, z-1, a-2, c-2, p-2, t-2, v-2, w-2, y-2, z-2, b-3, f-3, g-3.
B. K. Sweeney Mfg. Co., g, z-2.
Systron Corp., r, u, c-1, m-2, y-2.
W. A. Taylor & Co., d-2.
Technology Instrument Corp., b, g, h, g-1, n-1, v-1, z-1, e-2, b-3.
Temperature Engrg. Corp., i-2, v-2.
Texas Instruments Inc., z-1, n-2, z-2.
Thermo Electric Co., Inc., p-1, s-1, y-1, i-2, n-2, v-2.
Theta Instrument Corp., y-1, e-2.
Tracerlab Inc., p, q, k-2, k-3.
Trans-Sonics, Inc., x, h-2, w-2.
Trepac Corp. of America, a-1, s-1, a-2, b-2, g-2, n-2, o-2.
Trio Laboratories, Inc., n, h-1, s-1, y-1, a-2, e-2, b-3, f-3.
Triplett Electrical Instrument Co., b, c, k, l, h-1, k-1, n-1, r-1, s-1, v-1, x-1, z-1, a-2, c-2, p-2, q-2, v-2, b-3, f-3, g-3.
United Aircraft Products, Inc., x, h-2.
U. S. Industries, Inc., x-1, r-2, z-2.
U. S. Science Corp., Div.-Topp Industries, inc., a, v.
Varo Mfg. Co., Inc., e, n.
Victor R. F. & Microwave Co., c-1, q-1, i-3.
Victoreen Instrument Co., i, j, p, q, s, k-2, l-2.
Virginia Electronics Co., Inc., w, g-1.
Vocaline Co. of America Inc., r.
Wacline, Inc., b, c, e, k, l, n, r, s, a-1, c-1, k-1, l-1, n-1, p-1 thru s-1, v-1, z-1, a-2, b-2, c-2, g-2, i-2, o-2, s-2 thru v-2, i-3.
Wallace & Tiernan Inc., h-1, d-2, h-2.
Waltham Electronics Corp., j-2.
Wang Labs., Inc.
Warren Components, Div.-El-Tronics, Inc., u-1.
Waugh Engrg. Co., x, c-1.
Waveline, Inc., c-1, q-1, s-2, i-3.
Weighing & Control Components, Inc., u-1, x-2.
Wekser Instruments Corp., h-2, n-2, w-2, y-2.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., b, k, l, b-1, d-1, h-1, k-1, l-1, m-1, r-1, z-1, c-2, d-2, f-2, i-2, q-2, v-2, g-3.
Wells Industries Corp., i, u-1, f-2.
Westberg Mfg. Co., c-1.
Western Coil & Electrical Co., o-2.
Westinghouse Electric Corp., b, l-2, n-2, h-3.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., e-2.
Wollensak Optical Co., v.
Yellow Springs Instrument Co., The, w-2.
Zoomar Inc., m-1.

MICA, GLASS BONDED

Allied Plastics Supply Corp.
Continental Diamond Fibre Corp.
Insulation Mfrs. Corp.
Mica Fabricating Co.
Micacraft Products Inc.
*MINNESOTA MINING & MFG. CO.
Mycalex Corp. of America
Tingstol Co.

MICA PLATE & SHEET

Allied Plastics Supply Corp.
Asheville-Schoonmaker Mica Co.
L. J. Barwood Mfg. Co. Inc.
Arthur E. Booth Co.
Bram Metallurgical Chemical Co.
Insulation Mfrs. Corp.
Mica Fabricating Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Micacraft Products Inc.
*MINNESOTA MINING & MFG. CO.
Spruce Pine Mica Co.
Tingstol Co.
United Mineral & Chemical Corp.

MICROMANOMETERS

*CONSOLIDATED ELECTRODYNAMICS CORP.
Decker Corp., The
Flow Corp.
E. Vernon Hill & Co.
Trans-Sonics, Inc.
Trimount Instrument Co.

MICROMETERS, ELECTRONIC

Bendix Aviation Corp.
Brown & Sharpe Mfg. Co.
Daystrom Inc., Weston Instruments Div.
J. W. Dice Co.
Electro Products Labs., Inc.
Federal Products Corp.
Hammett-Mercury-Rex Div.
Wayne Kerr Corp.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div.
Paco Electronics Co., Inc

MICRO-OHMMETERS

James G. Biddle Co.
J. W. Dice Co.
Electro Instruments, Inc.
Hammett-Mercury-Rex Div.
Keithley Instruments, Inc.
Paco Electronics Co., Inc.
Shallcross Mfg. Co.
Sunshine Scientific Instrument

MICROPHONES

American Microphone Mfg. Co., Div.-G-C Textron Electronics
B & K Instruments, Inc.
Budelman Electronics Corp.
CBS Electronics, Div.-Columbia Broadcasting System, Inc.
Chance Vought Aircraft, Inc.
Du Kane Corp.

Electronic Applications, Inc
Electro-Voice, Inc
Fla Aircraft Radio & Marine
G-C Electronics Co.
General Coil Products Corp.
Carl Hirschmann Co., Inc.
Melody Master Mfg. Co.
Motorola, Inc.
Permoflux Products Co.
Photocon Research Products
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Remler Co
Rye Sound Corp
Sonotone Corp
Stephens Trusonic Inc
Stromberg-Carlson Div.-General Dynamics Corp.

MICROSCOPES, ELECTRON

Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div
New England Scientific Instruments Co.
Philips Electronic Instruments
*RADIO CORP. OF AMERICA
Telechrome Mfg Corp

MICROSCOPES, OPTICAL

American Optical Co., Instrument Div.
American Optical Co., Safety Products Div
Bausch & Lomb Optical Co.
Davidson Optronics, Inc.
Edmund Scientific Co.
Eglett Optical Co., Inc.
*ENGIS EQUIPMENT CO.
Fisher Scientific Co., Maryland
Gardner Laboratory, Inc.
Gordon Enterprises
Carl Hirschmann Co., Inc
New England Scientific Instruments Co
Optical Gaging Products, Inc.
Opto-Metric Tools, Inc.
Parker-Hartford Corp., The

MICROWAVE ABSORBERS

Airtron, Div.-Litton Industries
Bogart Mfg. Corp.
Carborundum Co., The
Chemalloy Electronics Corp.
Dalmo Victor Co., Div.-Textron, Inc
Joe Davidson & Associates
Demornay-Bonardi
Don-Lan Electronics Inc.
Emerson & Cuming, Inc.
Globar Plant, Refractories Div.-The Carborundum Co.
B. F. Goodrich Co., The
B. F. Goodrich Sponge Products
Gulton Industries, Inc.
Hammett-Mercury-Rex Div
Kearfott Div., General Precision, Inc
Mc Millan Companies, The
Mc Millan Lab., Inc
Microwave Associates, Inc.
Pyroferric Co. Inc.
Radar Design Corp
Rantec Corp.
TRG, Inc

MICROWAVE ACCESSORIES

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Aircom Inc.
Aircraft Armaments, Inc.
Airtron, Div.-Litton Industries
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Aluminum Co. of America
Amerac Inc
*ANDREW CORP.
Automatic Switch Co.
Bendix Aviation Corp
Bogart Mfg. Corp.
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Chance Vought Aircraft, Inc.
Chemalloy Electronics Corp.
Dalmo Victor Co., Div.-Textron, Inc.
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp
Douglas Microwave Co., Inc.
Electronic Applications, Inc
Eljay Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Products Sales Corp.
FXR, Inc
Ferroxcube Corp. of America
General Communication Co.
General Instrument Corp., Defense & Engrg. Products Group
General Radio Co.
Gilfillan Bros. Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammett-Mercury-Rex Div.
George E. Harris & Co., Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co.
ITE Circuit Breaker Co., Special Products Div.
J-V-M Microwave Co.
*KEARFOTT DIV., GENERAL PRECISION, INC.
Lab. for Electronics, Inc.
Lieco, Inc.
Litton Industries, Maryland Div.
Meridian Metalcraft, Inc.
Microphase Corp
Microwave Associates, Inc
Motorola, Inc.
Narda Microwave Corp., The
Omega Labs., Inc.
On Mark Couplings, Inc.
Philco Corp.-Govt. & Industrial Group
Polytechnic Research & Development Co., Inc.
Radalab Inc.
Radar Design Corp.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Rantec Corp.
Sage Labs., Inc.
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
TRG Inc.
Tamar Electronics, Inc.
Topco Group, Thompson Ramo Wooldridge Inc
Technicraft, Div.-Electronic Specialty Co.
Telerad Mfg. Corp
Thompson Ramo Wooldridge Inc.
Transco Products, Inc
Victor R. F. & Microwave Co.
Waveline, Inc

MICROWAVE JOINTS, ROTARY

Advanced Engineering Div., D. S. Kennedy & Co
Ainslie Corp.
Aircom Inc
Airtron, Div.-Litton Industries
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Bendix Aviation Corp.
Bogart Mfg. Corp.
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Chance Vought Aircraft, Inc
Dalmo Victor Co., Div.-Textron, Inc.
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Don-Lan Electronics Inc.
Douglas Microwave Co., Inc.
FXR, Inc.
Gilfillan Bros. Inc
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammett Mercury-Rex Div
Hazeltine Electronics Div.-Hazeltine Corp.
ITE Circuit Breaker Co., Special Products Div.
J-V-M Microwave Co
*KEARFOTT DIV., GENERAL PRECISION, INC.
D. S. Kennedy & Co
Lieco, Inc.
Litton Industries, Maryland Div.
Meridian Metalcraft, Inc
Microwave Associates, Inc.
On Mark Couplings, Inc
Radalab Inc
Reeves Instrument Corp.
Sage Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Strand Engrg. Co.
TRG, Inc.
Tober Electronic Corp.
Waveline, Inc.
Wheeler Laboratories, Inc.

MIDFRAME SECTIONS

Beacon Steel Corp.
Brooks & Perkins, Inc.
Clark-Aiken Co., The
ITE Circuit Breaker Co., Special Products Div.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc
*LAVELLE AIRCRAFT CORP.
Solar Aircraft Co.
Twin Coach Co., Aircraft-Missiles
United States Chemical Milling Corp.
Weber Aircraft Corp.
Winder Aircraft Corp. of Florida

MIDFRAME SECTIONS, AXIAL FLOW

Beacon Steel Corp.
ITE Circuit Breaker Co., Special Products Div.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.

MILLIOHMMETERS

James G. Biddle Co.
Calvert Electronics Inc
Daystrom Inc., Weston Instruments Div
Dejur-Amsco Corp., Electronic Sales Div
Electro Instruments, Inc.
Erdco Engrg. Corp
Hammett-Mercury-Rex Div.
Hickok Electrical Instrument Co., The
Industrial Instruments Inc.
Keithley Instruments, Inc.
National Electronics
New England Scientific Instruments Co.
Shallcross Mfg. Co
Simpson Electric Co
Southwestern Industrial Electronics Co.
Herman H. Sticht Co., Inc
Sunshine Scientific Instrument
Technology Instrument Corp.

MIRRORS, INSPECTION

Semon Bache & Co.
Bausch & Lomb Optical Co.
Blowers Inc
Davidson Optronics, Inc
Eddington Metal Specialty Co.
Edmund Scientific Co.
*ENGIS EQUIPMENT CO.
J. W. Fecker Div., American Optical Co.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Liberty Mirror Div., Libbey-Owens-Ford Glass Co.
Ohlson Empire Inc.
Pacific Universal Products Corp.
Tinsley Labs., Inc
Ullman Devices Corp.
Van Wagner Co.

MIRRORS, SPECIAL PURPOSE

Allison Div., General Motors Corp.
American Optical Co., Instrument Div
Arde-Portland, Inc.
Semon Bache & Co.
Bausch & Lomb Optical Co.
Davidson Optronics, Inc.
Edmund Scientific Co.
*ENGIS EQUIPMENT CO.
J. W. Fecker Div., American Optical Co.
Gordon Enterprises
Guided Missile Div., The Firestone Tire & Rubber Co.
Hammett-Mercury-Rex Div.
Liberty Mirror Div., Libbey-Owens-Ford Glass Co.
*MARTIN CO., THE, DENVER DIV.
Northrop Corp.
Ohlson Empire Inc.
Optical Coating Lab., Inc.
Pacific Universal Products Corp.
Seiscor, Div.-Seismograph Service Corp.
Sillcocks-Miller Co.
Singer Military Products Div.-The Singer Mfg. Co.
Spectracoat, Inc.
Sterling Glass Corp.
Texas Instruments Inc
Thermal Dynamic Products Div.-Waltham Precision Instrument Co.
Tinsley Labs., Inc
Valpey Crystal Corp.
Van Wagner Co.
Zenith Optical Laboratory
Zoomar Inc.

MISSILE BOOSTERS

*AEROJET-GENERAL CORP.
Aerojet-General Corp., Downey Plant
Amcel Propulsion Inc.
Bell Aircraft Corp., Niagara Frontier Div
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Bermite Powder Co
Broadview Research Corp.
A. M. Byers Co.
Calcor Corp.
Chance Vought Aircraft, Inc
Douglas Aircraft Co., Inc.
*EXCELCO DEVELOPMENTS INC.
Gabriel Co., Rocket Power-Talco
General Electric Co., Rocket Engine Section
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Grand Central Rocket Co.
Haskel Engrg. & Supply Co.
Hicks Corp., The
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kaiser Fleetwings, Inc.

Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Marquardt Corp., The
Missile Div., North American Aviation, Inc.
Norris-Thermador Corp.
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pressed Steel Tank Co.
Propellex Chemical Div., Chromalloy Corp.
Reynolds Metals Co., Sheffield Missile Plant
Solar Aircraft Co.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
Young Development Div., Hercules Powder Co.

MISSILE FRAMES

Aerocal Div., Aeronca Mfg. Corp.
***AEROJET-GENERAL CORP.**
Arde-Portland, Inc.
Atlas Industrial Corp.
Basic Tool Industries, Inc.
Cyril Bath Co., The
Beacon Steel Corp.
Beech Aircraft Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bethlehem Steel Co.
E. W. Bliss Co.
Brooks & Perkins, Inc.
A. M. Byers Co.
Calcor Corp.
Chance Vought Aircraft, Inc.
Clark-Aiken Co., The
Colonial Aircraft Corp.
Cromer Mfg. & Engrg., Inc.
Dahlstrom Metallic Door Co.
Douglas Aircraft Co., Inc.
Drayer Hanson Div.-Crane Co.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Farwell Metal Fabricating
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Guided Missile Div., The Firestone Tire & Rubber Co.
Herlo Corp.
ITE Circuit Breaker Co., Special Products Div.
Iron Fireman Mfg. Co., Aircraft Div.
Kaiser Fleetwings, Inc.
Kanarr Corp.
Kellett Aircraft Corp.
Ladish Co.
***LAVELLE AIRCRAFT CORP.**
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Meg Products, Div.-Mandrel Industries, Inc.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Mc Donnell Aircraft Corp.
***MINNESOTA MINING & MFG. CO.**
Missile Div., North American Aviation, Inc.
Monrovia Aviation Corp.
Narmco Mfg. Co.
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Parsons Corp., Special Products Div.
Piasecki Aircraft Corp.
REF Mfg. Corp.
Edw. Renneburg & Sons Co.
Republic Aviation Corp., Missile Systems Div.
Reynolds Metals Co.
Reynolds Metals Co., Sheffield Missile Plant
Rimak, Inc.
Spaceatomics Div., The Budd Co.
Stainless Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
Twin Coach Co., Aircraft-Missiles
U. S. Industries, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Chemical Milling Corp.
Vinco Corp.
Waco Aircraft Co.
Weber Aircraft Corp.

MISSILE SUPPORT EQUIPMENT

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Accessory Controls & Equipment Corp.
Accessory Products Co., Div.-Textron Inc.
Adler Electronics, Inc.
Advance Industries, Inc.
Aerocal Div., Aeronca Mfg. Corp.
Aeroflex Labs. Div., Aeroflex Corp.
***AEROJET-GENERAL CORP.**
Aero-Test Equipment Co., Inc.
Aerotest Laboratories, Inc.
Air Logistics Corp.
Airborne Accessories Corp.
***AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP.**
All American Engrg. Co.
Allis-Chalmers
Allison Steel Mfg. Co.
American Car & Foundry Div., ACF Industries, Inc.
American Latex Products Corp.
American Machine & Foundry Co.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
American Missile Products Co., Inc.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Anaheim Electronics Div.-Electronic Engrg. Co. of Calif.
Anderson, Greenwood & Co.
***ANDREW CORP.**
Arde-Portland, Inc.
Armament Div.-Universal Match Corp.
Arnolt Corp.
Aronson Machine Co., Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Associated Co., Inc.
Atlas Industrial Corp.
Avco Corp., Nashville Div.
Avco Corp.-Research & Advanced Development Div.
Avtron Mfg., Inc.
Barth Engrg. & Mfg. Co., Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Beech Aircraft Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bell & Gossett Co.
Belock Instrument Corp.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Filter Div., Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bernco Engrg. Corp.
E. W. Bliss Co.
Bogue Electric Mfg. Co.
Bowmar Instrument Corp.
Broadview Research Corp.
Brooks & Perkins, Inc.
Bruce Engrg. Co.
Budd Co., The
Budd Lewyt Electronics, Inc.
A. M. Byers Co.
Calcor Corp.
California Stamping & Mfg. Co.
Cambridge Filter Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Captive Seal Corp.
Caterpillar Tractor Co., Defense Products Dept.
Chance Vought Aircraft, Inc.
Chicago Bridge & Iron Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Clark Equipment Co.
Clark-Aiken Co., The
Compudyne Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Continental Aviation & Engrg. Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Control Technology Co.
Craig Systems, Inc.
Crane Co., Special Products Div.
Crescent Engrg. & Research Co.
Cromer Mfg. & Engrg., Inc.
Cryogenic Engrg. Co.
Curtiss-Wright Corp., Santa Barbara Div.
Cutler Metal Products Co.
Dahlstrom Metallic Door Co.
Dalmo Victor Co., Div.-Textron, Inc.
Dana Corp.
C. R. Daniels, Inc.
Davidson Optronics, Inc.
Daystrom Inc., Transicoil Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Delavan Mfg. Co.
***DEL MAR ENGRG. LABS.**
Designers for Industry, Inc.
Douglas Aircraft Co., Inc.

Drayer Hanson Div.-Crane Co.
Du Kane Corp.
Allen B. Du Mont Labs., Inc.
Dynatronics, Inc.
Electro Instruments, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Eubanks Industries, Inc.
Ex-Cell-O Corp.
FWD Corp.
FAE Instrument Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Farwell Metal Fabricating
J. W. Fecker Div., American Optical Co.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
Flight Refueling, Inc.
Flight Support, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Ford Instrument Co., Div.-Sperry Rand Corp.
Futurecraft Corp.
General American Transportation Corp.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Ordnance Dept.
General Logistics Div., Aeroquip Corp.
Genisco, Inc.
Gilfillan Bros. Inc.
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Gramm Trailer Corp.
Great Lakes Mfg. Corp.
Gremco, Inc.
Grove Valve & Regulator Co.
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Gyrex Corp., The
B. H. Hadley, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hammett-Mercury-Rex Div.
Harco Containers Div.-Harbor Boat Building Co.
Harman Equipment Co.
Haskel Engrg. & Supply Co.
A. W. Haydon Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
Hobart Brothers Co.
Hoefner Corp.
Hoover Electronics Co.

***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hughes Tool Co., Aircraft Div.
Hydro-power Corp.
Hydraulic Research & Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Dynamics Corp.
International Fermont Machinery Co., Inc.
International Steel Co.
Interstate Electronics Corp
Irving Air Chute Co., Inc.
Jack & Heintz, Inc.
Janke & Co. Inc.
Kanarr Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kellett Aircraft Corp.
Kerns Mfg. Corp.
Kigley & Mueller, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Langley Corp.
Leach Corp.
Lear, Inc.
Leland Airborne Products, Div.-American Machine & Foundry Co.
Librascope Div., General Precision, Inc.
Link-Belt Co.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lofstrand Co., The
Lycoming Div., Avco Corp.
Lyncoach & Truck Co. Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Corp.
Marchant Machining Corp.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Mason-Neilan
W. L. Maxson Corp., The
Mc Donnell Aircraft Corp.
Mc Dowell-Wellman Companies, The
Metronix, Inc., Sub.-Assembly Products, Inc.
Miami Engrg., Div.-Miami Shipbuilding Corp.
Micro Gee Products, Inc.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div.
Missile Div., North American Aviation, Inc.
Monrovia Aviation Corp.
George L. Nankervis Co.
Napier Engines Inc.

Northeast Metals Industries, Inc.
Northrop Corp
Nortronics, Div.-Northrop Corp.
Olin Mathieson Chemical Corp., Winchester-Western Div
On Mark Couplings, Inc
Optomechanisms Inc.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Pacific Automation Products, Inc
Pacific Coast Engrg. Co.
Packard-Bell Electronics Corp.
Pegasus Labs., Inc
Perkin-Elmer Corp.
Pesco Products Div.-Borg-Warner Corp.
Philco Corp.-Govt. & Industrial Group
Piasecki Aircraft Corp
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp
Pry Welding & Mfg., Inc
REF Mfg. Corp.
Radiophone Co. Inc
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Development & Research Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc
Rantec Corp.
Recony Div.,-Vinco Corp.
Reed Research Inc
Republic Aviation Corp., Missile Systems Div
Research Controls
Resistoflex Corp.
Rimak Inc
J. R. Robbins Co
Rome Cable Div.-Alcoa
Ronson Hydraulic Units Corp
Rucker Co., The
Rayan Industries, Inc., Dept. M
Sancor Dept
Sargent Engrg. Corp.
Schaffer Air Industries, Inc
Seeburg Corp., The
Silent Hoist & Crane Co
Skiatron Electronics & Television Corp
Skydyne, Inc
Skyline Electric & Mfg. Co
Solar Aircraft Co
Soroban Engrg., Inc.
Southwestern Valve Corp.
Spaceatomics Div., The Budd Co
Specialty Electronics Development Corp.
Spectra Electronics Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp
Stainless Inc
Stamping Div.,-Rockwell Standard Corp.
Standard Steel Corp., Cambridge Div.
Stearns-Roger Mfg. Co., The
A. U. Stone & Co., Inc.
Struthers Wells Corp.
Sun Electric Corp., Aeronautical Div
Superior Industrial Machine Co.
Tapco Group, Thompson Ramo Wooldridge Inc
Telkor, Inc
Temco Aircraft Corp.
Theta Instrument Corp.
Thiokol Chemical Corp, Hunter-Bristol Div
H. I. Thompson Fiber Glass Co
Thompson Ramo Wooldridge Inc.
Transco Products, Inc.
Tucson Instrument Corp.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
United Mfg. Co., The
United Mfg. Co., Div., The W. L. Maxson Corp.
U. S. Industries, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div
U. S. Science Corp., Div.-Topp Industries, Inc
United States Rubber Co
United States Steel Corp.
Universal Dynamics Corp.
Varo Mfg. Co., Inc
Vickers Inc. Div. Sperry Rand
Vickers, Inc., Mich
*WEATHERHEAD CO., THE
Weber Aircraft Corp
Welded Construction Inc
Wells Industries Corp
Western Design, Div.-U. S. Industries Inc.
Western Gear Corp.-Precision Products Div
Westinghouse Electric Corp
Wickes Engrg. & Construction Co
Wickfield, Inc.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.

MISSILES, GROUND CHECK-OUT EQUIPMENT

*AC SPARK PLUG, THE ELECTRONICS DIV. GENERAL MOTORS
ACF Electronics Div., ACF Industries Inc
ACF Industries Inc.
A. R. F. Products, Inc.
Accessory Controls & Equipment Corp.
Accessory Products Co., Div.-Textron Inc.
Adler Electronics, Inc.
Advance Industries, Inc.
Aeroflex Labs. Div., Aeroflex Corp.
*AEROJET-GENERAL CORP.
Aeronca Mfg. Corp.-Aerospace Div.
Aero-Test Equipment Co., Inc.
Aerotest Laboratories, Inc.
Air Logistics Corp
*AIRESEARCH MFG. CO. DIV.-THE GARRETT-CORP.
American Electronics, Inc.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
American Missile Products Co., Inc.
American Rectifier Corp.
Anaheim Electronics Div.-Electronic Engrg. Co. of Calif
Anderson, Greenwood & Co.
Antlab Inc.
Armament Div.-Universal Match Corp.
Arnott Corp
*ARNOUX CORP.
Automatic Switch Co
Autonetics, Div.-North American Aviation, Inc.
Avco Corp.-Research & Advanced Development Div.
Avien, Inc.
Avtron Mfg., Inc.
Beacon Steel Corp.
Beckman-Systems Div.
Beech Aircraft Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bell & Gossett Co.
Belock Instrument Corp
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Aviation Corp., York Div
Bendix Corp., The, Eclipse-Pioneer Div.
Bendix Filter Div., Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Benson-Lehner Corp
Bernco Engrg Corp.
Bogue Electric Mfg. Co.
Broadview Research Corp
Brunson Instrument Co.
Budd Co., The
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
CBS Laboratories, Div.-Columbia Broadcasting System
Calcor Corp
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Captive Seal Corp
Caterpillar Tractor Co., Defense Products Dept
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Compudyne Corp
Consolidated Diesel Electric Corp.
*CONSOLIDATED ELECTRODYNAMICS CORP.
Control Technology Co.
Craig Systems, Inc.
Crescent Engrg. & Research Co
Curtiss-Wright Corp., Santa Barbara Div
Dalmo Victor Co., Div.-Textron, Inc
Datascan Inc.
Davidson Optronics, Inc.
Daystrom, Inc., Military Electronics Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
*DEL MAR ENGRG. LABS.
Designers for Industry, Inc.
Dit-Mco, Inc.
Douglas Aircraft Co., Inc
Du Kane Corp
Allen B. Du Mont Labs., Inc.
Dunn Engrg. Associates Inc.
Dynametrics Corp.
Dynatronics, Inc
Eastman Kodak Co
Electric Machinery Mfg. Co.
Electro Instruments, Inc.
Electronic Engrg. Co. of California
Electronic Tube Corp
Electronics Div.-The National Cash Register Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*ENGIS EQUIPMENT CO.
*EQUIPMENT DIV., RAYTHEON CO.
Erie Instrumation, Div.-Erie Resistor Corp.
FAE Instrument Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Farwest Mfg. Div., Inc.
J. W. Fecker Div., American Optical Co.
Flight Support, Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Ford Instrument Co., Div.-Sperry Rand Corp.
Futurecraft Corp.
Gates Electronic Co.
General Communications Co.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept
General Electric Co., Computer Dept
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa
General Mills, Inc
Genisco, Inc.
Gilfillan Bros. Inc
Goodyear Aircraft Corp.
Gramm Trailer Corp.
Great Lakes Mfg. Corp.
Gremco, Inc.
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hamilton Watch Co., Military Products Div.
Haskel Engrg. & Supply Co
Hathaway Instruments, Inc.
A. W. Haydon Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
Hoefner Corp.
Hoover Electronics Co.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Hughes Tool Co., Aircraft Div.
Huyck Systems Co.
Hydraulic Research & Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Iconix Inc.
Indiana Gear Works, Inc.
Intercontinental Dynamics Corp.
International Fermont Machinery Co., Inc.
International Steel Co
Interstate Electronics Corp.
Janke & Co. Inc.
Kahn & Co., Inc.
*KEARFOTT DIV., GENERAL PRECISION, INC.
Kellett Aircraft Corp
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lab. for Electronics, Inc.
Leach Corp.
Lear, Inc.
*WALLACE O. LEONARD, INC.
Librascope Div., General Precision, Inc
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div
Lycoming Div., Avco Corp
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Corp.
Marquardt Corp., The
*MARTIN CO., THE, DENVER DIV.
W. L. Maxson Corp., The
Mc Donnell Aircraft Corp.
Metronix, Inc., Sub.-Assembly Products, Inc.
Micro Gee Products, Inc.
Milgo Electronic Corp
Millipore Filter Corp.
Minneapolis-Honeywell Regulator Co.-Aeronautical Div
Missile Div., North American Aviation, Inc.
Motor Generator Corp.
Motorola, Inc.
Mullenbach Div.-Electric Machinery Mfg. Co.
George L. Nankervis Co.
National Co., Inc.
Navigation Computer Corp.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
On Mark Couplings, Inc.
Optomechanisms Inc.
Pacific Automation Products, Inc
Packard Bell Computer Corp.
Packard-Bell Electronics Corp.
Ralph M. Parsons Co., The, Electronics Div.
Pegasus Labs Inc
Perkin-Elmer Corp.
Pesco Products Div., Borg-Warner Corp., Calif.
Philco Corp.-Govt. & Industrial Group
Potter Instrument Co., Inc.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Pryor Mfg. Co.
REF Mfg. Corp.
Radiophone Co. Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Development & Research Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Republic Aviation Corp., Missile Systems Div.

Research Controls
Richmont, Inc.
J. R. Robbins Co.
Ronson Hydraulic Units Corp.
Royal Jet, Div.-Royal Industries, Inc.
Rucker Co., The
Sancor Corp.
Sargent Engrg. Corp.
Schaffer Air Industries, Inc.
Seeburg Corp., The
Skiatron Electronics & Television Corp.
Skydyne, Inc.
Skyline Electric & Mfg. Co.
Southwestern Valve Corp.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Squiers Gage Co.
Stearns-Roger Mfg. Co., The
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Sundstrand Turbo
Superior Industrial Machine Co.
TRG, Inc.
Taffet Electronics, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Telkor, Inc.
Temco Aircraft Corp.
Theta Instrument Corp.
Thompson Ramo Wooldridge Inc.
Transco Products, Inc.
Trio Laboratories, Inc.
Tucson Instrument Corp.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
United Mfg. Co., Div., The W. L. Maxson Corp.
U. S. Industries, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Vickers Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Vinco Corp.
***WEATHERHEAD CO., THE**
Weber Aircraft Corp.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Wiancko Engrg. Co.
Wickes Engrg. & Construction Co.
Wolverine Diesel Power Co.

MIXING MACHINES

Alsop Engrg. Corp.
Atlantic Research Corp.
J. H. Day Co., The, Div.-The Cleveland Automatic Machine Co.
Del's Tumbling Service
Gardner Laboratory, Inc.
General American Transportation Corp.
Houston Fearless Corp.
Murphy & Miller Inc.
Naz-Dar Co
Pfaudler Div., Pfaudler Permutit Inc.
Pyles Industries, Inc.
Read Standard, Div.-Capitol Products Corp.
Edw. Renneburg & Sons Co.
Charles Ross & Son Co., Inc.
Skinner Engine Co.
Standard Steel corp., Cambridge Div
F. J. Stokes Corp.
MOBILE LIQUID OXYGEN & CLEANING FACILITY
***STELLARDYNE LABS., INC.**

MODULATORS, MAGNETIC

ACDC Electronics, Inc.
ACF Industries Inc.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bradley Semiconductor Corp.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
***EQUIPMENT DIV., RAYTHEON CO.**
Freed Transformer Co., Inc.
General Devices, Inc.
General Magnetics, Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Lear, Inc.
Levinthal Electronic Products, Inc.
Magnetic Circuit Elements, Inc.
Micro Gee Products, Inc.
Microwave Associates, Inc.
Northrop Corp.
Philco Corp.-Govt. & Industrial Group
Polyphase Instrument Co.
RS Electronics Corp.
***RADIO CORP. OF AMERICA**
Rantec Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Torwico Electronics, Inc.
Tresco, Inc.
Varo Mfg. Co., Inc.
Voi-Shan Electronics
Westinghouse Electric Corp.

MODULATORS, PHASE

ACF Industries Inc.
Bendix Aviation Corp.
Blonder-Tongue Labs. Inc., Special Products Div.
Bradley Semiconductor Corp.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Daystrom Inc., Weston Instruments Div.
Dorsett Electronic Labs., Inc.
Dytronics Co.
***EQUIPMENT DIV., RAYTHEON CO.**
General Devices, Inc.
Huyck Systems Co.
Lear, Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Corp.
Magnetic Circuit Elements, Inc.
W. L. Maxson Corp., The
Micro Gee Products, Inc.
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radiation, Inc.
***RADIO CORP. OF AMERICA**
Rantec Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Theta Instrument Corp.
Varo Mfg. Co., Inc.
Victory Engrg. Corp.
Virginia Electronics Co., Inc.

MODULATORS, PULSE

ACDC Electronics, Inc.
ACF Industries Inc.
AMP Inc.
Amerac Inc.
Applied Electronics Corp. of N. J.
Bendix Aviation Corp.
Bradley Semiconductor Corp.
Clegg Labs., Div.-Clegg, Inc.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
***DEL MAR ENGRG. LABS.**
Dorsett Electronics Labs., Inc.
***EQUIPMENT DIV., RAYTHEON CO.**
FXR, Inc.
Filtron Co., Inc.
General Devices, Inc.
General Instrument Corp., Defense & Engrg. Product Group
General Radio Co.
Hazeltine Electronics Div.-Hazeltine Corp.
Huyck Systems Co.
Levinthal Electronic Products, Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Madigan Corp.
Manson Labs., Inc.
Marconi Instruments
W. L. Maxson Corp., The
Micro Gee Products, Inc.
Microwave Associates, Inc.
Mid-West Coil & Transformer Co.
Motorola, Inc.
Narda Microwave Corp., The
National Co., Inc.
Omega Labs., Inc.
Philco Corp.-Govt. & Industrial Group
RS Electronics Corp.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Rantec Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Varo Mfg. Co., Inc.
Victory Engrg. Corp.
Voi-Shan Electronics

MOLDERS, PLASTIC

American Latex Products Corp.
Associated Engrg. Corp.
Chemplast, Inc.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Dimco-Gray Co.
Eisler Engrg. Co., Inc.
Eljay Corp.
Emeloid Co., Inc., The
Eubanks Industries, Inc.
Formica Corp.
Form-It Products, Inc.
Garlock Packing Co.
General American Transportation Corp.
George E. Harris & Co., Inc.
Heil Process Equipment Corp.
Hydro Molding Co. Inc.
Industrial Devices, Inc.
Joclin Mfg. Co., The
H. Koch & Sons
Kurz-Kasch, Inc.
Lone Star Plastics Co. Inc.
Luzerne Rubber Co.
***MINNESOTA MINING & MFG. CO.**
Molded Insulation Co.
Mycalex Corp. of America
Olympic Plastics Co., Inc.
Panduit Corp.
Plastic Age Sales, Inc.
Prewitt Aircraft Co.
Pry Welding & Mfg. Inc.
Quality Components, Inc.
Remler Co.
Milton Ross Metals Co., The
Sanford Plastics Corp.
Silicocks-Miller Co.
Swedlow Inc.
Tetrafluor, Inc.
Thiokol Chemical Corp. Hunter-Bristol Div.
Topper Mfg. Co., Inc.
Waterbury Companies, Inc.
Western Coil & Electrical Co
Western Control Corp.
Westinghouse Electric Corp., Micarta Div.

MOLYBDENUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co., Inc.
Associated Engrg. & Mfg. Corp.
Bram Metallurgical Chemical Co.
Budd Co., The
Climax Molybdenum Co. of Michigan
Custom Tool & Mfg. Co.
Eisler Engrg. Co., Inc.
Electronic Parts Mfg. Co., Inc.
Elmet Div. North American Philips Co., Inc.
Fansteel Metallurgical Corp.
Firth Sterling Inc.
General Electric Co., Lamp Metals & Components Dept.
Harvey Aluminum
Hughes Tool Co., Aircraft Div.
Walter K. Jaros Aircrafters
Johnson & Funk Metallurgical Corp.
NUMEC-Nuclear Materials & Equipment Corp.
Rembar Co., Inc., The
Stauffer Chemical Co.
Steel Improvement & Forge., The
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Thermionic Aeronautical Div.
United Mineral & Chemical Corp.
Universal-Cyclops Steel Corp.
Var-Lac-Oid Chemical Co.
Wah Chang Corp.
Westinghouse Electric Corp.
Wyman-Gordon Co.

MONEL

Accurate Specialties Co. Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co., Inc.
Ampco Metal, Inc.
Bram Metallurgical Chemical Co.
Crucible Steel Co. of America
Deringer Metallurgical Corp.
Wilbur B. Driver Co.
Driver-Harris Co.
Electronic Parts Mfg. Co., Inc.
Hamilton Watch Co.-Industrial Div.
Huntington Alloy Products Div.-The International Nickel Co., Inc.
Walter K. Jaros Aircrafters
Rodney Metals Inc.
Roovers-Lotsch Corp.
Techalloy Co. Inc.
Var-Lac-Oid Chemical Co.
Wah Met Alloys Co.

MONITORING EQUIPMENT, TRANSMISSION

Aeronca Mfg. Corp.-Aerospace Div.
Allied International Corp.
Applied Electronics Corp. of N. J.
***ARNOUX CORP.**
Babcock Radio Engrg., Inc.
Bendix Aviation Corp., Cincinnati Div.
Budd Lewyt Electronics, Inc.
Douglas Microwave Co., Inc.
Electronic Applications, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Flight Support, Inc.
General Radio Co.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Lynch Carrier Systems Inc.
***MARTIN CO., THE, DENVER DIV.**

Moore Associates, Inc.
Motorola, Inc.
New London Instrument Co. Inc.
Philco Corp.-Govy & Industrial Group
Sun Electric Corp., Aeronautical Div.
Tamar Electronics, Inc.
Telechrome Mfg. Corp.
Television Utilities Corp.
Telex, Inc.
Trepac Corp. of America
U. S. Science Corp., Div.-Topp Industries, Inc.

MONITORS

a. AM & FM Transmitter
b. Antenna
c. Audio
d. Frequency
e. Line & Program
f. Modulation
g. Phase
h. RF Power
i. Service
j. Shift
k. Waveform

Allied International Corp., **a.**
Amerac Inc., **a, d.**
American Missile Products Co., Inc., **a.**
Antalab Inc., **b, d.**
Applied Electronics Corp. of N. J., **a, h.**
Beckman Instruments, Inc., Berkeley Div., **d.**
Bendix Aviation Corp., Cincinnati Div., **a, c, d.**
Blonder-Tongue Labs. Inc., Special Products Div.,
Brunswick Instruments., **h.**
Budd Lewyt Electronics, Inc., **a, h.**
CGS Labs., Inc., **d.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **a, k.**
Chalco Engrg. Corp., **c, e.**
Chance Vought Aircraft, Inc., **f.**
Chemalloy Electronics Corp., **h.**
Collins Radio Co., **a.**
Control Electronics Co., Inc., **g.**
Dage Television Div., Thompson Ramo Wooldridge, Ing , **k.**
Daven Co., The, **c, d.**
Designers for Industry, Inc., **a, c, d, e.**
Dytronics Co., **g, j.**
Electro Impulse Lab., Inc., **h.**
Electronic Applications, Inc., **h.**
Emertron, Sub.-Emerson Radio & Phonograph Corp. **a.**
Empire Products Sales Corp., **a, f, h.**
Erie Resistor Corp., **f.**
Fla. Aircraft Radio & Marine, **a.**
Foto-Video Labs., Inc., **d, e, f, k.**
Gates Radio Co., **a, d thru g.**
General Communication Co., **h.**
General Instrument Corp., Defense & Engrg. Products Group, **a.**
General Radio Co., **a, d, f, k.**
Good Electronic Corp., **a, i.**
Guided Missile Div., The Firestone Tire & Rubber Co., **a, b.**
Hammett-Mercury-Rex Div., **k.**
Hazeltine Electronics Div.-Hazeltine Corp
Hewlett-Packard Co., **a.**
ITI Electronics, Inc., **e.**
Kahn & Co., Inc., **d.**
Wayne Kerr Corp., **c, d, h, k.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lab. for Electronics, Inc., **f, k.**
Lampkin Labs., Inc., M. R. Div., **d, f.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **a.**
Langevin Div., The W. L. Maxson Corp., **c.**
Lear, Inc., **g.**
Litton Industries, Maryland Div., **b, c, d, g, h.**
Madigan Corp., **a thru d, f, g.**
Magnasync Corp., **c.**
Marconi Instruments, **a, f, h.**
*MARTIN CO., THE, DENVER DIV., **c thru g, k.**
James Millen Mfg. Co. Inc., **a, c, f.**
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., **c,**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **e.**
Motorola, Inc., **a, d, f, g, h, k.**
National Co., Inc., **a, d, h.**
New London Instrument Co. Inc., **a, d, f.**
Northeast Electronics Corp., **h.**
Panoramic Radio Products, Inc., **a, d, f, k.**
Philco Corp.-Govt. & Industrial Group, **a thru h.**
Potter Aeronautical Corp , **d.**
Rodalab Inc., **a.**
*RADIO CORP. OF AMERICA., **a thru h, j, k.**
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS., **a.**
St. John X-Ray Laboratory
Scopes Co., Inc., The, **k.**
Sierra Electronic Corp., Div.-Philco Corp., **h, k.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **d, h.**
Standard Electronics Div.-Reeves Instrument Corp., **a, c, d, f, g, h.**
State Testing Laboratory Inc., **e.**
Stromberg- Carlson Div.-General Dynamics Corp., **c, e.**
Tamar Electronics, Inc., **b, g, h.**
Technology Instrument Corp., **g.**
Television Utilities Corp., **e.**
Theta Instrument Corp., **g.**
Thompson Ramo Wooldridge Inc.
Torwico Electronics, Inc., **d.**
Trepac Corp. of America, **h.**
Trio Laboratories, Inc., **e.**
U. S. Science Corp., Div.-Topp Industries, Inc., **d, f, j.**
Varo Mfg. Co., Inc., **c thru g, k.**
Vicon Corp. Sub.-Insul-8-Corp., **e.**
Virginia Electronics Co., Inc.
Voi-Shan Electronics, **d.**
Waltham Electronics Corp., **d, f.**

MONOPROPELLANTS

Allied Chemical Corp., Nitrogen Div.
American Potash & Chemical Corp., National Northern Div.
American Rocket Co.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Callery Chemical Co.
Chlor-Alkali Div.-Food Machinery & Chemical Corp.
Clevite Ordnance, Div.-Clevite Corp.
E. I. Du Pont de Nemours & Co. Inc.
Gabriel Co., Rocket Power-Talco
Hughes Tool Co., Aircraft Div.
Hummel Chemical Co., Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pennsalt Chemicals Corp.
Shell Chemical Co., Indsl. Chemical Div.
Southwest Research Institute
Stauffer Chemical Co.
Thiokol Chemical Corp., Redstone Div.
Topper Mfg. Co., Inc.

MOTORS

a. Clock
b. Control
c. Electric
d. Fluid
e. Fractional Hp
f. Hydraulic
g. Hysteresis
h. Instrument
i. Miniature
j. Servo
k. Timing-Regulated, Constant Speed
l. Turntable
m. Universal

ACF Industries Inc., **f.**
Adel Precision Products of Calif., Div.-General Metals Corp., **d, e, f.**
Airborne Accessories Corp., **c, e.**
Aircraft Accessory Turbine Dept.-General Electric Co., **d, f.**
*AiRESEARCH MFG. CO. DIV.-THE GARRETT CORP., **c, e, g, i, j.**
Air-Marine Motors, Inc., **c, e, g, i, j.**
Alco Valve Co., **c, e.**
Allard Instrument Corp., **c, i.**
Allis-Chalmers, **c.**
American Brake Shoe Co., **f.**
American Electronics, Inc., **b, c, e, g thru k.**
American Electronics Incorporated, **j.**
American Potash & Chemical Corp., National Northern Div., **i, j.**
Amglo Corp., **b, c, h, i, k.**
Raymond Atchley, Inc., **j.**
Automatic Switch Co., **b.**
Barber-Colman Co., **b, c, e, h thru l.**
Bendix Aviation Corp., **b thru j.**
*BENDIX AVIATION CORP., HAMILTON DIV., **d, f, i, j.**
Bendix Aviation Corp.-Montrose Div., **c, e, h.**
Bendix Corp., The, Eclipse-Pioneer Div., **b, h, i, j.**
Bendix-Pacific Div., Bendix Aviation Corp., **c, e, j.**
A. Biederman, Inc., **h.**
Bodine Electric Co., **a, c, e, g thru m.**
Bogue Electric Mfg. Co., **c, j.**
Borg Equipment Div., Amphenol-Borg Electronics Corp., **b, e, h.**
Bristol Motors Div.-Vocaline Co. of America, Inc., **g, k.**
Calvert Electronics Inc., **k.**
Carter Motor Co., **c, e, i, k, m.**
Cedar Engrg. Div.-Control Data Corp., **c, e, h thru k.**
Clark Equipment Co., **d, f.**
Clifton Precision Products Co., Inc., **h, j.**
Commercial Shearing & Stamping Co., **f.**
Consolidated Diesel Electric Corp., **c.**
Control Data Corp., **c, e, h, i, j.**
Cornelius Co., The, Aero Div., **d, e, f.**
Cramer Controls Corp., **a, c, h, i, k.**
Dale Products, Inc., **g, l.**
Data Instruments Div.-Telecomputing Corp.
Joe Davidson & Associates, **a, b, c, e, g thru m.**
Daystrom Inc., Transicoil Div., **j.**
Decker Corp., The, **i, j.**
Delco Products Div.-General Motors Corp., **c, e.**
Denison Engrg. Div., American Brake Shoe Co., **d, f.**
Diehl Mfg. Co., **b, h, j.**
Eagle Signal Co., **e, k.**
Eastern Industries Inc., **d, f.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **h, j.**
Eicor Div.-Scranton, **b, c, e, g, h, i, k, l, m.**
Electric Autolite Co., The, **b, c, e, m.**
Electric Indicator Co. Inc., **b, c, e, g thru k, m.**
Electric Machinery Mfg. Co., **c.**
Electric Motors & Specialties, Inc., **c, e.**
Electronic Specialty Co., Eemco Div., **c, e, i, m.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **a, i.**
Eureka Williams Corp., **c, e, m.**
Ex-Cell-O Corp., **f.**
Fairfield Engrg. Corp., **b.**
Fasco Industries Inc., **e.**
Ford Instrument Co., Div.-Sperry Rand Corp., **c, g, j.**
G-M Labs. Inc., **j.**
Garwin, Inc., **c.**
Gar Wood Industries Inc., **f.**
General Controls Co., **e.**
General Electric Co., Apparatus Sales Div., **b, c, e, i, j, m.**
General Industries Co., The, **e, l.**
Genisco, Inc., **b, c, e, g, j.**
Paul E. Gerst & Co., **c, e, k, m.**
Gordon Enterprises, **a, c, h thru k.**
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., **j.**
Guidance Controls Corp., **j.**
Guided Missile Div., The Firestone Tire & Rubber Co., **j.**
B. H. Hadley, Inc., **f, j.**
Hagen Mfg. Co., **a, b, c, e, k.**
Hamilton Watch Co., Military Products Div., **a, t.**
Hammett-Mercury-Rex Div., **a, c, e, i, j, l.**
Hansen Mfg. Co. Inc., **a, b, c, g, h, i, k.**
George E. Harris & Co., Inc., **c, e, g thru j, m.**
Haskel Engrg. & Supply Co., **d, f.**
A. W. Haydon Co., The, **a, b, c, e, g, h, i, k.**
Helipot Div.-Beckman Instruments, Inc., **j.**
Hertner Electric Co., The, **b, c, g thru j.**
E. Vernon Hill & Co., **i.**
Holtzer-Cabot Div., National Pneumatic Co., Inc., **b, c, e, g thru l.**
Hoover Electric Co., **b, c, e, i.**
Hunter Spring Co., Div.-American Machine & Metals, Inc., **a.**
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., **f.**
IMC Magnetics Corp., **c, e, g, i, j, l.**
Industrial Control Co., **j.**
Ingraham Co., The, **a, h, i, k.**
Integrated Dynamics Div., Globe Industries, Inc., **a, k.**
Jack & Heintz, Inc., **c, e, j.**
*KEARFOTT DIV., GENERAL PRECISION, INC., **e, i, j.**
Kerns Mfg. Corp., **d, f.**
Ketay Dept., Norden Div., United Aircraft Corp., **j.**
Kieley & Mueller, Inc., **b, f.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **e g thru j.**
L & R Mfg. Co., **e, m.**
Lamb Electric Co., The, Div.-American Machine & Metals, Inc., **b, c, e, g, i, m.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **j.**
Lear, Inc., **a thru k, m.**
Leece-Neville Co., The, **b, c, e, i.**
G. H. Leland, Inc., **j.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **c, e.**
Librascope Div., General Precision, Inc., **j.**
Lincoln Electric Co., The, **c.**
Link-Belt Co., **d.**
Lundy Mfg. Corp., **c, e.**
Lytle Corp., **b.**
Mamco Corp., **c, e, m.**
Marquardt Corp., The, **f, j.**
Motor Appliance Corp., **c, e.**
Motordyne Inc., **b, e, g thru j, m.**
Motoresearch Co., **c, e, i.**
Heinz Mueller Eng. Co. Inc., **c, e, i, m.**
Muirhead Instruments Inc., **e, g, j, k.**
National Pneumatic Co., Inc., Holtzer-Cabot Divs., **b, c, e, g thru j, l.**
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc., **f.**
New York Air Brake Co., The, Watertown Div., **f.**
Northrop Corp., **j.**
Northwestern Electric Co., **c.**
Oil-Dyne, Inc., **f.**
John Oster Mfg. Co., Avionic Div., **c, e, h, i, j.**
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y., **c, e, g, i, j.**

Pesco Products Div.-Borg-Warner Corp., **c, e, f, i.**
Power Supplies Inc., **j.**
Radio Development & Research Corp., **c, j.**
Rae Motor Corp., **c, e, m.**
Redmond Co., Inc., Sub.-Controls Co. of America, **c, e, f, l, m.**
Reeves-Hoffman Div., **c.**
Reflectone Electronics, Inc., **i.**
Reliance Electric & Engrg. Co., **c, e, j.**
J. R. Robbins Co., **b, c, e, g, i.**
Safety Electrical Equipment Corp., **c.**
Sangamo Electric Co., **a, b, c, e, g thru k.**
Sargent Engrg. Corp., **f.**
Servomechanisms, Inc., **b, c, e, h, i, j.**
Servo-Tek Products Co., **b, e, i, j, m.**
Singer Military Products Div.-The Singer Mfg. Co., **j.**
Small Motors Inc., **b, c, e, g, i, j, k, m.**
A. O. Smith Corp., Smith-Erie Div., **c, e.**
Stator Electric Corp., **m.**
Herman D. Steel Co., **a.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **f.**
Summers Gyroscope Co., **h, i, j.**
Sundstrand Turbo, **d, f.**
Superior Electric Co., The, **c, j.**
Talley Corp., The, **b, c, e, g thru m.**
Telkor, Inc., **c, e, i.**
Transicoil Div.-Daystrom Inc., **j.**
U. S. Electrical Motors, **c, e.**
Universal Electric Co., **c, e, h, i, l, m.**
Varo Mfg. Co., Inc., **a, b, j, k.**
Vickers Inc., **d, f, j.**
Vickers Inc., Div.-Sperry Rand, **d, f, j, k.**
Vickers, Inc., Mich., **f.**
Vocaline Co. of America Inc., **g.**
Westinghouse Electric Corp., **c, e, m.**
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., **j.**
Wickfield, Inc., **d, f.**
Wincharger Corp., Sub.-Zenith Radio Corp., **m.**
Worthington Corp., **c, f.**

MOUNTINGS, METALLIC

Aerocal Div., Aeronca Mfg. Corp.
Ampco Metal, Inc.
B. H. Aircraft Co., Inc.
Barry Controls Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Belmar Wheel & Machine Co., Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Capital City Mfg. Co., Inc.
Clark-Aiken Co., The
Conrad & Moser
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Flight Refueling, Inc.
General Logistics Div., Aeroquip Corp.
Hamilton Kent Mfg. Co.
Iron Fireman Mfg. Co., Aircraft Div.
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc.
Kellett Aircraft Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kling Metal Spinning & Stamping Co.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Ladish Co.
MB Electronics
***MARTIN CO., THE, DENVER DIV.**
Norrich Screw Machine Products
Northeast Metals Industries, Inc.
Northrop Corp.
Parts Engrg. Co., Inc.
Richard Philip Co.
Pry Welding & Mfg., Inc.
Edw. Renneburg & Sons Co.
Rimak, Inc.
United States Chemical Milling Corp.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Winder Aircraft Corp. of Florida

MOUNTINGS, NON-METALLIC

Acushnet Process Co.
Allied Plastics Supply Corp
American Felt Co.
American Latex Products Corp.
Barry Controls Inc.
Dow-Elco, Inc.
Enfab Inc.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
Hamilton Kent Mfg. Co.
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc.
MB Electronics
M & Q Plastic Products
Minnesota Rubber Co.
Norrich Screw Machine Products
Northrop Corp.
Owens-Corning Fiberglas Corp.
Pry Welding & Mfg., Inc.
Rubbercraft Corp. of California
Tetrafluor, Inc.
Thor Ceramics, Inc.
United States Chemical Milling Corp.
United States Rubber Co.
Victor Tool & Mfg., Inc.
Winder Aircraft Corp. of Florida
Zippertubing Co., The

MOUNTINGS, VIBRATION & SHOCK

Acushnet Process Co.
Allied International Corp.
American Felt Co.
American Latex Products Corp.
American Machine & Foundry Co., Greenwich Engrg. Div.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Associated Engineers, Inc.
Barry Controls Inc.
Basic Tool Industries, Inc.
Bushings, Inc.
Dow-Elco, Inc.
Enfab Inc.
Felters Co., The
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
General Logistics Div., Aeroquip Corp.
General Tire & Rubber Co., The, Industrial Products Div.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Kent Mfg. Co.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
International Electronic Research Corp.
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc.
Kemp Aero Products
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lear, Inc.
Lord Mfg. Co.
MB Electronics
Mechanics Research Div., American Machine & Foundry Co.
Menasco Mfg. Co.
Minnesota Rubber Co.
Northrop Corp.
Owens-Corning Fiberglas Corp.
Piasecki Aircraft Corp.
Pneumafil Corp.
Propulsion Test Facilities Div.-MB Electronics
Pry Welding & Mfg., Inc.
Raybestos-Manhattan, Inc.
Robinson Technical Products, Inc.
Rubbercraft Corp. of California
Ray A. Scharer & Co.
Southwest Research Institute
A. T. Stevens Co.
United States Rubber Co.
Vibration Isolation Products
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida
Zippertubing Co., The

MOUNTS

Acushnet Process Co.
Aeroflex Labs. Div., Aeroflex Corp.
Allied International Corp.
American Felt Co.
American Latex Products Corp.
American Machine & Foundry Co., Government Products Group
Antlab Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Barry Controls Inc.
Beacon Steel Corp.
Belmar Wheel & Machine Co., Inc.
Bushings, Inc.
Capital City Mfg. Co., Inc.
Chance Vought Aircraft, Inc.
Dow-Elco, Inc.
Ex-Cell-O Corp.
Hamilton Kent Mfg. Co.
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc.
Kellett Aircraft Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Ladish Co.
MB Electronics
***MARTIN CO., THE, DENVER DIV.**
Narda Microwave Corp., The
Northeast Metals Industries, Inc.
Northrop Corp.
Optomechanisms Inc.
Owens-Corning Fiberglas Corp.
Richard Philip Co.
Piasecki Aircraft Corp.
Pneumafil Corp.
Pry Welding & Mfg., Inc.
Edw. Renneburg & Sons Co.
Robinson Technical Products, Inc.
Tower Construction Co.
Twin Coach Co., Aircraft-Missiles
United Aircraft Products, Inc.
Waco Aircraft Co.
Winder Aircraft Corp. of Florida

MOUNTS, ANTENNA

Acushnet Process Co.
Aeroflex Labs. Div., Aeroflex Corp.
Ainslie Corp.
Allied International Corp.
American Beryllium Co.
American Latex Products Corp.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich Engrg Div.
***ANDREW CORP.**
Antlab Inc.
Aronson Machine Co., Inc.
Barry Controls Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Belmar Wheel & Machine Co., Inc.
Bendix Aviation Corp.
E. W. Bliss Co.
Brooks & Perkins, Inc.
Chance Vought Aircraft, Inc.
Conrad & Moser
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Dalmo Victor Co., Div.-Textron, Inc.
Joe Davidson & Associates
Daystrom, Inc., Military Electronics Div.
Diamond Antenna & Microwave Corp.
Don-Lan Electronics Inc.
Dow-Elco, Inc.
Ex-Cell-O Corp.
G-C Electronics Co.
General Electric Co., Ordnance Dept.
Guided Missile Div., The Firestone Tire & Rubber Co.
K. W. Johnson & Co., Inc.
Kellett Aircraft Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
MB Electronics
Master Mobile Mounts, Inc.
W. L. Maxson Corp., The
Norrich Screw Machine Products
Northeast Metals Industries, Inc.
Permax Products Div., Chisholm-Ryder Co., Inc.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Prodelin Inc.
Pry Welding & Mfg., Inc.
Radiation, Inc.
***RADIO CORP. OF AMERICA**
Robinson Technical Products, Inc.
Scientific-Atlanta, Inc.
Stainless Inc.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
TRG, Inc.
Technical Appliance Corp.
Tober Electronic Corp.
Tower Construction Co.
Transco Products, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida

MOUNTS, ENGINE

Acushnet Process Co.
American Latex Products Corp.
American Welding & Mfg. Co., The
Ampco Metal, Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Barry Controls Inc.
Basic Tool Industries, Inc.
Bell Aircraft Corp., Niagara Frontier Div.
Bushings, Inc.
Capital City Mfg. Co., Inc.
Chance Vought Aircraft, Inc.
Clark-Aiken Co., The
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Dow-Elco, Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc.
Kellett Aircraft Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Ladish Co.

*LAVELLE AIRCRAFT CORP.
Lord Mfg. Co.
MB Electronics
*MARTIN CO., THE, DENVER DIV.
Northeast Metals Industries, Inc.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Pry Welding & Mfg., Inc.
Robinson Technical Products, Inc.
Southwest Products Co
Temco Aircraft Corp.
United Aircraft Products, Inc.
Vibration Isolation Products
Westholt Mfg Inc
Wolverine Diesel Power Co.
Woolf Aircraft Products, Inc

MOUNTS, SHOCK

Acushnet Process Co.
American Felt Co.
American Latex Products Corp.
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Greenwich Engrg Div
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Barry Controls Inc
Bushings, Inc
Carr Fastener Co., Div.-United-Carr Fastener Corp
Chance Vought Aircraft, Inc.
Colonial Rubber Co
Dow-Elco Inc
Enfab Inc
General Logistics Div., Aeroquip Corp
Hamilton Kent Mfg. Co.
George E. Harris & Co., Inc.
Houdaille Industries, Inc., Buffalo Hydraulics Div
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc
Kemp Aero Products
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc
Lord Mfg. Co.
MB Electronics
*MARTIN CO., THE, DENVER DIV.
Northrop Corp.
Owens-Corning Fiberglas Corp
Propulsion Test Facilities Div.-MB Electronics
Pry Welding & Mfg., Inc.
Robinson Technical Products, Inc
Rubbercraft Corp. of California
A. T. Stevens Co.
United States Rubber Co
Vibration Isolation Products
Western Design, Div.-U. S. Industries, Inc
Westinghouse Electric Corp.

MOUNTS, THERMISTOR

Advanced Electronics, Inc.
American Latex Products Corp.
FXR, Inc
Fenwal Inc.
Hewlett-Packard Co.
K. W. Johnson & Co. Inc
Kings Electronics Co., Inc
MB Electronics
Microwave Associates, Inc.
Narda Microwave Corp., The
Omega Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Victor R. F. & Microwave Co.

MUFFLERS, JET ENGINE INTAKE & EXHAUST

Allied Witan Co. Inc
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Associated Co., Inc
B. H. Aircraft Co., Inc.
Chicago Bridge & Iron Co.
Crane Co., Special Products Div.
Emhart Mfg. Co., Maxim Div
Industrial Acoustics Co., Inc.
Janke & Co. Inc.
Kittell-Lacy, Inc.
Koppers Co., Inc., Metal Products Div.
Lycoming Div., Avco Corp
Northrop Corp
Portland Copper & Tank Works Inc.
Recony Div.-Vinco Corp.
Edw. Renneburg & Sons Co.
Southwest Research Institute
Waco Aircraft Co

MUFFS

Allied Witan Co. Inc
Associated Co., Inc.
California Stamping & Mfg. Co
Colonial Aircraft Corp.
Edw. Renneburg & Sons Co.

MULTIPLEX SYSTEMS

ASCOP Div., Electro-Mechanical Research, Inc.
Adler Electronics, Inc.
Airtron, Div.-Litton Industries
Applied Electronics Corp. of N. J.
Applied Research Inc.
*ARNOUX CORP.
Budd Lewyt Electronics, Inc.
Control Electronics Co., Inc.
Dynatronics, Inc.
Electro Instruments, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
GPL Div.-General Precision, Inc.
Hammarlund Mfg. Co., The
JFD Electronics Corp.
Kahn Research Labs., Inc.
Lear, Inc.
Lenkurt Electric Co., Inc.
Lynch Carrier Systems Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Motorola, Inc.
Packard Bell Computer Corp.
M. V. Palmer, Inc.
Philco Corp.-Govt. & Industrial Group
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Servomechanisms, Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Texas Instruments Inc.
Transco Products, Inc.
Trepac Corp. of America
Western Union Telegraph Co., The

MULTIPLIERS

a. Crystal
b. Diode
c. Electronic
d. Frequency
e. Magnetic
f. Meter
g. Servo

Aircom Inc., **a, b, d.**
Alfred Electronics, **a, c, d.**
Amerac Inc., **d.**
American Electronics, Inc., **d.**
American Research & Mfg. Corp., **d.**
Applied Research Inc., **c.**
Beckman Instruments, Inc., Berkeley Div., **c.**
Bendix Aviation Corp., **c, g.**
Chadwick-Helmuth Co., **c.**
Control Technology Co., **g.**
Daven Co., The, **f.**
Daystrom Inc., Weston Instruments Div., **f.**
Delco Radio Div.-General Motors Corp., **c.**
*DEL MAR ENGRG. LABS., **d.**
Demornay-Bonardi, **a, d.**
Djeco, Div.-Djordjevic Engrg. Co., **c.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **g.**
Electro Precision Corp., **g.**
Electronic Applications, Inc., **c, d.**
Ensco, Inc., **c.**
Feedback Controls, Inc., **g.**
General Magnetics Inc., **e.**
Guided Missile Div., The Firestone Tire & Rubber Co., **c, d.**
B. H. Hadley, Inc., **g.**
Hammett-Mercury-Rex Div., **a, b, c, g.**
ITT Federal Div., International Telephone & Telegraph Corp., **c.**
Industrial Test Equipment Co., **c.**
J-V-M Microwave Co., **d.**
*KEARFOTT DIV., GENERAL PRECISION, INC., **g.**
Lab. for Electronics, Inc., **c, d.**
Lear, Inc., **c, e, g.**
Lel, Inc., **b, d.**
*MARTIN CO., THE, DENVER DIV., **c, e, f.**
Microwave Associates, Inc., **b, d.**
Motorola, Inc., **a thru d.**
National Co., Inc., **a thru d.**
Northrop Corp., **c.**
Packard Bell Computer Corp., **c.**
Piasecki Aircraft Corp., **d.**
Pitometer Log Corp., **a, c, d.**
Radiation, Inc., **d.**
*RADIO CORP. OF AMERICA, **b, c, d.**
Rantec Corp., **d.**
Reeves Instrument Corp., **b, c.**
*SEMICONDUCTOR DIV., RAYTHEON CO., **b.**
Sensitive Research Instrument Corp., **f.**
Spectralab Instruments, **d.**
Sperry Electronic Tube Div., Sperry Rand Corp., **d.**
Standard Electronics Div.-Reeves Instrument Corp., **d, e.**
Statham Development Corp., **g.**
TRG, Inc., **a, d.**
Telechrome Mfg. Corp., **c.**
Telkor, Inc., **d.**
Trio Laboratories, Inc., **g.**
Valpey Crystal Corp., **a.**
Varo Mfg. Co., Inc., **a thru e, g.**
Voi-Shan Electronics, **b thru e.**
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., **f.**

NAILS, SPECIAL

Abbott Screw & Mfg. Co.
Allmetal Screw Products Co., Inc.
Aluminum Co. of America
Atlas Tack Corp.
Aviation Textile Associates
Bethlehem Steel Co.
Chase Brass & Copper Co., Inc.
Copperweld Steel Co., Wire & Cable Div.
John Hassall, Inc.
Illumitronic Engrg. Co.
Mercury Air Parts Co., Inc.
Nuclear Development Corp. of America
Ohlson Empire Inc.
Republic Steel Corp.
Reynolds Metals Co.
United Shoe Machinery Corp.
United States Steel Corp.

NAMEPLATES

Acromark Co., The
Adept Industries Inc.
Allied Decals, Inc.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
Apahouser Corp. of N. E.
W. H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
C & H Supply Co.
California Plasteck Inc.
Canadian Radium & Uranium Corp.
Cleveland Metal Specialties Co., Electronics Div.
Croname Inc.
Crystal-X Corp.
Henry G. Dietz Co., Inc.
Duralith Corp.
Duramark, Inc.
Electrical Insulation Co., Inc.
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Fisher & Crome
Fouch Electric Mfg. Co., Inc.
George Gorton Machine Co.
Walter J. Hyatt Co., The
Walter K. Jaros Aircrafters
Keil Engrg. Products Inc.
Kerrco
Litho-Etch Metal Name Plate Co.
Jas. H. Matthews & Co.
Meyercord Co., The
Meyercord Co., The, AMC Div.
Mica Instrument Co.
*MINNESOTA MINING & MFG. CO.
Mullenbach Div.-Electric Machinery Mfg. Co.
Nameplates Inc
Nelson Electric Mfg. Co.
New England Etching Co. Inc.
Norsid Mfg. Co., Inc., The
North Shore Nameplate, Div.-Anodyne, Inc.
Panob Corp.
Park Nameplate Co., Inc.
Pee Cee Tape & Label Co., Inc.
Q-Circuits, Div.-Etching Co. of Calif.
Regal Air Corp.
Milton Ross Metals Co., The
D. A. Schultz Co.
Scioto Sign Co.
Sillcocks-Miller Co
Technical Ply-Woods Sales
Telectro Industries Corp.
Telkor, Inc.
Topflight Corp.
E. F. Twomey Co., Inc.
United States Radium Corp.
Virginia Plak Co.

NAVIGATION DOMES

Allied International Corp.
Allied Plastics Supply Corp.
Broodview Research Corp.
Lunn Laminates, Inc.
Northrop Corp.
Parsons Corp., Special Products Div.
Specialty Electronics Development Corp.
Swedlow Inc.
TRG, Inc.
Universal Unlimited, Inc

NAVIGATION EQUIPMENT, GROUND

Allied International Corp.
Belock Instrument Corp.
Bendix Aviation Corp

A. Biederman, Inc.
Broadview Research Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chance Vought Aircraft, Inc.
Allen B. Du Mont Labs., Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Gates Radio Co.
General Communication Co.
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Ordnance Dept.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
Guidance Controls Corp.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co.
Lear, Inc.
Madigan Corp.
W. L. Maxson Corp., The
Motorola, Inc.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Seiscor, Div.-Seismograph Service Corp.
Skiatron Electronics & Television Corp.
Specialty Electronics Development Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.
Texas Instruments Inc.
Virginia Electronics Co., Inc.
Westinghouse Electric Corp.
Wickes Engrg. & Construction Co.
Winder Aircraft Corp. of Florida

NAVIGATION SYSTEMS

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
ACF Industries Inc.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Allied International Corp.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Chance Vought Aircraft, Inc.
Communications Research Co.
Designers for Industry, Inc.
Douglas Aircraft Co., Inc.
Allen B. Du Mont Labs., Inc.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Edmund Scientific Co.
Electromation Co., Div.-Del Mar Engrg. Labs.
***EQUIPMENT DIV., RAYTHEON CO.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Fla. Aircraft Radio & Marine
Ford Instrument Co., Div.-Sperry Rand Corp.
GPL Div.-General Precision, Inc.
General Electric Co., Armament & Control Sect., Light Mil. Elec. Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Ordnance Dept.
General Instrument Corp., Defense & Engrg. Products Group
General Mills, Inc.
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollmorgen Optical Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lab. for Electronics, Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
Litton Industries, Inc.
Lockheed Electronics Co., Stavid Div.
Madigan Corp.
W. L. Maxson Corp., The
Minneapolis-Honeywell Regulator Co., Boston Div.
Motorola, Inc.
National Co., Inc.
Norden Div., United Aircraft Corp.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Packard-Bell Electronics Corp.
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Seiscor, Div.-Seismograph Service Corp.
Skiatron Electronics & Television Corp.
Specialty Electronics Development Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.
Tamar Electronics, Inc.
Texas Instruments Inc.
Thompson Ramo Wooldridge Inc.
Weems System of Navigation, Inc.
Westinghouse Electric Corp.

NEEDLES, DIAMOND

Electro-Voice, Inc.
Fidelitone, Inc.
Moser Jewel Co.

NEEDLES, METAL

Electronic Parts Mfg. Co., Inc.
Electro-Voice, Inc.
Fidelitone, Inc.
Moser Jewel Co.
Torrington Co., The

NETWORKS

a. Crossover
b. Directions Antenna Phasing
c. Matching
d. Potted
e. Pulse Forming

ACDC Electronics, Inc., **a, c, d, e.**
AMP Inc., **e.**
Anderson Labs., Inc., **e.**
Axel Electronics-Div.-Axel Bros. Inc., **e.**
Bendix Aviation Corp., **e.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **b. b.**
Chance Vought Aircraft, Inc., **e.**
Communication Accessories Co., **e.**
Cornell-Dubilier Electric Corp., **e.**
Corson Electric Mfg. Corp., **e.**
Crescent Engrg. & Research Co., **d.**
Dale Products, Inc., **c, d, e.**
Daven Co., The., **d, e.**
Djeco, Div.-Djordjevic Engrg. Co., **c, e.**
Dmeter Mfg. Co., **c, d.**
Double E Products Co., **a, c, d, e.**
Dynatronics, Inc., **e.**
Electronic Applications, Inc., **a.**
FXR, Inc., **e.**
Fidelitone, Inc.
Film Capacitors, Inc., **a, e.**
Filtron Co., Inc., **d, e.**
Foto-Video Labs., Inc., **e.**
Gates Radio Co., **b, c.**
General Electric Co., Apparatus Sales Div., **e.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **c.**
Lear, Inc., **d.**
Librascope Div., General Precision, Inc., **a, d, e.**
Lockheed Electronics Co., Stavid Div., **e.**
Madigan Corp., **a, b, c, e.**
Magnetic Research Corp., **e.**
***MARTIN CO., THE, DENVER DIV., c, d, e.**
Micamold Electronics Mfg. Corp., **e.**
Microphase Corp., **a, b, c.**
Milgo Electronic Corp., **e.**
James Millen Mfg. Co. Inc., **d.**
Motorola, Inc., **d.**
Northrop Corp.
Packard Bell Computer Corp., **e.**
Parkway Specialties Co., **a.**
Ralph M. Parsons Co., The, Electronics Div., **e.**
Plastic Capacitors, Inc., **e.**
Polyphase Instrument Co., **d, e.**
Radio Condenser Co., **c.**
***RADIO CORP. OF AMERICA., a thru e.**
Rantec Corp., **b, e.**
Republic Aviation Corp., Missile Systems Div., **b, c, d.**
Sangamo Electric Co., **e.**
Shallcross Mfg. Co., **c, d.**
Southwestern Industrial Electronics Co., **a, e.**
Special Products Dept., Melpar, Inc., **b.**
Sprague Electric Co., **e.**
Standard Electronics Div.-Reeves Instrument Corp., **b, c, e.**
Stephens Trusonic Inc., **a.**
Stewart-Warner Electronics Div., **e.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, e.**
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., **b.**
Tapco Group, Thompson Ramo Wooldridge Inc., **b.**
Telechrome Mfg. Corp., **a.**
Telex, Inc., **d, e.**
Thompson Ramo Wooldridge Inc., **b.**
University Loudspeakers, Inc., **a.**
Valor Instruments, Inc., **c, d, e.**
Varo Mfg. Co., Inc., **d, e.**
Walkirt Co., **d, e.**
White Instrument Labs., **d.**
Wickes Engrg. & Construction Co., **a.**

NICKEL

Accurate Specialties Co. Inc.
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Allied Research Products, Inc.
American Nickel Alloy Mfg. Corp.
American Silver Co., Inc.
American Smelting & Refining Co.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical Chemical Co.
Chromium Corp. of America
City Chemical Corp.
Wilbur B. Driver Co.
Driver-Harris Co.
Electric Steel Foundry Co.
Electronic Parts Mfg. Co., Inc.
Foote Mineral Co.
Gibson Electric Co.
Hughes Tool Co., Aircraft Div.
Huntington Alloy Products Div.-The International Nickel Co., Inc.
Secon Metals Corp.
Seymour Mfg. Co., The
Techalloy Co. Inc.
Udylite Corp., The
United Mineral & Chemical Corp.
Van Der Horst Corp of America
Var-Lac-Oid Chemical Co.
Wia Met Alloys Co.

NOSE CONES

Aerocal Div., Aeronca Mfg. Corp.
Aluminum Co. of America
American Latex Products Corp.
American Potash & Chemical Corp., National Northern Div.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Avco Corp.-Research & Advanced Development Div.
Beacon Steel Corp.
Bendix Aviation Corp.
Bendix Filter Div., Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
E. W. Bliss Co.
Bonny Mfg. Corp.
Brooks & Perkins, Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
A. M. Byers Co.
California Stamping & Mfg. Co.
Carborundum Co., The
Colorado Fuel & Iron Corp., The
Coors Porcelain Co.
Corning Glass Works
Custom Tool & Mfg. Co.
Dayton Rubber Co., The
Douglas Aircraft Co., Inc.
Eljay Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Garlock Packing Co.
General Electric Co., Missile & Space Vehicle Dept., Pa.
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
ITE Circuit Breaker Co., Special Products Div.
Ingersoll Kalamzoo Div., Borg-Warner Corp.
Kaiser Fleetwings, Inc.
Kanarr Corp.
C. B. Kaupp & Sons, Inc.
Kellett Aircraft Corp.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kling Metal Spinning & Stamping Co.
Lamtex Industries Inc.
.*LAVELLE AIRCRAFT CORP.
Le Fiell Mfg. Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Lodge & Shipley Co., The
Lycoming Div., Avco Corp.
Marquardt Corp., The
Mc Gregor Mfg. Corp.
Narmco Mfg. Co.
National Beryllia Corp.
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
Norton Co., New Products Dept.
Olympic Plastics Co., Inc.
Parsons Corp., Special Products Div.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Portland Copper & Tank Works Inc.
Prewitt Aircraft Co.
Raybestos-Manhattan, Inc.

Reynolds Metals Co., Sheffield Missile Plant
Seaman Products, Div.-Seaman Paper Co.
Solar Aircraft Co.
Spaceatomics Div., The Budd Co.
Spincraft, Inc.
Swedlow Inc.
Taylor Fibre Co.
Temco Aircraft Corp.
Thermionic Aeronautical Div.
H. I Thompson Fiber Glass Co.
G. W. Torngren Co., Inc.
Twin Coach Co., Aircraft-Missiles
Weatherhead Co., The
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micarta Div.
Young Development Div., Hercules Powder Co.

NOZZLE ASSEMBLIES

ACF Industries Inc.
Aerocal Div., Aeronca Mfg. Corp.
American Welding & Mfg. Co., The
Arde-Portland, Inc.
Arrowhead Products, Div.-Federal-Mogul Bower Bearings, Inc.
Atlantic Research Corp.
Auto Specialties Mfg. Co., Inc.
Avco Corp.-Research & Advanced Development Div.
B. H. Aircraft Co., Inc.
Beaton & Corbin Mfg. Co., The
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Brunswick Balke Collender Co., The, Defense Products Div.
Buckeye Iron & Brass Works
California Aircraft Products
Carborundum Co., The
Christie Machine Works
Continental Diamond Fibre Corp.
Delavan Mfg. Co.
Douglas Aircraft Co., Inc.
***EXCELCO DEVELOPMENTS INC.**
Ex-Cell-O Corp.
Fibercraft, Inc.
Garlock Packing Co.
General Electric Co., Rocket Engine Section
H & H Mfg. Co. Inc.
ITE Circuit Breaker Co., Special Products Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kaiser Fleetwings, Inc.
Kanarr Corp.
Kelsey-Hayes Co.
Kerns Mfg. Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lamtex Industries Inc.
Lear, Inc.
Lee Co., The
Le Fiell Mfg. Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Mc Gregor Mfg. Corp.
Napier Engines Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
Parts Engrg. Co., Inc.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Schellens-True Corp.
C. M. Smillie & Co.
Spaceatomics Div., The Budd Co.
Spraying Systems Co.
Thermionic Aeronautical Div.
H. I. Thompson Fiber Glass Co.
United Aircraft Products, Inc.
United States Chemical Milling Corp.
Vac-Hyd Processing Corp.
Wall Colmonoy Corp., Stainless Processing Div.
Water Cooling Corp.
Weatherhead Co., The
Western Design, Div.-U. S. Industries, Inc.
Young Development Div., Hercules Powder Co.

NOZZLE DIAPHRAGMS

ACF Industries Inc.
Bendix Aviation Corp.
Capital City Mfg. Co., Inc.
ITE Circuit Breaker Co., Special Products Div.
Kerns Mfg. Corp.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lee Co., The
Lycoming Div., Avco Corp.
Marquardt Corp., The
Mc Gregor Mfg. Corp.
Portland Copper & Tank Works Inc.
United Aircraft Products, Inc.
United States Chemical Milling Corp.
Water Cooling Corp.

NOZZLES

a. Exhaust
b. Exhaust, Metallic
c. Fuel Injection

ACF Industries Inc., **a, b, c.**
Aerocal Div., Aeronca Mfg. Corp., **a, b.**
***AEROJET-GENERAL CORP., a.**
Allison Div., General Motors Corp., **a, b.**
American Brake Shoe Co., **b.**
American Potash & Chemical Corp., National Northern Div., **a, b.**
American Welding & Mfg. Co., The., **a, b.**
Ampco Metal, Inc., **c.**
Anchor Metal Spinning Co., The., **b.**
Arde-Portland, Inc., **a, b.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **a.**
Associated Co., Inc., **a.**
Auto Specialties Mfg. Co., Inc., **a, b, c.**
Avco Corp.-Research & Advanced Development Div. **a, b.**
B. H. Aircraft Co., Inc., **a, b, c.**
Basic Tool Industries, Inc., **a.**
Bendix Aviation Corp., **a, c.**
Bendix Filter Div., Bendix Aviation Corp., **a, b.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., a, c.**
Bethlehem Steel Co., **a.**
Bruce Engrg. Co., **a, b.**
Brunswick Balke Collender Co., The, Defense Products Div., **a.**
California Aircraft Products., **a.**
California Stamping & Mfg. Co., **a.**
Capital City Mfg. Co., Inc., **a, b, c.**
Carbone Corp., The., **a.**
Carborundum Co., The
Carborundum Co., Refractories Div., **a.**
Christie Machine Works
Continental Diamond Fibre Corp., **a.**
Crane Co., Special Products Div., **a, b.**
Curtiss-Wright Corp.-Wright Aeronautical Div., **a.**
Delavan Mfg. Co., **c.**
Douglas Aircraft Co., Inc., **a, b.**
Eddington Metal Specialty Co., **c.**
***EXCELCO DEVELOPMENTS INC., a, b.**
Ex-Cell-O Corp., **c.**
Fibercraft, Inc., **a.**
Firth Sterling Inc., **a, b.**
Flexonics Corp., **a.**
Garlock Packing Co., **a.**
General Electric Co., Lamp Metals & Components Dept., **b.**
General Electric Co., Rocket Engine Section., **a, b.**
B. F. Goodrich Aviation Products., **a.**
Grand Central Rocket Co., **a.**
Graphite Metallizing Corp., **a.**
H & H Mfg. Co. Inc., **a, b.**
Hicks Corp., The. **b.**
Holley Carburetor Co., **c.**
Hupp Aviation Div.-Hupp Corp., **a.**
Ingersoll Kalamazoo Div., Borg-Warner Corp., **a.**
Kaiser Fleetwings, Inc., **a.**
Kanarr Corp., **a, b.**
C. B. Kaupp & Sons, Inc., **a.**
Kelsey-Hayes Co., **a, b.**
Kennametal Inc.
H. Kock & Sons., **a.**
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., **a, b.**
Kwikset Powdered Metal Products., **a.**
Ladish Co., **a, b.**
Lamtex Industries Inc., **a.**
***LAVELLE AIRCRAFT CORP., b.**
Lear, Inc., **c.**
Lee Co., The., **c.**
Le Fiell Mfg. Co., **b.**
Lockheed Aircraft Corp., Missiles & Space Div., **a.**
Lone Star Plastics Co. Inc., **a.**
Lycoming Div., Avco Corp., **a.**
MB Electronics., **c.**
Marquardt Corp., The., **a, b, c.**
***MARTIN CO., THE, DENVER DIV., a, b.**
Martin Machine Works, Inc., **c.**
Mc Gregor Mfg. Corp., **a, b.**
Metal Carbides Corp.
***MINNESOTA MINING & MFG. CO., a.**
Morganite, Inc., **a.**
NUMEC-Nuclear Materials & Equipment Corp., **a.**
Napier Engines Inc., **a, c.**
Narmco Mfg. Co., **a.**
National Carbon Co., Div.-Union Carbide Corp., **a.**
Norrich Plastics Corp.
Norrich Screw Machine Products
Norris-Thermador Corp., **a, b.**
Norton Co., New Products Dept., **a.**
Olympic Plastics Co., Inc., **a.**
Parker-Hannifin Corp., **c.**
Parts Engrg. Co., Inc., **a, b, c.**
Plastic Age Sales, Inc., **a.**
Portland Copper & Tank Works Inc., **a, b.**
Pressed Steel Tank Co., **a, b.**
Raybestos-Manhattan, Inc., **a.**
Rocketdyne Div.-North America Aviation, Inc., **a, c.**
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Russell Mfg. Co., **a.**
Simmonds Aerocessories, Inc., **c.**
C. M. Smillie & Co., **a, c.**
Solar Aircraft Co., **a, c.**
Spaceatomics Div., The Budd Co., **b.**
Spraying Systems Co.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp., **a, b.**
Stauffer Chemical Co.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co., **a.**
A. U. Stone & Co., Inc., **c.**
Synthane Corp., **a.**
Taylor Fibre Co., **a.**
Temco Aircraft Corp., **b.**
Therm, Inc.
Thermionic Aeronautical Div., **a, b.**
H. I. Thompson Fiber Glass Co., **a, b, c.**
C. W. Torngren Co., Inc., **a.**
United Aircraft Products, Inc., **a, b, c.**
United Carbon Products Co., **a.**
U. S. Pipe & Foundry Co., Steel & Tubes Div., **a, b.**
United States Chemical Milling Corp., **b.**
Water Cooling Corp.
***WEATHERHEAD CO., THE, c.**
Westinghouse Electric Corp., Micarta Div., **a.**
Young Development Div., Hercules Powder Co., **a.**

NUCLEAR

a. Analyzers, Coincidence
b. Analyzers, Neutron Absorption
c. Analyzers, Spectrum
d. Assemblies, Shield
e. Badges, Radiation
f. Controls, Reactor
g. Counters
h. Crystals
i. Detectors
j. Indicators, Radiation
k. Installations Facilities
l. Manipulators
m. Meters, Counting Rate
n. Meters, Dosimeter
o. Meters, Nuclear Radiation
p. Processors, Cataclystic Flow Rate
q. Pumps
r. Shielding, Lead
s. Shielding, Radiation
t. Tubes, Geiger Counter
u. Tubes, Scintillation

ACF Industries Inc., **d, r, s.**
Acromark Co., The., **e.**
Adept Industries Inc., **e.**
Advance Industries, Inc., **i.**
***AEROJET-GENERAL CORP., f, k.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., q.**
Allied Plastics Supply Corp., **s.**
Alloys Unlimited Inc., **r.**
Alpha Metals, Inc., **r.**
American Agile Corp., **s.**
American Electronics, Inc., **e, g, i, j, m, o, u.**
American Electronics, Inc., Nuclear Div., **g thru k, m, o.**
American Machine & Foundry Co., Government Products, N. Y., **f, m, r, s.**
American Potash & Chemical Corp., National Northern Div., **f.**
American Smelting & Refining Co., **r.**
American-Tradair Corp., **c, g, h, i, m, t.**
Amperex Electronic Corp., **t, u.**
Armament Div.-Universal Match Corp., **d.**
Automatic Switch Co., **f.**
Avco Corp.-Research & Advanced Development Div., **k.**
Baird-Atomic, Inc., **c, e thru i, m, n, p, t.**
Ball Brothers Research Corp., **g.**
Bar-Ray Products, Inc., **d, r, s.**
Bausch & Lomb Optical Co., **c.**
Beaver Precision Products Inc., **l.**
Bendix Aviation Corp., **c, d, f, g, i, j, l thru o.**
Bendix Aviation Corp., Cincinnati Div., **c, f, i, j, m, n, o.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., f.**
E. W. Bliss Co., **l.**
Broadview Research Corp.
Brooks & Perkins, Inc., **d, s.**
Budd Co., The., **k, r, s.**
A. M. Byers Co., **l, s.**
Byron Jackson Pumps, Inc., **q.**
Callery Chemical Co., **s.**
Carborundum Co., The., **s.**
Central Research Labs., Inc., **l.**
Compudyne Corp., **f.**
Consolidated Controls Corp.,
Corning Glass Works, **d, e, j, s.**

Datex Corp., **f.**
Daystrom, Inc., Controls Systems Div., **f.**
Daystrom, Inc., Military Electronics Div., **f.**
Designers for Industry, Inc., **c.**
Diamond Power Specialty Corp., **f, l.**
Division Lead Co., **r, s.**
Eastman Kodak Co., **e, j.**
Eberline Instrument Corp., **g, i, j, o.**
Edgerton, Germeshausen & Grier, Inc., **i, n.**
Thomas A. Edison Ind. Instrument Div.-Mc Gray-Edison Co., **f, i.**
Eldorado Electronics., **c, g.**
Electro Instruments, Inc., **g, m.**
Emerson & Cumings, Inc., **s.**
Engrg. Specialties., **m.**
Epsco Inc., **g.**
Ex-Cell-O Corp., **f, l.**
Fansteel Metallurgical Corp., **s.**
Firth Sterling Inc., **s.**
Flight Refueling, Inc., **f.**
Franklin Electronics Inc., **c.**
Furane Plastics, Inc., **r, s.**
General Mills, Inc., **l.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **s.**
W. R. Grace & Co., Davison Chem Div., Nuclear Reactor Mat. Plant., **s.**
Hammett-Mercury-Rex Div., **h.**
High Voltage Engrg. Corp., **c.**
Iconix Inc., **g, m.**
Industrial Equipment Div., Baldwin Lima Hamilton Corp., **l, r, s.**
Instrument Div., The Budd Co., **j, o.**
International Electronic Research Corp., **f, i, j, m, o.**
International Instruments Inc., **o.**
International Steel Co., **d, k, s.**
Interstate Electronics Corp., **a thru d, f thru k, m thru p, r thru u.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **e, l, o, r.**
Jan Hardware Mfg. Co., Inc., **s.**
Johns-Manville Sales Corp., **c, s.**
Keithley Instruments, Inc., **f.**
Kennametal Inc., **s.**
Kieley & Mueller, Inc., **f.**
Morris P. Kirk & Son, Inc., **d, r.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **b.**
Lavoie Labs., Inc., **c, g.**
Lear, Inc., **f.**
Leeds & Northrup Co., **f.**
Levinthal Electronic Products, Inc., **h.**
Madigan Corp., **a.**
Mc Gregor Mfg. Corp., **f.**
Metal Carbides Corp., **s.**
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., **f, m, o.**
Monsanto Chemical Co., **k.**
Mycalex Corp. of America, **s.**
NUMEC-Nuclear Materials & Equipment Corp., **f, g, i, j, k, m, o.**
National Carbon Co., Div.-Union Carbide Corp., **s.**
M. M. Newman Corp., **d, j, n, q, r, s.**
Norrich Plastics Corp., **d.**
Northrop Corp., **s.**
Norton Co., New Products Dept., **s.**
Nuclear Corp. of America., **a, i, j, m, n, o, t, u.**
Nuclear Development Corp. of America., **f, k, l, s.**
Nuclear Development Lab., **i, t.**
Nuclear Measurements Corp., **a, c, g thru j, m, n, o, t, u.**
Nuclear-Chicago Corp., **a, c, d, e, g thru j, m, n, n, o, r thru u.**
Ohmart Corp., The., **c, d, f thru k, m, n, o, t, u.**
Pacific Coast Engrg. Co., **l, r, s.**
Patterson Moos Research, Div.-Leesona Corp., **f, h thru k, n.**
Peerless Pump Div., Food Machinery & Chemical Corp., **q.**
Pegasus Labs., Inc., **f.**
Piasecki Aircraft Corp., **g, i, j, n, n, o.**
Pilot Chemicals, Inc., **h, i.**
Portland Copper & Tank Works Inc., **d, k, r, s.**
Precision Equipment Co., Inc., **f.**
Radiation Instrument Development Lab., Inc., **a, c, f, g, i, j, m, s, t, u.**
***RADIO CORP. OF AMERICA., t, u.**
Ray Proof Corp., **r, s.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., t.**
Riggs Nucleonics Corp., **i, j.**
St. John X-Ray Laboratory., **e.**
Sillcocks-Miller Co., **e.**
Space Corp., **k.**
Spaceatomics Div., The Budd Co., **d, s.**
Specialty Electronics Development Corp., **j, n, o.**
Stearns-Roger Mfg. Co., The., **k.**
A. U. Stone & Co., Inc., **f.**
Strand Engrg. Co., **o.**
Stromberg-Carlson Div.-General Dynamics Corp., **f.**
Sundstrand Turbo., **q.**
TRG, Inc., **s.**
Tapco Group, Thompson Ramo Wooldridge Inc., **f, q.**
Teleflex Inc., **f, l.**
Thompson Ramo Wooldridge Inc., **f, q.**
Tracerlab Inc., **a thru e, g, i thru o, r, s, t.**
Tung-Sol Electric, Inc., **i.**
United Aircraft Products, Inc., **d.**
United Shoe Machinery Corp., **f.**
U. S. Industries, Inc., **k.**
Vickers Inc., Electric Products Div., **f.**
Vickers, Inc., Mich., **f.**
Victoreen Instrument Co., **c, g thru j, m, n, o, t, u.**
Western Gear Corp.-Precision Products Div., **f.**
Western Union Telegraph Co., The.. **i.**
Westinghouse Electric Corp., **j, o, q.**
Westinghouse Electric Corp., Micarta Div., **s.**
N. Wood Counter Lab., **g, t, u.**
Worthington Corp., **q.**
Zippertubing Co., The., **r, s.**

NUCLEAR PRODUCTS

a. Analyzers, Coincidence
b. Analyzers, Neutron Absorption
c. Analyzers, Spectrum
d. Assemblies, Shield
e. Badges, Radiation
f. Chambers, Alpha
g. Counters, Alpha
h. Counters, Radiation
i. Counters, Scintillation
j. Crystal, Scintillation
k. Detectors, Scintillation
l. Equipment, Nuclear Radiation
m. Indicators, Radiation
n. Reactors
o. Spectrometers
p. Tubes, Gamma Ray
q. Tubes, Geiger Counter
r. Tubes, Scintillation

ACF Industries Inc., **d.**
Acromark Co., The., **e.**
Adept Industries Inc., **e.**
Aerojet-General Corp., **n.**
American Electronics, Inc., **e, h, i, k, l, p.**
American Electronics, Inc., Nuclear Div., **i thru l.**
American Machine & Foundry Co., Government Products, N. Y., **l, n.**
Amperex Electronic Corp., **p, q, r.**
Baird-Atomic, Inc., **a, d, e, g thru m, o thru r.**
Ball Brothers Research Corp., **i.**
Barry Electronics Corp., **i.**
Bausch & Lomb Optical Co.. **c, m, o.**
Bendix Aviation Corp., **c, h, k, m, n.**
Bendix Aviation Corp., Cincinnati Div., **c, h, l, m, o.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Braun-Knecht-Heimann Co., Industrial Div., **q.**
Broadview Research Corp.
Brooks & Perkins, Inc., **d.**
Budd Co., The, **l.**
Chicago Development Corp., **m.**
Coil Co. of America., **n.**
***CONSOLIDATED ELECTRODYNAMICS CORP., o.**
Corning Glass Works., **e, m.**
Curtiss-Wright Corp., Princeton Div., **k, l.**
Davidson Optronics, Inc., **o.**
Eberline Instrument Corp., **f thru i, k, l.**
Eldorado Electronics., **c.**
Hahn & Clay., **n.**
High Voltage Engrg. Corp., **l.**
Iconix Inc., **g, h, i.**
Industrial Div., Baldwin Lima Hamilton Corp., **l, n.**
Instrument Div., The Budd Co., **p.**
International Electronic Research Corp., **h, l, m.**
Interstate Electronics Corp., **a thru d, f thru r.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America., **e, g, h, i, l.**
Johns-Manville Sales Corp., **d.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **b, h, i, k, l, m.**
Lavoie Labs., Inc., **c.**
Lear, Inc., **n.**
Leeds & Northrup Co., **l.**
Levinthal Electronic Products, Inc., **j.**
Marquardt Corp., The., **n.**
Metal Carbides Corp., **d.**
NUMEC-Nuclear Materials & Equipment Corp., **h, l, m.**
National Carbon Co., Div.-Union Carbide Corp., **n.**
M. M. Newman Corp., **c.**
Northeastern Engrg. Inc., **c.**
Northrop Corp.
Nuclear Corp. of America, **c, f thru m, o thru r.**
Nuclear Development Corp. of America., **n.**
Nuclear Development Lab., **g, h, p, q.**
Nuclear Measurements Corp., **f thru m, o thru r.**
Nuclear-Chicago Corp., **a, c thru r.**
Ohmart Corp., The, **c, f thru m, o thru r.**
Pacific Coast Engrg. Co., **n.**
Patterson Moos Research, Div.-Leesona Corp., **e, l, m, n.**
Philips & Davies Inc., **n.**
Philips Electronic Instruments, **i, k, q, r.**
Piasecki Aircraft Corp., **h, i, k, m.**
Pilot Chemicals, Inc., **i, j, k.**
Portland Copper & Tank Works Inc., **d, n.**
Precision Equipment Co., Inc.
Production Research Corp., Sub.-Radio Condenser Co., **c, o.**
Radiation Instrument Development Lab., Inc., **a, c, h thru m, o, q.**
***RADIO CORP. OF AMERICA, p, q, r.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **b.**
Ray Proof Corp., **d.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., p.**
Research Indsl. Lab. of Electronics, **g.**
Resitron Labs., Inc., **p.**
Riggs Nucleonics Corp., **m.**
St. John X-Ray Laboratory, **e.**
Semi-Elements, Inc., **j.**
Sillcocks-Miller Co., **e.**
Spaceatomics Div., The Budd Co., **d.**
Specialty Electronics Development Corp., **l, m.**
Telechrome Mfg. Corp., **g, h, i, k, l.**
Tracerlab Inc., **a thru m, o thru r.**
Victoreen Instrument Co., **c, g thru m, o thru r.**
Westinghouse Electric Corp., **h, m, n.**
N. Wood Counter Lab., **h, i, p, q, r.**
Zippertubing Co., **The, d.**

NUTS, SELF-LOCKING

Abbot Screw & Mfg. Co.
Aero Spares, Inc.
Aerotron Supply Co.
Airhardware, Inc.
All Specs Corp.
Alvo Nut & Bolt Co., Inc.
Atlas Screw & Specialty Co.
Autoscrew Co., Inc.
Aviation Textile Associates
Best Aircraft Corp.
Boots Aircraft Nut Corp.
Central Screw Co.
Cherry Rivet Div.-Townsend Co.
Collins Mfg. Corp.
Delron Co., Inc., The
R. C. Dudek & Co.
Eaton Mfg. Co., Reliance Div.
Elastic Stop Nut Corp. of America
George K. Garrett Co., Inc.
Grip Nut Co.
H. M. Harper Co.
Jacobson Nut Mfg. Corp.
Jan Hardware Mfg. Co., Inc.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
Klincher Locknut Corp.
Mercury Air Parts Co., Inc.
J. I Morris Co.
National Screw & Mfg. Co., The
Nylok Corp., The
Ohlson Empire Inc.
Prestole Corp.
Republic Steel Corp.
Shur-Lok Corp.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Tinnerman Products, Inc.
United Supply Co.
Voi-Shan Mfg. Co., Div.-Voi-Shan Industries, Inc.

OMNIRANGE

Allied International Corp.
Bendix Aviation Corp.
Broadview Research Corp.
Collins Radio Co.
General Instrument Corp., Defense & Engrg. Products Group
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Litton Industries, Maryland Div.
Motorola, Inc.
National Co., Inc.
Radalab Inc.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Tamar Electronics, Inc.
Telectro Industries Corp.

OMNIRANGE RECEIVERS

Allied International Corp.
Bendix Aviation Corp.
Broadview Research Corp.
Collins Radio Co.
Fla. Aircraft Radio & Marine

General Instrument Corp., Defense & Engrg. Products Group
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc
Litton Industries, Maryland Div.
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Tamar Electronics, Inc.
Telectro Industries Corp.

OPTICAL EQUIPMENT & SPECIALTIES

Acme Industrial Co.
American Cystoscope Makers, Inc
American Machine & Foundry Co., Government Products, N. Y.
American Optical Co., Instrument Div
American Optical Co., Safety Products Div.
*ASKANIA-WERKE, U. S. BRANCH OFFICE
Atlantic Research Corp.
Ball Brothers Research Corp.
Bausch & Lomb Optical Co.
Brunson Instrument Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Cartriseal Corp.
*CONSOLIDATED ELECTRODYNAMICS CORP.
Corning Glass Works
Data Instruments Div.,-Telecomputing Corp.
Davidson Optronics, Inc.
Dell Optics Co., Ltd.
*DEL MAR ENGRG. LABS.
Device Development Corp.
Du Kane Corp.
Eastman Kodak Co.
Elgeet Optical Co., Inc.
*ENGIS EQUIPMENT CO.
J. W. Fecker Div., American Optical Co.
Fenske, Fedrick & Miller Inc.
General Electric Co., Missile & Space Vehicle Dept. Pa.
Gordon Enterprises
Grimes Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
W. & L. E. Gurley
Kollmorgen Optical Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Leetronics, Inc.
Lenox Instrument Co.
Librascope Div., General Precision, Inc.
New England Scientific Instruments Co.
Northorp Corp.
Nortronics, Div.-Northrop Corp.
Nuclear Development Corp. of America
Optical Coating Lab., Inc.
Optical Gaging Products, Inc.
Pacific Optical Corp., Div.-Chicago Aerial Industries
Parker-Hartford Corp., The
Perkin-Elmer Corp.
Precision Lapping Co. Inc.
Radalab Inc.
Seiscor, Div.-Seismograph Service Corp.
Sterling Glass Corp.
Texas Instruments Inc.
H. I. Thompson Fiber Glass Co.
Tinsley Labs., Inc
Viewlex, Inc.
Warren-Knight Co.
Wollensak Optical Co.
Zenith Optical Laboratory

OSCILLATORS

a. Audio
b. Cavity
c. Code
d. Crystal
e. Grid Dip-High Frequency & VHF
f. Microwave
g. Oven Crystal Control
h. Pulse
i. Pushbutton
j. RF
k. Strain-Gage
l. Sweep
m. Tuning Fork
n. Ultra-Low Frequency
n. Ultra-Low Frequency
o. Ultrasonic
p. Video Pattern
q. Video Range

ACF Electronics Div., ACF Industries Inc., **f.**
ACF Industries Inc., **f.**
Adler Electronics, Inc., **f.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **j.**
Aircom Inc., **f.**
Aircraft Instruments Co., **h.**
Alfred Electronics., **f.**
Amerac Inc., **f, e, f, h, h.**
American Missile Products Co., Inc., **a, j.**
Arkay Engrg., Inc., **d, h.**
Avo Ltd., **j.**
B & K Instruments, Inc., **a.**
Bendix Aviation Corp., **f, o.**
James G. Biddle Co., **m.**
Branson Instruments, Inc., **o.**
Bruno-New York Industries Corp., **f, j.**
Bud Radio, Inc., **c.**
Budd Lewyt Electronics, Inc., **a, b, f, h, j, l, n.**
Bulova Watch Co., Electronics Div., **d, g, n, o.**
Burr-Brown Research Corp., **a, o.**
CG Electronics Corp., **h.**
CGS Labs., Inc., **b, f.**
Carol Electronics Corp., **e.**
Chalco Engrg. Corp., **a, n.**
Clevite Ordnance, Div.-Clevite Corp., **a, d, o.**
Collins Radio Co., **a, j.**
Communication Measurements Lab., Inc., **a.**
Control Electronics Co., Inc., **b, f.**
Crosby-Teletronics Corp., **i.**
Dage Television Div., Thompson Ramo Wooldridge, Inc., **p.**
Data-Control Systems, Inc., **k.**
Daven Co., The., **a, d, g thru j, o, p, q.**
Joe Davidson & Associates., **a, m, o.**
*DEL MAR ENGRG. LABS., **d.**
Diamond Antenna & Microwave Corp., **b, d, f, j.**
Djeco, Div.-Djordjevic Engrg. Co., **h.**
Dorne & Margolin, Inc., **d.**
Dorsett Electronic Labs., Inc., **k.**
Douglas Microwave Co., Inc., **b, f.**
Dynatronics, Inc., **d, f, h, j.**
Electronic Applications, Inc., **a, b, f, o, p, q.**
Electro-Pulse, Inc., **h.**
Elin Div., International Electronic Research Corp., **a.**
Empire Products Sales Corp., **b, f, h, n.**
*EQUIPMENT DIV., RAYTHEON CO., **f, h, o.**
FXR, Inc., **f.**
Ferrotran Electronics Co., Inc., **j.**
Fia Aircraft Radio & Marine
Foto-Video Labs., Inc., **p.**
Gates Radio Co., **d, g, j.**
General Communication Co., **f.**
General Devices, Inc., **a thru q.**
General Instrument Corp., Defense & Engrg. Products Group., **a, b, e, f, j, n, o.**
General Radio Co., **a, d, f, j, l, m, n.**
John Gombos Co., Inc., **b, f.**
Guided Missile Div., The Firestone Tire & Rubber Co., **d.**
Gyrex Corp., The., **a, m.**
Hallamore Electronics Co., Div.-Seigler Corp., **j.**
Hallicrafters Co., The., **f.**
Hammarlund Mfg. Co., The., **a.**
Hammett-Mercury-Rex Div., **d, f.**
Hathaway Instruments, Inc., **m.**
Hewlett-Packard Co., **a, b, d, f, j, l, n.**
Hicko Electrical Instrument Co., The., **a, e, h.**
Hill Electronics, Inc., **a, d, g, n.**
Hoover Electronics Co., **k.**
ITI Electronics, Inc., **a.**
Iconix Inc., **h.**
Industrial Test Equipment Co., **a, m.**
Industron Corp., **l.**
Instrument Div., The Budd Co., **k.**
Instrument Labs., **a.**
Instruments for Industry, Inc., **i, j, l.**
*INTERELECTRONICS CORP., **a.**
International Electronic Research Corp., **a, k.**
J-V-M Microwave Co., **b, f, j.**
Kay Electric Co., **a, f, h, j, l, n thru q.**
Wayne Kerr Corp., **a, j.**
Keystone Electronics Co., The., **d.**
James Knights Co., The., **a, d, g, n, o.**
Lab. for Electronics, Inc., **b, d, f.**
Lampkin Labs., Inc., M.R. Div., **j.**
La Pointe Industries Inc., **a, b, d, f.**
Lear, Inc., **a, d, i, j, l.**
Levinthal Electronic Products, Inc., **f, h.**
Ling Electronics Div.-Ling-Altec Electronics, Inc., **l.**
Litton Industries, Inc., **f.**
Manson Labs., Inc., **d, f, g, j.**
Marconi Instruments., **d, j, n.**
*MARTIN CO., THE, DENVER DIV., **c.**
Mc Kenna Labs., **o.**
Micro Gee Products, Inc., **a, d, l.**
Microwave Associates, Inc., **f.**
James Millen Mfg. Co. Inc., **e, j.**
Motorola, Inc., **a thru j, l, m, o, q.**
Muirhead Instruments Inc., **a, m, n.**
Nardo Ultrasonics Corp., The., **o.**
National Co., Inc., **a thru i, n.**
Navigation Computer Corp., **h.**
Ernest Norrman Laboratories., **d.**
Northrop Corp.
Pacific Mercury Electronics., **a.**
Packard Bell Computer Corp., **h.**
Paco Electronics Co., Inc., **a, n, o.**
Palmer Instruments., **d, g.**
Philamon Labs. Inc., **m.**
Philco Corp.-Govt. & Industrial Group., **a, f, h, j, k, l, p, q.**
Piasecki Aircraft Corp., **a, d, e, f, i, j, o.**
Piezo Crystal Co., **d, g.**
Pitometer Log Corp., **b, f, g, j.**
Polarad Electronics Corp., **b, f, l.**
Polytechnic Research & Development Co., Inc., **b, f.**
Precise Development Corp., **a, j**
Projects Unlimited, Inc., **e.**
Radalab Inc., **a thru e, i.**
Radiation, Inc., **b, f, j, n.**
Radiation Instrument Development Lab., Inc., **h.**
Radio City Products Co. Inc., **h, j.**
Radio Condenser Co., **j, n, o.**
*RADIO CORP. OF AMERICA., **a thru f, h, j, l thru q.**
Radio Development & Research Corp., **o.**
Radio Frequency Co., Inc., **o.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **a, b, e, f, j, n, o.**
Rantec Corp., **f, j.**
Reeves-Hoffman Div., **a, d, e, g, h, j, n, o.**
Republic Aviation Corp., Missile Systems Div.
Resdel Engrg. Corp., **b, j.**
Riverbank Labs., Dept.-Engrg., **m.**
Sanders Associates, Inc., **f.**
Scientific-Atlanta, Inc., **f, j, m.**
Secode Corp., **a, c, h.**
Servo Consultants Ltd., **n.**
Sierra Electronic Corp., Div.-Philco Corp., **f.**
Southwest Research Institute, **n.**
Southwestern Industrial Electronics Co.
Specialty Electronics Development Corp., **a, f.**
Spectralab Instruments, **b, e, f, j.**
Sperry Electronic Tube Div., Sperry Rand Corp., **f.**
Stewart-Warner Electronics Div., **b, c, f, h, m.**
H. W. Sullivan Ltd., **a, b, e, m.**
Sunshine Scientific Instrument, **m.**
Superior Electric Co., The, **h, o.**
TRG, Inc., **b, f.**
Tamar Electronics, Inc., **b, d, f, j.**
Technical Materiel Corp., The, **g.**
Telechrome Mfg. Corp., **f, p, q.**
Telex, Inc., **a.**
Tel-Instrument Electronics Corp., **g, j, l.**
Telkor, Inc., **a.**
Telonic Industries, Inc., **a, d, h, j, l.**
Universal Transistor Products Corp., **h.**
Valpey Crystal Corp., **a, d, g, n.**
Vari-L Co., Inc., **l.**
Varo Mfg. Co., Inc., **a, m.**
Victor R. F. & Microwave Co., **f.**
Video Instruments Co., Inc., **k.**
Virginia Electronics Co., Inc., **a, d, g, j.**
Voi-Shan Electronics, **a, j.**
Walkirt Co., **d, h, m.**
Waltham Electronics Corp., **g, j.**
Wang Labs., Inc., **h.**
Wickes Engrg. & Construction Co., **a.**

OSCILLOGRAPHS

a. Cathode Ray
b. Cathode Ray Camera
c. Cathode Ray Recording, Multi-Channel
d. Direct Writing
e. Multi-Channel
f. Multi-Element
g. Portable
h. Projection
i. Radar
j. Recording
k. Transient Study

Action Laboratories Inc., **i.**
Allegany Instrument Co., Inc., **b.**
American Instrument Co., Inc., **a.**
Brush Instruments, Div.-Clevite Corp., **d, e, j.**
Central Research Labs., Inc., **e, k.**
Century Electronics & Instruments, Inc., **d, e, f.**
*CONSOLIDATED ELECTRODYNAMICS CORP., **a thru g, j.**
Daven Co., The, **a.**
Designers for Industry, Inc., **d, i, k.**
Allen B. Du Mont Labs., Inc., **a, b, c, e thru k.**
Eastman Kodak Co., **b, h, j.**
Electro-Medical Lab., Inc., **d.**
Electronic Tube Corp., **a, b, c, e.**
Epic, Inc., **e, g, j.**
Foto-Video Labs., Inc., **i.**
General Electric Co., Apparatus Sales Div., **a, g, j.**
Gordon Enterprises, **a thru g, i, j.**
Hammett-Mercury-Rex Div., **a, b, c.**
Hathaway Instruments, Inc., **a, c, e, f, j, k.**
Hewlett-Packard Co., **a.**
ITI Electronics, Inc., **a, g.**

Massa Div.-Cohu Electronics, Inc., **d thru g, j, k.**
Midwestern Instruments, Inc., **d thru g, j.**
James Millen Mfg. Co. Inc., **a, g.**
Minneapolis-Honeywell, Heiland Div., **d thru g, j, k.**
Motorola, Inc., **i.**
National Scientific Labs., Inc., **a.**
New England Scientific Instruments Co., **c, d, e, k.**
Northrop Corp.
Offner Electronics Inc., **d thru g, j, k.**
Optomechanisms Inc., **b.**
Paco Electronics Co., Inc., **a.**
Philco Corp.-Govt. & Industrial Group, **a, b, e, g, i**
Photron Instrument Co., **d thru g, j.**
Precise Development Corp., **a.**
Radalab Inc., **i.**
Scientific-Atlanta, Inc., **e.**
Southwestern Industrial Electronics Co., **e, g, j.**
Technology Instrument Corp., **j.**
Tektronix, Inc., **a, b, k.**
Telectro Industries Corp., **a, d, e, g, j.**
Viewlex, Inc., **g, j.**
Wollensak Optical Co., **b.**

OSCILLOSCOPES

a. Cathode Ray
b. Cathode Ray-Multiple Channel
c. Portable
d. Portable Projection

Allen Electric & Equipment Co., **a, c.**
American Electronic Labs., Inc., **a, b.**
American Instrument Co., Inc., **a.**
Armament Div.-Universal Match Corp., **b.**
Blonder-Tongue Labs. Inc., Special Products Div., **d.**
Daven Co., The, **a, c.**
Allen B. Du Mont Labs., Inc., **a thru d.**
Edgerton, Germeshausen & Grier, Inc., **a.**
Electro Instruments, Inc., **c.**
Electronic Measurements Corp., **a.**
Electronic Tube Corp., **a, b, c.**
Electronics of Clearfield, Inc., **a.**
Foto-Video Labs., Inc., **a.**
Hammett-Mercury-Rex Div., **a, b.**
Hewlett-Packard Co., **a, b.**
Hickok Electrical Instrument Co., The, **a, b, c.**
I-L-S Instrument Div., The Meriam Instrument Co., **c.**
I-T-I Electronics, Inc., **a.**
Kingston Electronics-Div.-Kingston Industries Inc., **a, c.**
Lavoie Labs., Inc., **a, b.**
Levinthal Electronic Products, Inc., **b.**
Marconi Instruments, **a, c.**
James Millen Mfg. Co. Inc., **a, c.**
Moran Instrument Corp., **a.**
Paco Electronics Co., Inc., **a.**
Philco Corp.-Govt. & Industrial Group, **a thru d.**
Pioneer Industries Div., Almar-York Co. Inc., **a, c.**
Precise Development Corp., **a, b, c.**
Probescope Co. Inc., **a, b.**
Radalab Inc., **a, c, d.**
***RADIO CORP. OF AMERICA, a, c.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS,**
Railway Communications, Inc., **b.**
Scopes Co., Inc., The, **a, b, c.**
Sierra Electronic Corp., Div.-Philco Corp., **a, b.**
Simpson Electric Co., **a, c.**
Skiatron Electronics & Television Corp., **a.**
Specialty Electronics Development Corp., **a.**
Tektronix, Inc., **a, b, c.**
Telectro Industries Corp., **a, b.**
Waters Mfg., Inc., **a.**
Winder Aircraft Corp. of Florida, **a, b.**

OUTLETS, ANTENNA

Alden Products Co.
Allied International Corp.
American Brass Co., The
Blonder-Tongue Labs., Inc.
Chance Vought Aircraft, Inc.
Javex Electronics
Norrich Screw Machine Products
Radalab Inc.
Rantec Corp.

OVENS

a. Crystal
b. Environmental Testing
c. Infrared Drying
d. Temperature Controlled

American Electronic Labs., Inc., **a.**
American Instrument Co., Inc., **b, d.**
American Research Corp., **b, d.**
Andersen Labs., Inc., **d.**
Arkay Engrg., Inc., **d.**
Associated Testing Labs., Inc., **b, d.**
Auto-Control Labs. Inc., **a thru d.**
Rex Bassett, Inc., **a.**
Binks Mfg. Co., **c.**
Blue M Electric Co., **b, d.**
Brunswick Balke Collender Co., The, Defense Products Div., **d.**
California Stamping & Mfg. Co., **d.**
Chempump Div., Fostoria Corp., **c.**
Cincinnati Cleaning & Finishing Machinery, **c, d.**
Circo Equipment Co., **d.**
Circo Ultrasonic Corp., **d.**
Clark Crystal Co., **a.**
Cosmic Instruments Inc., **a.**
Cox & Co., Inc., **a.**
Designers for Industry, Inc., **a.**
Despatch Oven Co., **b, d.**
Development Engrg. Co., Inc., **b, d.**
Farwest Mfg. Div., Inc., **c.**
Fisher Scientific Co., **c, d.**
Fisher Scientific Co., Maryland, **d.**
Fostoria Corp., Infra-Red Div., **c.**
Gardner Laboratory, Inc., **a thru d.**
Hathaway Instruments, Inc., **d.**
C. I. Hayes, Inc., **d.**
Hevi-Duty Electric Co., Div.-Basic Products Corp., **a, b, d.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., **a, b, d.**
A. F. Holden Co., The, **c, d.**
Hunt Corp., The, **a, d.**
Huppert, K. H., Co., **d.**
Industrial Systems Co., **d.**
***ITEMCO, INC., b, d.**
Keystone Electronics Co., The, **a, d.**
Kirk & Blum Mfg. Co., The, **d.**
Labline, Inc., **b, d.**
Lavoie Labs., Inc., **a, d.**
Lucifer Furnaces Inc., **d.**
Magnetic Controls Co., **a, d.**
R. C. Mahon Co., The, **b, d.**
Manson Labs., Inc., **a.**
Mc Coy Electronics Co., **a.**
Miskella Infra-Red Co., The, **c.**
Motorola, Inc., **a.**
Murphy & Miller Inc., **b, d.**
National Co., Inc., **a, d.**
Northeast Metals Industries, Inc., **b.**
Northern Engrg. Laboratories, Inc., **a, d.**
Palmer Instruments, **a, d.**
Phoenix Products Co., **d.**
Piezo Crystal Co., **a.**
Pimex, Inc., **d.**
Pioneer Industries Div., Almar-York Co. Inc.m **b, d.**
Portland Copper & Tank Works Inc., **b.**
Premier Research Laboratories, Inc., **a, d.**
REF Mfg. Corp., **d.**
Edw. Renneburg & Sons Co.
Research, Inc., **b, c, d.**
Robertshaw-Fulton Controls Co., A & I Div., **a.**
Roto Finish-Ransohoff, **c, d.**
Selas Corp. of America, **d.**
Special Products Dept., Melpar, Inc., **d.**
State Testing Laboratory Inc., **b, c, d.**
Statham Development Corp., **b.**
Statham Instruments, Inc., **b, d.**
Steiner-Ives Co., **a, d.**
F. J. Stokes Corp., **a thru d.**
Temperature Engrg. Corp., **b, c, d.**
Tenney Engrg., Inc., **b, d.**
Thermionic Products Co., **d.**
Therman Mfg. Co., **b, d.**
Twix Mfg. Co., Inc., **b.**
United States Testing Co., Inc., **b.**
Valpey Crystal Corp., **a.**
Valverde Labs., **d.**
Veeco Vacuum Corp., **d.**
Waltham Electronics Corp., **a.**
Webber Engrg. Corp., **b, d.**
Webber Mfg. Co., Inc., **b, d.**
Young Brothers Co., **d.**

OXIDE, ALUMINUM

Aluminum Co. of America
American Smelting & Refining Co.
Carborundum Co., The
Carborundum Co., Refractories Div.
City Chemical Corp.
Corning Glass Works
Delta Chemical Works, Inc.
Fisher Scientific Co.
Gulton Industries, Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Monsanto Chemical Co.
National Beryllia Corp.
Norton Co., New Products Dept.
Olin Mathieson Chemical Corp., N. Y.
Portland Copper & Tank Works Inc.
Reynolds Metals Co.
Semi-Elements, Inc.
Supreme Indsl. Products Co
Thor Ceramics, Inc
Topper Mfg. Co., Inc.
United Mineral & Chemical Corp.
Vascoloy-Ramet Corp.
Western Gold & Platinum Co.

OXIDIZERS

Allied Chemical Corp., General Chemical Div.
Allied Chemical Corp., Nitrogen Div.
American Potash & Chemical Corp.
American Rocket Co.
Hughes Tool Co., Aircraft Div.
Hummel Chemical Co., Inc.
Martin Machine Works, Inc.
Olin Mathieson Chemical Corp., N. Y.
Pennsalt Chemicals Corp.
Southwest Research Institute
Stauffer Chemical Co.

OXYGEN APPARATUS & BREATHING EQUIPMENT

Accessory Products Co., Div.-Textron Inc.
Acushnet Process Co.
Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Airborne Research & Development Corp.
American Latex Products Corp.
Aro Equipment Corp., The
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
A. Biederman, Inc.
Essex Mfg., Co., Inc.
Fluid Power Inc.
Futurecraft Corp.
General Electric Co., Missile & Space Vehicle Dept. Pa.
Hardman Tool & Engrg., Co.
Hofman Labs., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
Mine Safety Appliances Co.
Mira Corp., The
J. J. Monaghan Co., Inc.
National Cylinder Gas, Div.,-Chemetron Corp.
National Welding Equipment Co.
Ohio Chemical & Surgical Equip. Co., Div.-Air Reduction Co., Inc.
Oxygen Equipment & Service Co.
Puritan Aerospace Div.-Puritan Compressed Gas Corp.
Robbins Aviation, Inc.
Fred T. Roberts & Co.
Robertshaw-Fulton Controls Co., A & I Div.
Ronan & Kunzl, Inc., Cryogenic Div.
Scott Aviation Corp.
Sierra Engrg. Co.
Standard Steel Corp., Cambridge Div.
Sun Electric Corp., Aeronautical Div.
Superior Air Products Co.
United Electric Controls Co.
Wells Industries Corp.
Zep Aero

OXYGEN SYSTEMS & CONTROLS

Accessory Products Co., Div.-Textron Inc.
Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Airborne Research & Development Corp.
Aro Equipment Corp., The
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
A. Biederman, Inc.
Components Corp.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Cryogenerators, Inc.
Custom Component Switches Inc.
R. E. Darling Co., Inc.
Ellison Draft Gage Co., Inc.
Fluid Power Inc
B. H. Hadley, Inc.
Haskel Engrg. & Supply Co.
Hofman Labs., Inc.
Walter J. Hyatt Co., The
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kieley & Mueller, Inc.
Lear, Inc.
Linde Co., Div.-Union Carbide Corp.
Liquid Carbonic Div.-General Dynamics Corp.
***MARTIN CO., THE, DENVER DIV.**
Meletron Corp.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Missiles Equipment Div.
National Cylinder Gas, Div.,-Chemetron Corp.
National Welding Equipment Co.
Ohio Chemical & Surgical Equip. Co., Div.-Air Reduction Co., Inc.
On Mark Couplings, Inc.
Oxygen Equipment & Service Co.
Pneu-Hydro Valve Corp.

Puritan Aerospace Div.-Puritan Compressed Gas Corp.
Research Controls
Robbins Aviation, Inc.
Robertshaw-Fulton Controls Co., A & I Div.
Ryan Industries, Inc., Dept. M.
Scott Aviation Corp.
Sierra Engrg. Co.
Standard Steel Corp., Cambridge Div.
Stearns-Roger Mfg. Co., The
Superior Air Products Co.
Ultra-Violet Products, Inc.
United Electric Controls Co.
Vinson Mfg. Co. Inc.
Wells Industries Corp.
Zep Aero

PACK SETS

American Latex Products Corp.
Dage Television Div., Thompson Ramo Wooldridge Inc.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Motorola, Inc.
National Co., Inc.
Seiscor, Div.-Seismograph Service Corp.
Winder Aircraft Corp. of Florida

PACKAGING, ELECTRONIC EQUIPMENT, SERVICE ONLY

Advance Instrument Corp.
American Latex Products Corp.
American Missile Products Co., Inc.
Anderson, Greenwood & Co.
Bearing Inspection, Inc.
Bernco Engrg. Corp.
Calcor Corp.
Camerflex Div., The, Federal Mfg. & Engrg. Corp.
Cleveland Metal Specialties Co., Electronics Div.
Commercial Services Co., Inc.
Crystal-X Corp.
Datascan Inc.
Dayton Aircraft Products, Inc.
Delco Radio Div.-General Motors Corp.
***DEL MAR ENGRG. LABS.**
Designers For Industry, Inc.
Farwell Metal Fabricating
Fenwal Inc.
General Box Co.
General Logistics Div., Aeroquip Corp.
Goldsman
Halliburton, Inc.. Mfg. Div.
Hoover Electronics Co.
Johnson Electronics Inc.
Lab. For Electronics, Inc.
Lear, Inc.
W. D. Long Packaging Co.
Lyon Aircraft Services
Lyon Van & Storage Co., Aircraft Div.
Magee-Bralla & Associates
***MARTIN CO., THE, DENVER DIV.**
Mutron Corp.
Northeast Metals Industries, Inc.
Northrop Corp.
Owens-Corning Fiberglas Corp.
Pak-Rapid, Inc.
Philco Corp.-Govt. & Industrial Group
Reed Research Inc.
Roberts Industries Inc.
Skydyne, Inc.
Special Products Dept., Melpar, Inc.
Specialty Electronics Development Corp.
Technical Materiel Corp., The
Telkor, Inc.
Temco Aircraft Corp.
Topper Mfg. Co., Inc.
Virginia Electronics Co., Inc.
Western Coil & Electrical Co.
Wickes Engrg. & Construction Co.
Winder Aircraft Corp of Florida
Zero Mfg. Co.

PACKAGING MATERIALS

***AEROJET-GENERAL CORP.**
Air Logistics Corp.
American Felt Co.
American Latex Products Corp.
Armour Alliance Industries
Armstrong Cork Co.
Bemis Bro. Bag Co.
Bestcraft Products Co. Inc.
Blossom Mfg. Co. Inc.
Borden Chemical Co.
Bostrom Corp.
Commerical Services Co., Inc.
Container Labs., Inc.
Corrugated Paper Products, Inc.
Crystal-X Corp.
Daubert Chemical Co.
Joe Davidson & Associates
Dayton Aircraft Products, Inc.
Dow Chemical Co., The
Emerson & Cuming, Inc.
Fidelity Chemical Products Corp.
Gatewood Products, Inc.
B. F. Goodrich Sponge Products
Halliburton, Inc., Mfg. Div.
Hinde & Dauch Div.-West Virginia Pulp & Paper
International Steel Co.
Isocyanate Products, Inc.
Lyon Van & Storage Co., Aircraft Div.
P. R. Mallory & Co. Inc.
***MARTIN CO., THE, DENVER DIV.**
Martin Machine Works, Inc.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Molded Insulation Co.
Monsanto Chemical Co.
Naz-Dar Co.
Nopco Chemical Co., Plastics Div.
Olin Mathieson Chemical Corp., N. Y.
Owens-Corning Fiberglas Corp.
Plastic Film Co., Inc.
Pry Welding & Mfg. Inc.
Reed Research Inc.
Reynolds Metals Co.
Reynolds Metals Co., Plastics Div.
Seal-Peel, Inc.
Sillcocks-Miller Co.
Skydyne, Inc.
Thiokol Chemical Corp., Hunter-Bristol Div.
H. I. Thompson Fiber Glass Co.
Topper Mfg. Co., Inc.
United Mineral & Chemical Corp.
United States Rubber Co.
Western Coating Co.
Zophar Mills Inc.

PAINT, METALLIC

Bart Mfg. Corp.
Bel Fuse Inc.
Better Finishes & Coatings Inc.
Carboline Co.
Dennis Chemical Co.
Felton-Sibley & Co., Inc.
Kish Industries, Inc.
Krylon, Inc.
Mass & Waldstein Co.
Metaplast Co., Inc.
Micro-Circuits Co.
Midland Industrial Finishes Co.
Midland Paint & Varnish Co., The
Naz-Dar Co.
Protex-A-Cote, Inc.
Raffi & Swanson, Inc.
Rust-Oleum
Standard-Toch Chemicals, Inc.
Tempil Corp.
Thompson & Co.
Vita-Var Corp.
Wilbur & Williams Co., Inc., The

PAINTS

Arco Co., The
Avondale Co., The
Better Finishes & Coatings Inc.
Bjorksten Research Labs. For Industry, Inc.
Borden Chemical Co.
Carboline Co.
Dennis Chemical Co.
Felton-Sibley & Co., Inc.
Goodyear Tire & Rubber Co., The, Aviation Products Div.
Kish Industries, Inc.
Krylon, Inc.
Maas & Waldstein Co.
Micro-Circuits Co.
Midland Paint & Varnish Co., The
***MINNESOTA MINING & MFG. CO.**
Protex-A-Cote, Inc.
Raffi & Swanson, Inc.
Rust-Oleum
Standard-Toch Chemicals, Inc.
Tempil Corp.
Thompson & Co.
Vita-Var Corp.
Wilbur & Williams Co., Inc., The
Zophar Mills Inc.

PALLADIUM

Alloys Unlimited Inc.
American Silver Co., Inc.
Bart Mfg. Corp.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
Deringer Metallurgical Corp.
Eastern Smelting & Refining Corp.
Gibson Electric Co.
Goldsmith Bros. Div., National Lead Co.
P. R. Mallory & Co. Inc.
Norrich Plastics Corp.
Technic Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Western Gold & Platinum Co.

PANEL BOARDS, ELECTRIC

Accurate Electronics Corp.
Adept Industries Inc.
Aero-Test Equipment Co., Inc.
Allen Electric & Equipment Co.
Anchor Specialty Mfg. Co. Inc.
Anderson, Greenwood & Co.
Bernco Engrg. Corp.
Brooks & Perkins, Inc.
California Plasteck Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Cardell Mfrs.
Devco Engrg. Inc.
Eljay Corp.
Emerson Plastics Corp.
Falstrom Co.
Farwest Mfg. Div., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Fouch Electric Mfg. Co., Inc.
General Electric Co., Apparatus Sales Div.
Grimes Mfg. Co.
Industrial Engrg. Corp.
Kellogg Switchboard & Supply Co., Communications Div-IT&T Corp.
Keystone Electronics Corp.
Kings Electronics Co., Inc.
Kirk & Blum Mfg. Co., The
Kolton Electric Mfg. Co.
Thomas J. Long, Inc.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
George L. Nankervis Co.
National Electronics
Nelson Electric Mfg. Co.
Norrich Screw Machine Products
Northern Plastics Corp.
Panel Engrg. Corp.
Panob Corp.
Piasecki Aircraft Corp.
Radio Development & Research Corp.
Ram Meter Inc.
Skyline Electric & Mfg. Co.
States Co., The
Stewart & Stevenson Services, Inc.
Sunshine Scientific Instrument
Telkor, Inc.
Tucson Instrument Corp.
United States Instrument Corp.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.

PANELS

a. Fibre
b. Instrument
c. Jack
d. Receiver & Transmitter
e. Relay Rack
f. Wood & Plywood

ADC Inc., **c.**
A&P Metal Products Mfg. Corp., **b, d, e.**
Accessory Products Co., Div.-Textron Inc., **b.**
Accurate Electronics Corp., **c.**
Ackerman Engravers, Inc., **b.**
Acromark Co., The, **b.**
Adept Industries Inc., **b.**
Aerocal Div., Aeronca Mfg. Corp., **b.**
Alden Products Co., **e.**
Allen Electric & Equipment Co., **b.**
Allied Engraving & Stamping Co., **a.**
Allied Plastics Supply c orp., **a, b.**
Alpitec, Inc., **b thru e.**
Amco Engrg. Co., **b, e.**
American Latex Products Corp., **b.**
American Missile Products Co., Inc., **d.**
Anchor Specialty Mfg. Co. Inc., **b thru f.**
Apahouser Corp. of N. E., **a thru e.**
Artisan Metal Works Co., **e.**
Associated Research, Inc., **b.**
Bestcraft Products Co. Inc., **a.**
A. Biederman, Inc., **b.**
J. F. Bingham Mfg. Co., **b.**
***BRISTOL CO., THE, b.**
Milton H. Brooks & Son Engraving & Mfg. Co., Inc., **b, d, e.**
Brooks & Perkins, Inc., **b.**
Bud Radio, Inc., **b thru e.**
Budd Co., The, **a.**
Calcor Corp., **e.**
California Plasteck Inc., **b thru e.**
Canadian Radium & Uranium Corp., **b.**
Carborundum Co., The, **a.**

Chemical Micro Milling Co., **b, d, e.**
Comco Plastics Inc., **a, b.**
Conoflow Corp., **d.**
Conrad & Moser, **e.**
Control Sw. Div. Controls Co. of America, **b.**
Courter Products, Div.-Model Engrg. & Mfg. Inc., **b.**
Croname Inc., **b.**
Cutler Metal Products Co., **e.**
Dage Television Div., Thompson Ramo Wooldridge. Inc., **c.**
Dahlstrom Metallic Door Co., **b, d, e.**
Daystrom Inc., Military Electronics Div., **b.**
Dejur-Amsco Corp., Electronic Sales Div., **b.**
Devco Engrg. Inc., **b.**
Donnelly Mfg. Co., **b.**
Durality Corp., **a.**
Eljay Corp., **a, b, c.**
Elzee Metal Products Co., Inc., **b thru e.**
Emerson Plastics Corp., **a.**
Engineered Plastics, Inc., **a.**
Falstrom Co., **b, e.**
Farwell Metal Fabricating, **b thru e.**
Farwest Mfg. Div., Inc., **b, c.**
Fischer & Porter Co., **b.**
Fisher & Crome, **a, b, c.**
Flight Support, Inc., **b.**
Fouch Electric Mfg. Co., Inc., **b.**
Franklin Fibre-Lamitex Corp., **a, b.**
Gates Radio Co., **d, e.**
Goldsman, **a, f.**
Gray Mfg. Co., The, **d, e.**
Hagen Chemicals & Controls Inc., **b.**
Hamilton Watch Co., Military Products Div., **b.**
Hampden Mfg. Co., Inc.
Harco Labs., Inc., **c.**
Haskelite Mfg. Div.-Evans Products Co., **f.**
Hays Corp., The, **b.**
Hoffman Engrg. Corp., **b.**
A. F. Holden Co., The, **b.**
Ludwig Honold Mfg. Co., **b.**
Industrial Engrg. Corp., **b.**
Insulation Mfrs. Corp., **a.**
Jan Hardware Mfg. Co., Inc., **c.**
Janke & Co. Inc., **b.**
Kahn & Co., Inc., **b.**
Kellett Aircraft Corp., **b.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **b, c, e.**
Kerrco, **b.**
Kirk & Blum Mfg. Co., The, **b, e.**
Lear, Inc., **b.**
Litho-Etch Metal Name Plate Co., **b.**
Lone Star Plastics Co. Inc., **b.**
Thomas J. Long, Inc., **a, b, f.**
R. H. Lynch Mfg. Co., **e.**
Madigan Corp., **b.**
*MARTIN CO., THE, DENVER DIV., **b, e.**
Masonite Corp., **a.**
Mason-Neilan, **b.**
Meridian Metalcraft, Inc., **b.**
Met-L-Wood Corp., **f.**
Mid-West Metal Products, Inc., **e.**
Miller Dial & Nameplate Co., **a, b, d, e.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **b.**
*MINNESOTA MINING & MFG. CO., **a, b,.**
Mullenbach Div.-Electric Machinery Mfg. Co., **c.**
George L. Nankervis Co., **b.**
New England Etching Co. Inc., **b, d.**
Norrich Plastics Corp., **a, e.**
Norrich Screw Machine Products., **a.**
Northeast Metals Industries, Inc., **b, d, e.**
Olin Mathieson Chemical Corp., N. Y., **f.**
Owens-Corning Fiberglas Corp., **a.**
P. B. R. Mfg. Co., **b.**
Packard-Bell Electronics Corp., **f.**
Panel Engrg. Corp., **b.**
Panob Corp., **a, b, d.**
Park Nameplate Co., Inc., **b.**
Parkway Specialties Co., **b.**
Penn Fibre & Specialty Co., Inc., **a.**
Pneumafil Corp., **b, e.**
Premier Metal Products Co., **b, d, e.**
Projects Unlimited, Inc., **b.**
Q-Circuits, Div.-Etching Co. of Calif.
REF Mfg. Corp., **b, d, e.**
Radiaphone Co. Inc., **b, e.**
Radio City Products Co. Inc., **d, e.**
Edw. Renneburg & Sons Co., **b, f.**
Rimak Inc., **b thru e.**
Roberts Industries Inc., **f.**
Skydyne, Inc., **b, f.**
Skyline Electric & Mfg. Co.
E. C. Smith Mfg. Co., Inc., **c.**
Southwestern Industrial Electronics Co., **b.**
Specialty Electronics Development Corp., **b.**
Standard Electric Time Co., The, **c.**
Standard Electronics Div.-Reeves Instrument Corp., **c, d, e.**
Structural Fibers, Inc., **a.**
Sun Dial Corp., **a thru e.**
Sun Electric Corp., Aeronautical Div., **b.**
Switchcraft, Inc., **c.**
Taylor Fibre Co., **a.**
Technical Materiel Corp., The, **c, d.**
Technical Ply-Woods Sales, **a, f.**
Telkor, Inc., **b, d.**
Texstar Plastics, Div.-The Texstar Corp., **a.**
Thermo Electric Co., Inc., **b, c.**
Unified Industries, Inc., **b, d, e.**
United States Instrument Corp., **c, e.**
United States Radium Corp., **b.**
Victor Tool & Mfg., Inc., **a, b.**
Virginia Electronics Co., Inc., **c, d.**
Waco Aircraft Co.
Wilmington Fibre Specialty Co., **a.**
Winder Aircraft Corp. of Florida, **b, d, e.**
Wolverine Diesel Power Co., **a, b.**
Wyco Metal Products, **e.**
Young Development Div., Hercules Powder Co., **a.**
Young & Rioux Woodworking Co., Inc., **f.**

PAPER, INSULATION

Allied Plastics Supply Corp.
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co. Inc.
Bemis Bro. Bag Co.
Bestcraft Products Co. Inc.
Budd Co., The
Carborundum Co., The
Carborundum Co., Refractories Div.
Comco Plastics Inc.
Form-It Products, Inc.
Franklin Fibre-Lamitex Corp.
Insulation Mfrs. Corp.
Thomas J. Long, Inc.
*MINNESOTA MINING & MFG. CO.
Mosinee Paper Mills Co.
National Vulcanized Fibre Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Penn Fibre & Specialty Co., Inc.
Rogers Corp.
Spaulding Fibre Co., Inc.
Stone City Products Co.
Westinghouse Electric Corp., Micarta Div.
Wilmington Fibre Specialty Co.

PAPER, RECORDING

*BRISTOL CO., THE
Brush Instruments, Div.-Clevite Corp.
Eastman Kodak Co.
Leeds & Northrup Co.
Minneapolis-Honeywell, Heiland Div.
*MINNESOTA MINING & MFG. CO.
Nashua Corp., Chart Paper Div.
Paper Mfrs. Co.
Soroban Engrg., Inc.
Texas Instruments Inc.
Westinghouse Electric Corp.

PAPERS, ELECTROSENSITIVE

Kay Electric Co.
Muirhead Instruments Inc.
Nashua Corp., Chart Paper Div.
Plastic Film Co., Inc.
Western Union Telegraph Co., The
Zippertubing Co., The

PARABOLAS, MICROWAVE

Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Aircom Inc.
*ANDREW CORP.
Bendix Aviation Corp.
Blaw-Knox Equipment, Div.-Blaw-Knox Co.
Brach Mfg. Corp.
Brooks & Perkins, Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Collins Radio Co.
Diamond Antenna & Microwave Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Fairchild Aircraft & Missile Div., Fairchild Engine & Airplane Corp.
Gabriel Co., The, Gabriel Electronics Div.
General Bronze Electronics Corp.
Houston Fearless Corp.
Litton Industries, Maryland Div.
Narmco Mfg. Co.
Phoenix Products Co.
Portland Copper & Tank Works Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
TRG, Inc.
Technical Appliance Corp.
Roland Teiner Co. Inc.

PARACHUTE HARDWARE

Aerial Machine & Tool Corp.
Amatom Electronic Hardware Co. Inc.
American Machine & Foundry Co.
American Machine & Foundry Co., Government Products, N. Y.
Anaconda Metal Hose Div., The American Brass Co.
Wallace Barnes Div. Associated Spring Corp.
Capewell Mfg. Co.
Joe Davidson & Associates
Flight Refueling, Inc.
General Electric Co., Missile & Space Vehicle Dept. Pa.
General Logistics Div., Aeroquip Corp.
Hardman Tool & Engrg. Co.
Irving Air Chute Co., Inc.
Walter K. Jaros Aircrafters
H. Koch & Sons
North & Judd Mfg. Co.
Northrop Corp.
Ohlson Empire Inc.
Pacific Scientific Co.
Phoenix Products Co.
Pioneer Parachute Co., Inc.
Reliance Industrial Prod., Inc.
Scott Aviation Corp.
Stanley-Judd Div.-The Stanley Works
Switlik Parachute Co., Inc.
Transco Products, Inc.
Tucson Instrument Corp.

PARACHUTES

American Machine & Foundry Co., Government Products, N. Y.
Gentex Corp.
Irving Air Chute Co., Inc.
Northrop Corp.
Pioneer Parachute Co., Inc.
Raven Industries Inc.
Reliance Industrial Prod., Inc.
Switlik Parachute Co., Inc.

PATCH CORDS

ADC Inc.
Aerolite Electronics Corp.
Alden Products Co.
Amatom Electronic Hardware Co. Inc.
Bernco Engrg. Corp.
Bestcraft Products Co. Inc.
Birnbach Radio Co., Inc.
Cambridge Thermionic Corp.
Dage Television Div., Thompson Ramo Wooldridge Inc.
Electric Cords & Supply Corp.
Empire Electronics Co., Inc.
Gates Radio Co.
International Electric Industries, Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kings Electronics Co., Inc.
Lab-Tronics, Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Milgo Electronic Corp.
Chester Morton Electronics Corp.
Paul Nurches Co.
Pomona Electronics Co., Inc.
Projects Unlimited, Inc.
Robins Industries Corp.
Standard Electric Time Co., The
Stromberg-Carlson Div.-General Dynamics Corp.
Switchcraft, Inc.
Technical Materiel Corp., The
Telex, Inc.
Vector Electronic Co., Inc.
Virginia Electronics Co., Inc.

PATCH PANELS, ANTENNA

Apahouser Corp. of N. E.
Belmar Wheel & Machine Co., Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Gates Radio Co.
Portland Copper & Tank Works Inc.
Technical Materiel Corp., The
Virginia Electronics Co., Inc.
Western Gear Corp.-Precision Products Div.

PEDESTALS

Ainslie Corp.
American Car & Foundry Div., ACF Industries, Inc.
American Machine & Foundry Co., Greenwich Engrg. Div.
Antlab Inc.
Bendix Aviation Corp.
Brooks & Perkins, Inc.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Conrad & Moser
Daystrom, Inc., Military Electronics Div.
George E. Harris & Co., Inc.
Houston Fearless Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.

Kirk & Blum Mfg. Co., The
Litton Industries, Maryland Div.
Northeast Metals Idustries, Inc.
Portland Copper & Tank Works Inc.
Premier Metal Products Co.
Rimak, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.

PERMEAMETERS, HIGH H

Sunshine Scientific Instrument

PHASEMETERS

Action Laboratories Inc.
Air Logistics Corp.
Bendix Aviation Corp.
Daystrom Inc., Weston Instruments Div.
Diamond Antenna & Microwave Corp.
Dytronics Co.
Electro Instruments, Inc.
Epic, Inc.
Industrial Test Equipment Co.
Muirhead Instruments Inc.
National Electronics
Nilsen Mfg. Co.
Statham Development Corp.
Technology Instrument Corp.
Theta Instrument Corp.
Westinghouse Electric Corp.

PHENOLICS

Allied Plastics Supply Corp.
Apahouser Corp. of N. E.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Bestcraft Products Co. Inc.
Borden Chemical Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Comco Plastics Inc.
Crystal-X Corp.
Eastern Chemical Div., Hooker Chemical Corp.
Eljay Corp.
Franklin Fibre-Lamitex Corp.
Garlock Packing Co.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Insulation Mfrs. Corp.
Lebec Chemical Corp.
Lone Star Plastics Co. Inc.
Thomas J. Long, Inc.
Marblette Corp., The
Mica Insulator Div.-Minnesota Mining & Mfg., Co.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Monsanto Chemical Co.
National Vulcanized Fibre Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Raybestos-Manhattan, Inc.
Rezolin, Inc.
Rogers Corp.
St. Regis Paper Co., Panelyte Div.
Southwest Research Institute
Spaulding Fibre Co., Inc.
Stevens Products, Inc.
Swedlow Inc.
Synthane Corp.
Taylor Fibre Co.
Tingstol Co.
U. S. Plastic Molding Corp.
United States Plywood Corp.
Westinghouse Electric Corp., Micarta Div.
Wilmington Fibre Specialty Co.

PHOTOCELLS & PHOTOTUBES

Amperex Electronic Corp.
Blonder-Tongue Labs., Inc., Special Products Div.
Clairex Corp.
Continental Electric Co.
Dejur-Amsco Corp., Electronic Sales Div.
Allen B. Du Mont Labs., Inc.
Eastman Kodak Co.
Electron-Radar Products
***ENGIS EQUIPMENT CO.**
Hoffman Electronics Corp., Semiconductor Div.
Infrared Industries, Inc.
JEM Electronics Corp.
Philco Corp.-Govt. & Industrial Group
Photobell Co., Inc.
***RADIO CORP. OF AMERICA**
Special Products Dept., Melpar Inc.
Transitron Electronic Corp.
Vickers Inc., Electric Products Div.
Wells Industries Corp.

PHOTOETCHED COMPONENTS

Adept Industries Inc.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
California Plasteck Inc.
Chemical Micro Milling Co.
Graphic Circuits, Div.-Cinch Mfg. Co.
W. & L. E. Gurley
George E. Harris & Co., Inc.
Instrument Div., The Budd Co.
Lear, Inc.
Motorola, Inc.
Patterson Moos Research, Div.-Leesona Corp.
***RADIO CORP. OF AMERICA**
Special Products Dept., Melpar, Inc.
Zenith Optical Laboratory

PHOTOFLASH EQUIPMENT ELECTRONIC

American Speedlight Corp.
Amglo Corp.
Armament Div.-Universal Match Corp.
Beattie-Coleman, Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chadwick-Helmuth Co.
Continental Electric Co.
Davenport Mfg. Co.
Eastman Kodak Co.
Edgerton, Germeshausen & Grier, Inc.
Electro Powerpacs, Inc.
Epic, Inc.
Gordon Enterprises
Graflex Inc.
Minneapolis-Honeywell, Heiland Div.

PHOTOGRAMMETRIC EQUIPMENT

Abrams Instrument Corp.
Aeroflex Labs. Div., Aeroflex Corp.
Bar-Ray Products, Inc.
Bausch & Lomb Optical Co.
Benson-Lehner Corp.
Eastman Kodak Co.
J. W. Fecker Div., American Optical Co.
Gordon Enterprises
Librascope Div., General Precision, Inc.
Logetronics Inc.
W. L. Maxson Corp., The
Mitchell Camera Corp.
Morse Instrument Co., The
Optomechanisms Inc.
Photogrammetry, Inc.

PHOTOGRAPHIC EQUIPMENT

American Optical Co.
Beattie-Coleman, Inc.
Benson-Lehner Corp.
Charles Beseler Co.
Cameraflex Div., The Federal Mfg. & Engrg. Corp.
Davidson Optronics, Inc.
Daystrom Inc., Weston Instruments Div.
Dejur-Amsco Corp., Electronic Sales Div.
Eastman Kodak Co.
Fairchild Camera & Instrument Corp.
Fairchild Camera & Instrument Corp., Industrial Products Div.
Flight Research, Inc.
General Aniline & Film Corp., Ansco Div.
Gordon Enterprises
Graflex Inc.
Haloid Xerox Inc.
Houston Fearless Corp.
Industrial Timer Corp.
Kalart Co., Inc., The
Librascope Div., General Precision, Inc.
Logetronics Inc.
J. A. Maurer, Inc.
Metalphoto Corp.
D. B. Milliken Co.
Morse Instrument Co., The
Naz-Dar Co.
Neumade Products Corp.
Optomechanisms Inc.
Peerless Photo Products Inc.
Photogrammetry, Inc.
Traid Corp.
Viewlex, Inc.
Wollensak Optical Co.

PHOTOGRAPHIC MATERIALS, SPECTROGRAPHIC INSTRUMENTS

American Optical Co.
Eastman Kodak Co.
General Aniline & Film Corp., Ansco Div.
Gordon Enterprises
Jarrell-Ash Co.
Merix Chemical Co.
Peerless Photo Products Inc.
Wollensak Optical Co.

PHOTOGRAPHIC MATERIALS, X-RAY FILMS

Baird-Atomic, Inc.
Eastman Kodak Co.
General Aniline & Film Corp., Ansco Div.
Hammett-Mercury-Rex Div.
Jarrell-Ash Co.
Merix Chemical Co.
Philips Electronic Instruments
Tracerlab Inc.

PHOTOMETERS

American Instrument Co., Inc.
Baird-Atomic, Inc.
Daystrom Inc., Weston Instruments Div.
Edwards High Vacuum Ltd.
***ENGIS EQUIPMENT CO.**
J. W. Fecker Div., American Optical Co.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Gordon Enterprises
Instrument Development Labs., Inc.
Jarrell-Ash Co.
Northrop Corp.
Photovolt Corp.
Scientific & Process Instruments Div.-Beckman Instruments, Inc.
Southwest Research Institute
Spectra Electronics Corp.
Ultrasonic Engineering Co.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.
Zoomar Inc.

PICKUP ARMS

CBS Electronics, Div.-Columbia Broadcasting System, Inc.
Dempster Brothers, Inc.
***RADIO CORP. OF AMERICA**
H. H. Scott, Inc.

PILOT LIGHT ASSEMBLIES

Accurate Electronics Corp.
Aerolite Electronics Corp.
American Machine & Foundry Co., Government Products, N. Y.
Aviation Textile Associates
Dialight Corp.
Eagle Electric Mfg. Co. Inc.
Federal Screw Products Inc.
Grimes Mfg. Co.
Hammett-Mercury-Rex Div.
Jan Hardware Mfg. Co., Inc.
E. F. Johnson Co.
H. R. Kirkland Co., The
Leecraft Mfg. Co., Inc.
Paraplegics Mfg. Co., Inc.
Sun Electric Corp., Aeronautical Div.
Transistor Electronics Corp.
Vemaline Products Co.

PINS, TUBULAR

Amatom Electric Hardware Co. Inc.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Bead Chain Mfg. Co., The
C. E. M. Co., Inc.,
Elastic Stop Nut Corp. of America
Electronic Parts Mfg. Co., Inc.
Honti Engrg. & Mfg. Co.
Walter K. Jaros Aircrafters
Keystone Electronics Corp.
Malco Mfg. Co.
Mercury Air Parts Co., Inc.
Norrich Plastics Corp.
Standard Pressed Steel Co.
Waldick Engrg. Co.

PITOT TUBES

Aerotec Industries Inc., Aircraft Equipment Div.
Chance Vought Aircraft, Inc.
Edcliff Instruments
E. Vernon Hill & Co.
Rosemount Engrg. Co.
H. W. Tuttle & Co.
United Sensor & Control Corp.
Waste King Corp., Technical Products Div.

PLASTIC

a. Acrylic
b. Allyls
c. Cellulose Acetate
d. Cellulose Acetate Butyrate
e. Cellulose Nitrate
c. Ceramic-Plastic Combinations
g. Epoxy Resins
h. Ethyl Cellulose
i. Fiber Glass
j. Fluorocarbons
k. Melamine Formaldehyde
l. Mica-Plastic Combination
m. Phenolics
n. Polyester
o. Polyethylene
p. Polystyrene
q. Polytrifluorochlorethylene

r. Reinforced
s. Silicones
t. Styrene
u. Tetrafluoroethylene Resin
v. Urea Formaldehyde
w. Vinyl

Abesto Corp., a, c, d, e, h thru k, m, o thru u, w.
Ace Plastic Co., a, c, d, h, m, o, p, t, w.
Acheson Colloids Co., Div.-Acheson Industries, Inc.
Actioncraft Products, s, w.
Acushnet Process Co., s.
Aero Gasket Corp., j, r, u.
Air Logistics Corp., r.
Allied Chemical Corp., Nitrogen Div., v.
Allied International Corp., g.
Allied Plastics Supply Corp., a, c thru u, w.
American Agile Corp., o, w.
American Feldmuehle Corp., f.
American Latex Products Corp., g, j, n, o.
American Oil & Supply Co., o.
American Printed Circuits Co., Inc., i, r, s.
American Rocket Co., g, i, n, r, w.
Anchor Plastics Co., Inc., a, c, d, h, o, p, t.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp., g, i, n, r.
Aries Laboratories, Inc., g.
Aristocraft Plastics, Inc., a, c, d, o, p, q, t, u, w.
Armstrong Products Co., g.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., g, i, j, k, m, n, o, r, s, w.
Asheville-Schoonmaker Mica Co., l.
Atkins & Merrill, Inc., i, n, r.
Atlantic Research Corp.
Auburn Mfg. Co., The, c, i, j, m, n, o, q, s, u, w.
Aviation Textile Associates, a.
L. J. Barwood Mfg. Co. Inc., a thru w.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., f.
Carl H. Biggs Co., g.
Bjorksten Research Labs. For Industry, Inc., a thru w.
Blossom Mfg. Co. Inc., o, w.
Bo Myte Co., Inc., The, i, j, l, r, s, v.
Bonny Mfg. Corp., u.
Borden Chemical Co., a, c, d, f, g, m, o, p, v, w.
William Brand, Rex Div.-American Enka Corp., p, r, t.
Brook Molding Corp., a thru d, g, h, i, k, m thru p, r, t, v.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc., g, i, m, r.
Brunswick Balke Collender Co., The, Defense Products Div., f, g, i, m, n, r.
Budd Co., The, l, n.
Cadillac Plastic & Chemical Co., a, c, d, g, i, j, m thru r, t, u, w.
Carborundum Co., The, f.
Carmer Industries Inc., j, q.
Catalin Corp. of America, o, p, t.
Chemical Products Corp., w.
Chemplast, Inc., j, q, u.
Chicago Gasket Co., j, u.
Ciba Products Corp., g.
Cincinnati Milling Machine Co., The, r.
Clevite Ordnance, Div.-Clevite Corp., g, i, n, o, r, w.
Colonial Rubber Co., s.
Comco Plastics Inc., a, c, d, g thru k, m thru p, r thru u, w.
Connecticut Hard Rubber Co., The, j, s, u.
Continental Diamond Fibre Corp., i thru n, r, s.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co., g, i.
Cordo Chemical Corp., f, g, i, m, n, r, s, w.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Crystal-X Corp., a, c, d, m thru r, t, w.
C. R. Daniels, Inc., i, n, p, t.
Darcoid Co. Inc., The, s.
R. E Darling Co., Inc., k, s.
Dayton Rubber Co., The, g, n.
Dilectrix Corp., u.
Dixon Corp., j.
John L. Dore Co., u.
Douglas Aircraft Co., Inc., r.
Dow Chemical Co., The, g, h, o, p, t, w.
Dow Corning Corp., f, s.
E. I. Du Pont de Nemours & Co. Inc., a, c, j, n, o, u, w.
Dura Plastics of N. Y., Inc., a, c, d, p.
Duracote Corp., i, r, w.
Duralith Corp., k, m, w.
Durez Plastics Div.-Hooker Chemical Corp., m, n, r.
Eastern Chemical Div., Hooker Chemical Corp., m, n, r.
Eastman Kodak Co., c, d.
Electrical Insulation Co., Inc., a, g, i, k, m thru p, s, t, w.
Eljay Corp., a, c, e, g, i, m, n, p, r, t, w.
Emeloid Co., Inc., The, a, c, d, o, p, t, w.
Emerson & Cuming, Inc., g, n, o, p.
Enfab Inc., i.
Engineered Plastics, Inc., a, c, j, m..
Epoxy Products, Inc., Div.-Joseph Waldman & Sons, g.
*EQUIPMENT DIV., RAYTHEON CO., a, f.
Fabricon Corp., f, j, m, p, q, s, t, w.
Fabri-Form Co., The, a, c, d, j, m, o, p, w.
Fibercraft, Inc., r.
Fiberfil, Inc., i, r, t.
Fidelity Chemical Products Corp., d, h.
Finnell System, Inc., p, w.
Fisher & Chrome, m
Flightex Fabrics Inc., c, d, e.
Fluorocarbon Co., The, j, q, u.
Fluorulon Labs., Inc., q, r, u.
Food Machinery & Chemical Corp.-Chemical & Plastics Div., n.
Food Machinery & Chemical Corp.-Dapon Dept., n.
Food Machinery & Chemical Corp.-Epoxy Dept., g.
Food Machinery & Chemical Corp.-Ordnance Div., r.
Formica Corp., g, k, m, s, v.
Franklin Fibre-Lamitex Corp., a thru e, g, h, i, k, m thru w.
Furane Plastics, Inc., f, g, l, v.
Garlock Packing Co., a, c, f, g, j, m, o thru w.
Garlock Packing Co., The-Electronic Products, a, c, d, h, j, k, m, o, p, q, s, t, u, w.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Plastics Corp., q, u.
General Products Corp., k, m, s.
B. F. Goodrich Aviation Products, w.
B. F. Goodrich Chemical Co., w.
B. F. Goodrich Industrial Products Co., w.
Goodyear Aircraft Corp., a, g, i, m, r, s.
Grant-Lehr Corp., g, i, n, r.
Guided Missile Div., The Firestone Tire & Rubber Co., w.
Halogen Insulator & Seal Corp., i, j, q, u.
Hastings Plastics, Inc., f thru i, m, n, p, t.
Hays Mfg. Co., n, r.
Heil Process Equipment Corp., g, i, n, o, r, w.
Homalite Corp., The, b, g, n, r.
Honeycomb Co. of America, c, g, n, r.
Honti Engrg. & Mfg. Co., n.
Illumitronic Engrg. Co., a, o, p, q, w.
Insulation Mfrs. Corp., c, g, i thru n, r, s, w.
Jan Hardware Mfg. Co., Inc., a, c, d.
Jennings Machine Corp., j, q, u.
Joclin Mfg. Co., The, f, g, j, m, n, o, q, r, s, u.
Johns-Manville Sales Corp., i, r.
Kelsey-Hayes Co., m.
Kerrco, a, c, d, i, k, n, o, p, r, t.
Kidde Aero-Space Div., Walter Kidde & Co., Inc., g, i, r.
Kirkhill Rubber Co., o, s, w.
Kish Industries, Inc., g, m, n.
Lam-Ply Inc., g.
Lamtex Industries Inc., i, r.
Lebec Chemical Corp., g, m, v.
Lone Star Plastics Co. Inc., a, c, d, g, h, i, l thru p, r, s, t.
Thomas J. Long, Inc., a, c, d, g, i, j, k, m thru q, s, t, w.
Lunn Lamitates, Inc., i.
Luzerne Rubber Co., w.
Marblette Corp., The, g, m, r.
Marbon Chemical Div.-Borg-Warner Corp.
*MARTIN CO., THE, DENVER DIV., r, s.
McMillan Companies, The, i, l, r.
Mechanical Rubber Products Co., n, o, s, w.
J. E. Menaugh Co., u.
Merix Chemical Co., s.
Mesa Plastics Co., b, i, r.
Mica Fabricating Co., k thru p.
Mica Insulator Div.-Minnesota Mining & Mfg. Co., g, i, l, m, n, r, s, u.
*MINNESOTA MINING & MFG. CO., g, i, j, l, q, r, s.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV., g, j, m.
Mitchell Rand Mfg. Corp., g, l.
Molded Fiber Glass Body Co., i, n.
Molding Corp. of America, i thru m, q, s.
Monsanto Chemical Co., c, k, m, o, p, t, v, w.
Mycalex Corp. of America, f, l.
NUMEC-Nuclear Materials & Equipment Corp., f.
Narmco Mfg. Co., r.
National Vulcanized Fibre Co., i, k, m, n, r, s.
Natvar Corp., o, p, w.
Naugatuck Chemical Div.-U.S. Rubber Co., n, r, w.
Nopco Chemical Co., Plastics Div.
Norrich Plastics Corp., a thru f, i, j, m thru p.
Norrich Screw Machine Products
Northern Plastics Corp., g, k, m, r.
Nureco, Inc., g, n.
Olin Mathieson Chemical Corp., Winchester-Western Div., i.
Olympic Plastics Co., Inc., a, c, d, f thru p, r, s, t, v.
Owens-Corning Fiberglas Corp., g, i, n, r.
Panel Engrg. Corp., a, g, j, o, p, t, w.
Parabam, Inc., i.
Parsons Corp., Special Products Div.
Penn Fibre & Specialty Co., Inc., c, m, n, r.
Permatex Co., Inc., g.
Perry Plastics, Inc., b, c, d, g, h, k, m, p, r, t, v.
Piasecki Aircraft Corp., g, i, r.
Pittsburgh Corning Corp., m, n.
Plastic Age Sales, Inc., a, c, d, f, g, i, k, m, n, p, r, s, t, v.
Plastics Distributor of New England, a, i, r.
Polymer Corp., The, j, p.
REF Mfg. Corp., i, r.
Raven Industries Inc., s.
Raybestos-Manhattan, Inc., j, m, q, r, u.
Reeves Brothers, Inc., o, w.
Reichhold Chemicals, Inc., g, k, m, n, v.
Ren Plastics, Inc., g.
Resistoflex Corp., i, j, q, r, u.
Reynolds Metals Co., o, w.
Reynolds Metals Co., Plastics Div., w.
Rezolin, Inc., g, m.
Rogers Corp., a, f, i, j, k, m, r.
Roovers-Lotsch Corp., w.
Milton Ross Metals Co., The., g.
Rubbercraft Corp. of California, s.
Russell Mfg. Co., m.
St. Regis Paper Co., Panelyte Div., m, o, s.
Sanford Plastics Corp., j, q, t.
Ray A. Scharper & Co., a, e, m, o, p, s, t, w.
Seaman Products, Div.-Seaman Paper Co., i, m, r, w.
W. S. Shamban & Co., g, n, q, u.
Shell Chemical Co., Plastics & Resins Div., g.
Sierracin Corp., The, n.
Silicone Products Dept., General Electric Co., Dept. c., s.
Silicones Div.-Union Carbide Corp., r.
Skydyne, Inc., g.
Smooth-on Mfg. Co.
Southern Plastics Co., a, c, d, h, o, p, w.
Southwest Research Institute, o.
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co., j, u.
Spalding Fibre Co., Inc., g, k, m, r.
Special Products Dept., Melpar Inc., g, n.
Stahlin Bros. Inc., i, m, n, r, w.
Stauffer Chemical Co.
Stevens Products, Inc., g, i, k, m, n, s.
Structural Fibers, Inc., f, r.
Swan Rubber Co., w.
Swedlow Inc., a, g, i, m, n, r, s.
Synthane Corp., g, k, m, r, s.
Tapco Group, Thompson Ramo Wooldridge Inc., r.
Taylor Fibre Co., g, k, m, r, s.
Tetrafluor, Inc., j, q, u.
Thermoid Div.-H. K. Porter Co., Inc., o, s, w.
H. I. Thompson Fiber Glass Co., i, r.
Thompson & Co., w.
Thompson Ramo Wooldridge Inc., r.
Thor Ceramics, Inc., g, m, n.
E. F. Timme & Son Inc., i, w.
Tingstol Co., g, m.
Topper Mfg. Co., Inc., b, f, g, j, p, s, u.
U B S Chemical Co., Div.-A. E. Staley Mfg. Co., a, p.
Union Asbestos & Rubber Co., i.
Union Carbide Plastics Co., g, m, o, p, w.
U. S. Indsl. Chemicals Co., Div.-Natl Distillers & Chemical Corp., o.
United States Chemical Milling Corp., i, r.
United States Plywood Corp., a, g, m, w.
United States Rubber Co., n, r, w.
United Supply Co., a, c, m, o.
Universal Moulded Products Corp., r.
Universal Unlimited, Inc., a, c, d, e, m, o, p, t, w.
Varflex Corp., w.
Waterbury Companies, Inc., a, c, d, g, h, k thru p, t, v, w.
Western Coating Co., d, h, w.
Western Felt Works & Acadia Synthetic Products Div., c, d, h, o, p, s, t, w.
Westinghouse Electric Corp., i, l, r.
Westinghouse Electric Corp., Micarta Div., f, g, i, k thru o, r, s.
Wilmington Fibre Specialty Co., m.
Winder Aircraft Corp. of Florida, f.
X-Pando Corp., g.
Yardley Plastics Co., a, c,d, h, o, p, t, w.
Young Development Div., Hercules Powder Co., r.
Zippertubing Co., The, i, j, o, w.

PLASTIC, ELECTRICALLY CONDUCTIVE

American Latex Products Corp.
American Printed Circuits Co., Inc.
Carl H. Biggs Co.
Bjorksten Research Labs. For Industry, Inc.
Bonny Mfg. Corp.
Connecticut Hard Rubber Co., The
Cordo Chemical Corp.
Dayton Aircraft Products, Inc.
Duracote Corp.
Emerson & Cuming, Inc.
Fabricon Corp.
Farwest Mfg. Div., Inc.
Franklin Fibre-Lamitex Corp.
General American Transportation Corp.
General Plastics Corp.
Hastings Plastics, Inc.

Markite Corp.
McMillan Companies, The
Merix Chemical Co.
Mesa Plastics Co.
Metaplast Co., Inc.
Micro-Circuits Co.
*MINNESOTA MINING & MFG. CO.
Olympic Plastics Co., Inc.
Panel Engrg. Corp.
Plastic Age Sales, Inc.
Plastic Film Co., Inc.
Rogers Corp.
Sierracin Corp., The
Structural Fibers, Inc.
Tetrafluor, Inc.
Topper Mfg. Co., Inc.
U. S. Plastic Molding Corp.
Virginia Plak Co.
Westinghouse Electric Corp., Micarta Div.
Zippertubing Co., The

PLASTICS FABRICATORS & FINISHERS

ABA Tool & Die Co.
Abestos Corp.
Ace Plastic Co.
Adept Industries Inc.
Air Logistics Corp.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
American Aerophysics Corp.
American Agile Corp.
American Insulator Corp.
American Latex Products Corp.
American Research & Mfg. Corp.
Armstrong Cork Co.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Atkins & Merrill, Inc.
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co. Inc.
Bemis Bro. Bag Co.
Bestcraft Products Co. Inc.
Blossom Mfg. Co. Inc.
Bonny Mfg. Corp.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Budd Co., The
Butler Mfg. Co.
California Plasteck Inc.
Chemplast, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Collectron Corp.
Colonial Aircraft Corp.
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cordo Chemical Corp.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Crystal-X Corp.
Dalmo Victor Co., Div.-Textron, Inc.
Dayton Aircraft Products, Inc.
Doak Aircraft Co., Inc.
Douglas Aircraft Co., Inc.
Driver-Harris Co.
Dura Plastics of N. Y., Inc.
Duralith Corp
Electrical Insulation Co., Inc.
Eljay Corp.
Emerson Plastics Corp.
Emmco Plastics Fabricators
Erie Resistor Corp.
Fabricon Corp.
Fabri-Form Co., The
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Farwest Mfg. Div., Inc.
Fibercraft, Inc.
Fisher & Crome
Fluorocarbon Co., The
Fluorulon Labs., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Formica Corp.
Franklin Fibre-Lamitex Corp.
Garlock Packing Co., The-Electronic Products
General American Transportation Corp.
General Plastics Corp.
Globe Electrical Mfg. Co
Grant-Lehr Corp.
Grimes Mfg. Co.
Hammett-Mercury-Rex Div.
Hampden Mfg. Co., Inc.
Heil Process Equipment Corp.
Homalite Corp., The
*HORKEY-MOORE ASSOCIATES-SUB. HOUSTON FEARLESS CORP.
Walter J. Hyatt Co., The
Hydro Molding Co. Inc.
Insulation Mfrs. Corp.
Joclin Mfg. Co., The
Johns-Manville Sales Corp.
Keil engrg. Products Inc.
Kelsey-Hayes Co
Keystone Electronics Corp.
H. Koch & Sons
Kurz-Kasch, Inc.
Lamtex Industries Inc.
Lone Star Plastics Co. Inc.
Thomas J. Long, Inc.
Lunn Laminates, Inc.
Luzerne Rubber Co.
M & O Plastic Products
Magee-Bralla & Associates
Mica Fabricating Co.
Midwest Molding & Mfg. Co.
*MINNESOTA MINING & MFG. CO.
Molding Corp. of America
J. J. Monaghan Co., Inc.
C. A. Morgren Co.
Narmco Mfg. Co.
National Vulcanized Fibre Co.
New England Tape Co., Div.-United-Carr Fastener Corp.
Northern Plastics Corp.
Northrop Corp.
Olympic Plastics Co., Inc.
Panduit Corp.
Panel Engrg. Corp.
Parsons Corp., Special Products Div.
Penn Fibre & Specialty Co., Inc.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Plastics Distributor of New England
Polymer Corp., The
Prewitt Aircraft Co.
Printloid Inc.
REF Mfg. Corp.
Raven Industries Inc.
Raybestos-Manhattan, Inc.
St. Regis Paper Co., Panelyte Div.
Sanford Plastics Corp.
Ray A. Scharer & Co.
D. A. Schultz Co.
Scientific-Atlanta, Inc.
H. M. Scott Co., The
Seaman Products, Div.-Seaman Paper Co.
W. S. Shamban & Co.
Sillcocks-Miller Co.
Spaulding Fibre Co., Inc.
Stahlin Bros. Inc.
Standard Molding Corp.
Stevens Products, Inc.
Structural Fibers, Inc.
Swedlow Inc.
Synthane Corp.
Temco Aircraft Corp.
Tetrafluor, Inc.
Texstar Plastics, Div.-The Texstar Corp.
H. I. Thompson Fiber Glass Co.
Tingstol Co.
Topper Mfg. Co., Inc.
Tri-Point Plastics Inc.
Tucson Instrument Corp.
Turco Products, Inc.
Uni-Flex Mfg. & Engrg. Inc.
U. S. Plastic Molding Corp.
United States Chemical Milling Corp.
United States Plywood Corp.
Universal Moulded Products Corp.
Universal Unlimited, Inc.
Virginia Plak Co.
Western Coil & Electrical Co.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micarta Div.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.
Yardley Plastics Co.
Young Development Div., Hercules Powder Co.
Zippertubing Co., The

PLASTICS LAMINATED

Abestos Corp.
Actioncraft Products
Adept Industries Inc.
Aerojet-General Corp.
Air Logistics Corp.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
American Aerophysics Corp.
American Brake Shoe Co.
American Insulator Corp.
American Latex Products Corp.
American Rocket Co.
Apahouser Corp. of N. E.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings Inc.
Atlantic Research Corp.
L. J. Barwood Mfg. Co. Inc.
Bjorksten Research Labs. For Industry, Inc.
Blossom Mfg. Co. Inc.
Bo Myte Co., Inc., The
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Budd Co., The
Clevite Ordnance, Div.-Clevite Corp.
Colonial Aircraft Corp.
Comco Plastics Inc.
Continental Diamond Fibre Corp.
Cordo Chemical Corp.
Custom Tool & Mfg. Co.
Dalmo Victor Co., Div.-Textron, Inc.
Dayton Aircraft Products, Inc.
Doak Aircraft Co., Inc.
Douglas Aircraft Co., Inc.
Duralith Corp.
Electrical Insulation Co., Inc.
Eljay Corp.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Emmco Plastics Fabricators
Fabricon Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Farley & Loetscher Mfg. Co., Plastics Div.
Farwest Mfg. Div., Inc.
Fibercraft, Inc.
Fisher & Crome
Fluorulon Labs., Inc.
Food Machinery & Chemical Corp., Epoxy Dept.
Food Machinery & Chemical Corp., Ordnance Div.
Formica Corp.
Franklin Fibre-Lamitex Corp.
General American Transportation Corp.
General Plastics Corp.
B. F. Goodrich Aviation Products
Grant-Lehr Corp.
Harco Containers Div.-Harbor Boat Building Co.
Haskelite Mfg. Div.-Evans Products Co.
Heil Process Equipment Corp.
Homalite Corp., The
Honeycomb Co. of America, Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Insulation Mfrs. Corp.
Joclin Mfg. Co., The
Johns-Manville Sales Corp.
Kerrco
H. Koch & Sons
Lam-Ply, Inc.
Lamtex Industries Inc.
Lone Star Plastics Co. Inc.
Thomas J. Long, Inc.
Lunn Laminates, Inc.
M & O Plastic Products
Magee-Bralla & Associates
Mica Fabricating Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
*MINNESOTA MINING & MFG. CO.
Morningstar-Paisley, Inc.
Narmco Mfg. Co.
National Vulcanized Fibre Co.
New England Laminates Co., Inc.
Norrich Plastics Corp.
Norrich Screw Machine Products
Norsid Mfg. Co., Inc., The
Northern Plastics Corp.
Olin Mathieson Chemical Corp., N. Y.
Olympic Plastics Co., Inc.
Owens-Corning Fiberglas Corp.
Panel Engrg. Corp.
Parabam, Inc.
Parsons Corp., Special Products Div.
Penn Fibre & Specialty Co., Inc.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Prewitt Aircraft Co.
Printloid Inc.
REF Mfg. Corp.
Raybestos-Manhattan, Inc.
Reeves Brothers, Inc.
Reynolds Metals Co.
Reynolds Metals Co., Plastics Div.
Rogers Corp.
Roovers-Lotsch Corp.
St. Regis Paper Co., Panelyte Div.
D. A. Schultz Co.
Scientific-Atlanta, Inc.
H. M. Scott Co., The
Seaman Products, Div.-Seaman Paper Co.
W. S. Shamban & Co.
Sierracin Corp., The
Sillcocks-Miller Co.
Skydyne, Inc.
Spaulding Fibre Co., Inc.
Stevens Products, Inc.
Structural Fibers, Inc.

Swedlow Inc.
Synthane Corp.
Taylor Fibre Co.
Temco Aircraft Corp.
Tetrafluor, Inc.
Texstar Plastics, Div.-The Texstar Corp.
H. I. Thompson Fiber Glass Co.
E. F. Timme & Son Inc.
Tingstol Co.
Turco Products, Inc.
United Mineral & Chemical Corp.
United States Plywood Corp.
United Moulded Products Corp.
Universal Unlimited, Inc.
Virginia Plak Co.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Micarta Div.
Wolverine Diesel Power Co.
Young Development Div., Hercules Powder Co.

PLATES, INSTRUCTION

Acromark Co., The
Adept Industries Inc.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
W. H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
California Plasteck Inc.
Canadian Radium & Uranium Corp.
Chemical Micro Milling Co.
Croname Inc.
Duralith Corp.
Eljay Corp.
Emeloid Co., Inc., The
Jas. H. Matthews & Co.
***MINNESOTA MINING & MFG. CO.**
New England Etching Co., Inc.
Park Nameplate Co., Inc.
United States Radium Corp.
Virginia Plak Co.

PLATES, METAL OR PLASTIC

Acromark Co., The
Adam Metal Supply Inc.
Adept Industries Inc.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
Aluminum Co. of America
American Latex Products Corp.
Apahouser Corp. of N. E.
Beacon Steel Corp.
Beemer Engrg. Co.
Belmar Wheel & Machine Co., Inc.
Bonny Mfg. Corp.
W. H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Brooks & Perkins, Inc.
California Plasteck Inc.
G. O. Carlson, Inc.
Colorado Fuel & Iron Corp., The
Conrad & Moser
Croname Inc.
Crucible Steel Co. of America
Crystal-X Corp.
Division Lead Co.
Dow Chemical Co., The
Dura Plastics of N. Y., Inc.
Duralith Corp.
Eljay Corp.
Elzee Metal Products Co., Inc.
Emeloid Co., Inc., The
Emerson Plastics Corp.
Erie Resistor Corp.
Falstrom Co.
Fisher & Crome
Franklin Fibre-Lamitex Corp.
Henry & Miller Industries, Inc.
Huntington Alloy Products Div.-The International Nickel Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Kerrco
Thomas J. Long, Inc.
Lukens Steel Co.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
Mico Instrument Co.
***MINNESOTA MINING & MFG. CO.**
New England Etching Co. Inc.
Northern Plastics Corp.
Opelika Welding, Machine & Supply Inc.
Panel Engrg. Corp.
Park Nameplate Co., Inc.
Parsons Corp., Special Products Div.
Plastic Age Sales, Inc.
Pneumatil Corp.
Polymer Corp., The
Printloid Inc.
Edw. Renneburg & Sons Co.
Reynolds Metals Co.
Rimak, Inc.
Joseph T. Ryerson & Son, Inc.
Sanford Plastics Corp.
Structural Fibers, Inc.
Sylvania-Corning Nuclear Corp.
Synthane Corp.
Texas Instruments Inc.
Unified Industries, Inc.
United Aircraft Products, Inc.
United Mineral & Chemical Corp.
United States Radium Corp.
United States Steel Corp.
Utility Brass & Copper Corp.
Victor Tool & Mfg., Inc.
Virginia Plak Co.
Waterbury Companies, Inc.
Westinghouse Electric Corp.
Wrought Washer Mfg. Co.

PLATES, PLASTIC LIGHTING

Adept Industries Inc.
Allied Engraving & Stamping Co.
Allied Plastics Supply Corp.
W. H. Brady Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Cable Electric Products Inc.
California Plasteck Inc.
Canadian Radium & Uranium Corp.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Duralith Corp.
Eljay Corp.
Emeloid Co., Inc., The
Fisher & Crome
Franklin Fibre-Lamitex Corp.
Thomas J. Long, Inc.
Northern Plastics Corp.
Owens-Corning Fiberglas Corp.
Panel Engrg. Corp.
Plastic Age Sales, Inc.
Tucson Instrument Corp.
United States Radium Corp.
Universal Unlimited, Inc.
Waterbury Companies, Inc.

PLATFORMS, FIRING

Beacon Steel Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
McCathron Boiler Works Co., Inc.
McGregor Mfg. Corp.
Edw. Renneburg & Sons Co.

PLATFORMS, STABLE

Associated Co., Inc.
Beacon Steel Corp.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
General Electric Co., Light Military Electronics Dept.
Hydra-Power Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kellett Aircraft Corp.
Lear, Inc.
Norden Div., United Aircraft Corp.
Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Richard Philip Co.
Raven Industries Inc.
South River Metal Products Co., Inc.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Westinghouse Electric Corp.

PLATING, PRECIOUS METAL

A & E Metal Specialties Inc.
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Alloys Unlimited Inc.
Arnolt Corp.
Bart Mfg. Corp.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
Brooks & Perkins, Inc.
Capital City Mfg. Co., Inc.
Chromium Corp. of America
Cohan Epner Co. Inc.
Sigmund Cohn Corp.
Deringer Metallurgical Corp.
General American Transportation Corp.
Hamilton Watch Co.-Industrial Div.
Harper-Leader, Inc.
Henry & Miller Industries, Inc.
Kanarr Corp.
La Pointe Industries Inc.
Lear, Inc.
Lycoming Div., Avco Corp.
Lytle Corp.
M-W Labs, Inc.
Michigan Chrome & Chemical Co.
Molded Insulation Co.
NUMEC-Nuclear Materials & Equipment Corp.
Optical Coating Lab., Inc.
Precision Electroplating Co.
Savage-Rowe Plating Co., Inc.
Steel Improvement & Forge., The
Technic Inc.
Texas Instruments Inc.
Thermionic Products Co.
United Plating Works, Inc.
Veeco Vacuum Corp.

PLATING, TIN ZINC

A & E Metal Specialties Inc.
Brooks & Perkins, Inc.
Capital City Mfg. Co., Inc.
Cohan Epner Co. Inc.
Henry & Miller Industries, Inc.
Lear, Inc.
Lytle Corp.
Metal & Thermit Corp.
Michigan Chrome & Chemical Co.
***MINNESOTA MINING & MFG. CO.**
Norris-Thermador Corp.
Savage-Rowe Plating Co., Inc.
Ultra Electroforming & Mfg. Co.
United Plating Works, Inc.

PLIERS

Aircraft Tools, Inc.
Ampco Metal, Inc.
Billings & Spencer Co., The
Detroit Stamping Co.
Handicraft Tools, Inc., Div.-X-Acto, Inc.
Hunter Tool Co.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Mathias Klein & Sons, Inc.
Owatonna Tool Co. Precision Hydraulic Div.
Proto Tool Co.
Snap-On-Tools Corp.
Vaco Products Co.
Vlchek Tool Co.

PLOTTERS, X-Y

Aeronca Mfg. Corp.-Aerospace Div.
Antlab Inc.
Benson-Lehner Corp.
***BRISTOL CO., THE**
Broadview Research Corp.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Electro Instruments, Inc.
Fenske, Fedrick & Miller Inc.
Gilmore Industries, Inc.
Gordon Enterprises
Hewlett-Packard Co.
Lear, Inc.
Leeds & Northrup Co.
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
Loral Electronics Corp.
Madigan Corp.
Milgo Electronic Corp.
Motorola, Inc.
Optical Gaging Products, Inc.
Optomechanisms Inc.
Radiation, Inc.
Skiatron Electronics & Television Corp.
Special Products Dept., Melpar, Inc.
Tally Register Corp.
Universal Unlimited, Inc.
Westgate Lab., Inc.

PLUG-IN-CIRCUIT UNITS

ACDC Electronics, Inc.
ACF Electronics Div., ACF Industries Inc.
Accurate Electronics Corp.
Adage, Inc.
Airflyte Electronics Co.
Alwac Computer, Div.-El-Tronics Inc.
American Research & Mfg. Corp.
Arthur Ansley Mfg. Co.
Becker Electronics Mfg. Corp.
Bendix Aviation Corp., Cincinnati Div.
Broadview Research Corp.
Burr-Brown Research Corp.
Centralab, Div.-Globe-Union, Inc.
Chalco Engrg. Corp.
Computer Control Co., Inc.
Computer Control Co., Inc., Western Div.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Military Electronics Div.
Delco Radio Div.-General Motors Corp.
Du Kane Corp.
Ferrotran Electronics Co., Inc.
Flight Support, Inc.
Garde Mfg. Co.
General Electric Co., Heavy Military Electronics Dept.
General Mills, Inc.
Good Electronic Corp.

ITT Federal Div., International Telephone & Telegraph Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
La Pointe Industries Inc.
Lear, Inc.
Lytle Corp.
P. R. Mallory & Co. Inc.
Micro Gee Products, Inc.
James Millen Mfg. Co. Inc.
Motorola, Inc.
National Co., Inc.
Northrop Corp.
Nugent Electronics Co., Inc.
Paul Nurches Co.
Packard Bell Computer Corp.
Piasecki Aircraft Corp.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Rese Engrg., Inc.
Special Products Dept., Melpar, Inc.
Stewart-Warner Electronics Div.
Technical Electronics Co. Div.-Consolidated Electronics Industries
Telex Inc.
Topper Mfg. Co., Inc.
Vector Electronic Co., Inc.
Virginia Electronics Co., Inc.
Walkirt Co.
Westinghouse Electric Corp.

PLUGS

a. Computer Board
b. Connector
c. Dehydrator
d. Expansion
e. Metallic
f. Non-Metallic
g. Printed Circuit
h. Telephone
i. Terminal

ADC Inc., **h.**
Accurate Electronics Corp., **a, b, g, h, i.**
All Specs Corp., **b, c, i.**
Amatom Electronic Hardware Co. Inc., **h.**
American Brass Co., The., **a, b, e, g, h, i.**
American Standard Products, Inc., **e.**
Armel Electronics, Inc., **b, g.**
Arnav Aircraft Associates, Inc., **e.**
Arnoux Corp., **b, g.**
Bead Chain Mfg. Co., The, **h, i.**
Belmar Wheel & Machine Co., Inc., **e, i.**
Bendix Aviation Corp., **b.**
Birnbach Radio Co., Inc., **b, h, i.**
Burndy Corp., Omaton Div., **b, g, i.**
Cable Electric Products Inc., **b, h, i.**
Cal Connector Co., **a, b, h, i.**
Cambridge Thermionic Corp., **a, b, g, i.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **e.**
Clover Industries, Inc.**e, f.**
Cole Electric Co., **a, b.**
C. R. Daniels, Inc., **f.**
Dejur-Amsco Corp., Electronic Sales Div., **b.**
Deutsch Co., The, Electronic Components Div., **b.**
Driare, Inc., **c.**
Dumont Engrg. Co., **e.**
Eagle Electric Mfg. Co. Inc., **b.**
Hugh H. Eby Co., **g.**
Emerson Plastics Corp., **f.**
Franklin Fibre-Lamitex Corp., **f.**
G-C Electronics Co., **h.**
Garde Mfg. Co., **g, i.**
Goe Engrg. Co., **i.**
Good Electronic Corp., **g.**
Graphic Circuits, Div.-Cinch Mfg. Co., **g.**
Harco Labs., Inc., **b, e.**
George E. Harris & Co., Inc., **g.**
Hermetic Seal Corp., **b, f, i.**
Honti Engrg. & Mfg. Co., **e, i.**
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp., **b.**
International Electric Industries, Inc., **b.**
Interstate Electronics Inc., **b.**
Javex Electronics, **b, i.**
Joclin Mfg. Co., The, **b.**
E. F. Johnson c o., **b, g.**
Howard B. Jones Div.-Cinch Mfg. Corp., **b.**
Joy Mfg. Co., **b.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **h, i.**
Kickhaefer Mfg. Co., **d.**
Kings Electronics Co., Inc., **b, g, h.**
Kulka Electric Corp., **b, g, i.**
Lab-Tronics, Inc., b, **f, h, i.**
Lear, Inc., **a, b, c, g.**
Lee Co., The, **d.**
Leviton Mfg. Co., Inc., **b,** i.
Liquidometer Corp., The, b.
Thomas J. Long, Inc., **f.**
Madigan Corp., **a, g.**
Malco Mfg. Co., **a, b, g, i.**
P. R. Mallory & Co. Inc., **b, e, h.**
Microdot Inc., **b, g, i.**
Moeller Mfg. Co. Inc., **d.**
Molded Insulation Co., **b, h.**
Molding Corp. of America, **b, i.**
Norrich Plastics Corp., **b, e, h, i.**
Norrich Screw Machine Products, **h, i.**
Paul Nurches Co., **a, b, i.**
Packard-Bell Electronics Corp., **g.**
Pyle-National Co., The, **b.**
Q-Circuits, Div.-Etching Co. of Calif., **g.**
***RADIO CORP. OF AMERICA, a, g.**
Remler Co., **b.**
Roberts Toledo Rubber Co., The, **f.**
Rogers Corp.,
Milton Ross Metals Co., The, **b, g, i.**
Royal Electric Corp., **b.**
Rye Sound Corp., **h, i.**
Sealectro Corp., **b.**
Seeger-Williams, Inc.
Skytronics, Inc., **b.**
Specialty Electronics Development Corp., **b, h.**
Herman D. Steel Co., **b, i.**
Stromberg-Carlson Div.-General Dynamics Corp., **h.**
Superior Electric Co., The, **b.**
Switchcraft, Inc., **h.**
Technical Development Co., **e.**
Telechrome Mfg. Corp., **b.**
Telex, Inc.
Tingstol Co., **g.**
United States Instrument Corp., **h.**
Vector Electronic Co., Inc., **b, g.**
Viking Industries Inc., **b, g.**
Wells Industries Corp., **c.**
Whitehead Stamping Co., **d.**
Wrought Washer Mfg. Co., **d.**

PLYWOOD

Commercial Services Co., Inc.
Curtis Companies, Inc.
Haskelite Mfg. Div.-Evans Products Co.
Packard-Bell Electronics Corp.
Technical Ply-Woods Sales
United States Plywood Corp.
Young & Rioux Woodworking Co., Inc.

PLYWOOD & METAL, BONDED

Albano Co. Inc.
Curtis Companies, Inc.
Goldsman
Haskelite Mfg. Div.-Evans Products Co.
Mel-L-Wood Corp.
Nuclear Development Corp. of America
Parsons Corp., Special Products Div.
REF Mfg. Corp.
Ray Proof Corp.
Skydyne, Inc.
Technical Ply-Woods Sales
United States Plywood Corp.

PNEUMATIC CONTROLS & SYSTEMS

Accessory Controls & Equipment Corp.
Accessory Products Co., Div.-Textron Inc.
Adel Precision Products of Calif., Div.-General Metals Corp.
Aircraft Accessory Turbine Dept.-General Electric Co.
Alco Valve Co.
American Instrument Co., Inc.
American Machine & Foundry Co., Government Products, N. Y.
Anderson, Greenwood & Co.
Applied Dynamics Corp.
Arkwin Industries, Inc.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Associated Testing Labs., Inc.
Barber-Colman Co.
***BENDIX-PACIFIC DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Bernco Engrg. Corp.
***BRISTOL CO., THE**
Bruning Co., The
Conoflow Corp.
Consolidated Controls Corp.
Consolidated Diesel Electric Corp.
Cornelius Co., The, Aero Div.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
George W. Dahl Co., Inc.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Dynamic Controls Corp.
Edwards High Vacuum Ltd.
Electrol Inc.
Flight Refueling, Inc.
Futurecraft Corp.
General Electric Co., Apparatus Sales Div.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hagan Chemicals & Controls Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Haskel Engrg. & Supply Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hughes Tool Co., Aircraft Div.
Walter J. Hyatt Co., The
Hydra-Power Corp.
Jonitrol Aircraft Div.-Midland-Ross Corp.
Kahn & Co., Inc.
Kemp Aero Products
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kieley & Mueller, Inc.
Langley Corp.
Lear, Inc.
Leeds & Northrup Co.
Mason-Neilan
Mead Specialties Co., Inc.
Meletron Corp.
National Instrument Laboratories, Inc.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc.
Northrop Corp.
OPW-Jordan
Ozone Metal Products Corp.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Parker-Hannifin Corp.
Pegasus Labs., Inc.
Pneu-Hydro Valve Corp.
Powers Regulator Co., The
REF Mfg. Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Randall Engrg. Corp.
Research Controls
Rimak, Inc.
J. R. Robbins Co.
Sargent Engrg. Corp.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Simmonds Aerocessories, Inc.
Skyvalve, Inc.
Solar Aircraft Co.
Southwestern Valve Corp.
A. U. Stone & Co., Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tactair Valve Div.-Aircraft Products Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
Transco Products, Inc.
United Aircraft Products, Inc.
Vap-Air Aeronautical Products Div., Vapor Heating Corp.
Vinson Mfg. Co. Inc.
***WEATHERHEAD CO., THE**
Wells Industries Corp.
Westinghouse Air Brake Co., Industrial Products Div.
Wiancko Engrg. Co.
Worthington Corp.

POINTERS, DIAL

Adept Industries Inc.
Allen Electric & Equipment Co.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
California Plasteck Inc.
Ellison Draft Gage Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
James Millen Mfg. Co. Inc.
United States Radium Corp.

POLONIUM

Canadian Radium & Uranium Corp.
Monsanto Chemical Co.
NUMEC-Nuclear Materials & Equipment Corp.
Small Motors Inc.
United States Radium Corp.

PORCELAIN

Adept Industries Inc.
American Lava Corp.
Bettinger Corp.
Centralab, Div.-Globe-Union, Inc.
Du-Co Ceramics Co.
Duramic Products, Inc.
Electrical Refractories Co., The
Gladding, McBean & Co.
Lapp Insulator Co., Inc., Radio Specialties Div.
National Ceramic Co.
Star Porcelain Co., The
Thor Ceramics, Inc.

POSITION INDICATORS

Ainslie Corp.

Aircraft Instruments Co.
Antlab Inc.
Bendix Aviation Corp.-Montrose Div.
Bendix Corp., The, Eclipse-Pioneer Div.
Benson-Lehner Corp.
Bowmar Instrument Corp.
Chalco Engrg. Corp.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Allen B. Du Mont Labs., Inc.
Flight Refueling, Inc.
General Electric Co., Apparatus Sales Div.
Hagan Chemicals & Controls Inc.
Huyck Systems Co.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co.
Lear, Inc.
Litton Industries, Maryland Div.
Madigan Corp.
Motorola, Inc.
Northrop Corp.
Servomechanisms, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Theta Instrument Corp.
Thompson Ramo Wooldridge Inc.
Transicoil Div.-Daystrom Inc.
Union Switch & Signal, Div.-Westinghouse Air Brake Co.
Whittaker Gyro. Div.-Telecomputing Corp.

POTENTIOMETERS

- **a. Absolute Pressure**
- **b. Differential Pressure**
- **c. High Resistance**
- **d. High Voltage**
- **e. Induction**
- **f. Linear Motion**
- **g. Linear & Non-Linear Precision Carbon Film**
- **h. Linear & Non-Linear Precision Wire Wound**
- **i. Metallic Film**
- **j. Portable Instrument**
- **k. Precision**
- **l. Precision Auto-Transformer**
- **m. Printed Circuit**
- **n. Rectilinear**
- **o. Slidewire**
- **p. Subminiature**
- **q. Wire Wound**

Ace Electronics Associates, Inc., **c, f, h, k, m, n, p, q.**
Aero Electronics Corp., **m, n, q.**
Allegany Instrument Co., Inc., **f.**
American Electronics, Inc., **e, k.**
Analogue Controls, Inc., **f, h, k, n thru q.**
Associated Engineers, Inc., **c, f, h, q.**
B & H Instrument Co., Inc., **c, h, j, k, o.**
Barco, Inc., **p.**
Bendix Aviation Corp.-Montrose Div., **a, b.**
A. Biederman, Inc., **a, b, j, k.**
Borg Equipment Div., Amphenol-Borg Electronics Corp., **h, k, n, o, p.**
Bourns, Inc., **a, b, c, f thru i, m thru q.**
***BRISTOL CO., THE, k, o.**
Brys Instrument Co., **c, d, f, h, k, m thru q.**
Calvert Electronics Inc., **j.**
Carter Mfg. Corp., **d, f, h, k, m thru q.**
Central Scientific Co., **o.**
Centralab, Div.-Globe-Union, Inc., **f, h, m, p, q.**
Clarostat Mfg. Co., Inc., **c, d, f, h, j, k, m, n, p, q.**
G. L. Collins Corp., **e, l.**
Colvin Labs., Inc., **a, b, f, h, n, p.**
Components Corp., **h, k, q.**
Computer Instruments Corp., **a thru g, k, n, p.**
Computer Systems, Inc.
***CONSOLIDATED ELECTRODYNAMICS CORP., a, b.**
Continental-Wirt Electronics Corp., **m, q.**
Dale Products, Inc., **m, p, q.**
Daven Co., The, **c, d, h, i, k, p, q.**
Joe Davidson & Associates, **e.**
Daystrom, Inc., Military Electronics Div., **h, k, p, q.**
Daystrom Inc., Pacific Div., **a thru d, i, k, p, q.**
Daystrom Inc., Transicoil Div., **e, h.**
Daystrom Inc., Weston Instruments Div., **i, k.**
Dejur-Amsco Corp., Electronic Sales Div., **c, d, f, h, k, n, p, q.**
Diehl Mfg. Co., **e.**
Edcliff Instruments, **a, b, f, q.**
Electromath Corp., **c, d, f, h, k, p, q.**
Elektro-Serv Co., **f, g, k, n.**
Ellison Draft Gage Co., Inc., **b, j.**
Erie Resistor Corp., **p, q.**
Fairchild Controls Corp., **a thru f, h, i, k, l, n, p, q.**
Fairchild Controls Corp., Components Div., **a, b, c, f, g thru i, p, q.**
Fisher Scientific Co., Maryland, **k.**
Ford Instrument Co., Div.-Sperry Rand Corp., **f, k, q.**
Foxboro Co., The, **j.**
Gamewell Co., The, **c, d, h, k, m, o, p, q.**
General Controls Co., **h, j, k, n, q.**
General Electric Co., Apparatus Sales Div.
General Radio Co., **h, q.**
Glassco Instrument Co., **a, b.**
Gray Instrument Co., **j, k.**
Guidance Controls Corp., **h, k, q.**
Harco Labs., Inc.
George E. Harris & Co., Inc., **b, f, n.**
Helipot Div.-Beckman Instruments, Inc., **c thru f, h, i, n, o, q.**
Humphrey, Inc. Electro Mechanical Instruments, **a, b, c, f, k, n.**
Huyck Systems Co., **b, c, d.**
Industrial Instruments Inc., **k.**
Javex Electronics, **q.**
***KEARFOTT DIV., GENERAL PRECISION, INC., e.**
Wayne Kerr Corp., **k.**
Ketay Dept., Norden Div., United Aircraft Corp., **h, k, n thru q.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **m.**
Lear, Inc., **c, e, f, g, i thru p.**
Leeds & Northrup Co., **j, k, o.**
Legris Resistor Corp., **g, h, i, k, o, p, q.**
***WALLACE O. LEONARD, INC., a, b.**
Lewis Engrg. Co., The, **j.**
Litton Industries, Inc., **k.**
P. R. Mallory & Co. Inc., **d, f, g, h, m, p, q.**
Markite Corp., **f, g, k, n.**
***MARTIN CO., THE, DENVER DIV., b, f, j, o.**
Maurey Instrument Corp., **c thru f, h, k, m, p, q.**
Minco Products, Inc., **n.**
Minneapolis-Honeywell Regulator Co.-Aeronautical Div., **h.**
Muirhead Instruments Inc., **o.**
Networks Electronic Corp., **f.**
New England Instrument Co., **c, h, j, k, m, n, q.**
Norden Div., United Aircraft Corp., **h, k, q.**
Northrop Corp.
Palo Alto Engrg. Co., **c, h, q.**
Perkin-Elmer Corp., **l.**
Pickering & Co., Inc., **e.**
Precision Line Inc., **c, d, g, h, k, m thru q.**
Q-Circuits, Div.-Etching Co. of Calif., **m.**
Rahm Instruments Div.-American Macnine & Metals, **a, b, c, q.**
Rinco, Inc., **h, k, o, q.**
Rockwood Sprinkler Co., Div.-The Gamewell Co., **c, e thru h, k.**
San Fernando Electric Mfg., Co., **k, q.**
Servomechanisms, Inc., **i.**
Servonic Instruments, Inc., **a thru d, f, h, k, n, o, q.**
Shallcross Mfg. Co., **c, d.**
Sorensen & Co., Inc., **d.**
Specialties, Inc., **h, q.**
Spectrol Electronics Corp., **c, h, k, m, o, p, q.**
H. W. Sullivan Ltd., **a, k, o.**
Systron Corp., **j, n.**
Technique Associates Div., Duncan Electric Co., Inc., **j.**
Technology Instruments Corp., **a thru d, f, thru i, k, m thru q.**
Thermo Electric Co., Inc., **j.**
Tingstol Co., **m.**
Transformers, Inc., **l.**
Transicoil Div.-Daystrom Inc., **e.**
Trans-Sonics, Inc., **a, b.**
Tucson Instrument Corp., **f, h, i, k, m, o, p, q.**
Vernistat Div., The Perkin-Elmer Corp., **h, k, l, q.**
Virginia Electronics Co., Inc., **l.**
Waters Mfg., Inc., **c, h, k, m, p, q.**
Wells Industries Corp., **f, h, k, m thru q.**
Wesrep Corp., **f, g, h, k, n, q.**

POTS, SOLDERING

American Gas Furnace Co.
Bios Labs., Inc.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
***MARTIN CO., THE, DENVER DIV.**
Temperature Engrg. Corp.
Waage Electric, Inc.
Western Coating Co.

POTS & TANKS, HEATING

Anchor Metal Spinning Co., The
Bethlehem Steel Co.
General American Transportation Corp.
General Electric Co., Apparatus Sales Div.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Hevi-Duty Electric Co., Div.-Basic Products Co.
A. F. Holden Co., The
Lukens Steel Co.
McCathron Boiler Works Co., Inc.
Nooter Corp.
Pyles Industries, Inc.
Edw. Renneburg & Sons Co.
Rolock Inc.
Seal-Peel, Inc.
Temperature Engrg. Corp.
Waage Electric, Inc.
Western Coating Co.

POWER ABSORBERS

Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Sun Electric Corp., Aeronautical Div.
Western Design, Div.-U. S. Industries, Inc.

POWER SOURCES, GROUND

- **a. Electric**
- **b. Hydraulic**
- **c. Mechanical**
- **d. Pneumatic**
- **e. Prime Mover**

Adel Precision Products of Calif., Div.-General Metals Corp., **b.**
***AEROJET-GENERAL CORP., a, b, d.**
Air Logistics Corp.
Aircraft Accessory Turbine Dept.-General Electric Co., **a, c.**
***AIRESEARCH MFG. OF ARIZONA., a, c.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, c, d, e.**
Allied International Corp., **a.**
Allis-Chalmers, **a.**
Allison Div., General Motors Corp., **c.**
American Brake Shoe Co., Kellogg Div., **b.**
American Electronics, Inc.
American Machine & Foundry Co., Greenwich Engrg. Div., **b.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **d.**
Auto-Control Labs. Inc., **b, d.**
Beech Aircraft Corp., **a.**
Bendix Aviation Corp., **a thru d.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., a thru d.**
Bendix Utica Div., Bendix Aviation Corp., **a thru d**
Bogue Electric Mfg. Co., **a, d.**
Caterpiller Tractor Co., Defense Products Dept., **a, b, c, e.**
Clark Bros. Co., Div.-Dresser Operations, Inc., **a, d, e.**
Consolidated Diesel Electric Corp., **a thru e.**
Continental Motors Corp., **c, e.**
Cornelius Co., The, Aero Div., **b, d.**
Daven Co., The, **a.**
Joe Davidson & Associates, **a.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **a.**
Delco Radio Div.-General Motors Corp., **a.**
Eagle-Picher Co., The, **a.**
Eastern Industries Inc., **b.**
Electrosolids Corp., **a.**
Farwest Mfg. Div., Inc., **a.**
Ferrotran Electronics Co., Inc.
Flight Support, Inc., **a thru d.**
Food Machinery & Chemical Corp., Ordnance Div., **a.**
General Electric Co., **a.**
General Electric Co., Apparatus Sales Div., **a.**
General Regulator Corp., **b.**
Gremco, Inc., **a thru d.**
Hallamore Electronics Co., Div.-Siegler Corp. **a, e.**
Hammett-Mercury-Rex Div., **a.**
George E. Harris & Co., Inc., **a.**
Haskel Engrg. & Supply Co., **b, d.**
Hertner Electric Co., The, **a.**
Hobart Brothers Co., **a.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., b, c, d.**
Huck Mfg. Co., **b.**
Hughes Tool Co., Aircraft Div., **a, b, d.**
Hydra-Power Corp., **b, d.**
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., **b.**
Indiana Gear Works, Inc.
Integral Corp., **b.**
International Fermont Machinery Co., Inc., **a, e.**
Jack & Heintz, Inc., **a.**
Janke & Co, Inc., **b, c.**
Jeta, Inc., **a, e.**
Joy Mfg. Co., **d.**
Kahn & Co., Inc., **a, b, d.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **d.**
Kieley & Mueller, Inc., **b, c, d.**
Leach Corp., **a, c, e.**
Lear, Inc., **a, b, c, e.**
Lee Electric & Mfg. Co., **a.**
Leece-Neville Co., The, **a.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **a.**
Lockheed Aircraft Corp., Missiles & Space Div., **a.**
***MARTIN CO., THE, DENVER DIV., a, b, d.**
Motor Generator Corp., **a.**
Mullenbach Div.-Electric Machinery Mfg. Co., **a.**
J. E. Myles, Inc., **b.**
National Cylinder Gas, Div.,-Chemetron Corp., **a.**
New York Air Brake Co., The, Watertown Div., **b.**
Nutron Mfg. Co. Inc., **a.**
D. W. Onan & Sons Inc., **a, e.**
Owatonna Tool Co. Precision Hydraulic Div., **b.**
Pacific Automation Products, Inc., **a.**
Patternson Moos Research, Div.-Leesona Corp., **a.**

Perkin Engrg. Corp., **a.**
Pesco Products Div.-Borg-Warner Corp., **a, b.**
REF Mfg. Corp., **b.**
Radio Development & Research Corp., **a, b.**
Robat Industries Inc., **a, b, c, e.**
Rucker Co., The, **b, d.**
Sangamo Electric Co., **a.**
Sargent Engrg. Corp., **b.**
Servo-Tek Products Co., **a, d, e.**
Solar Aircraft Co.
Stewart & Stevenson Services, Inc., **a thru e.**
Sun Electric Corp., Aeronautical Div., **a thru e, h, k, l.**
Talley Corp., The, **a, c, d, e.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, c.**
Temco Aircraft Corp., **a, b, d.**
Thompson Ramo Wooldridge Inc., **a, b, c.**
Trans-Sil Corp., **a.**
Twin Coach Co., Aircraft-Missiles, **e.**
United Mfg. Co., Div., The W. L. Maxson Corp., **b.**
Varo Mfg. Co., Inc., **a thru e.**
Vickers Inc., Div.-Sperry Rand, **b, e.**
Vickers, Inc., Mich., **a, b, c, e.**
***WEATHERHEAD CO., THE., a thru d.**
Wells Industries Corp., **b, d.**
Wesrep Corp., **a.**
Western Gear Corp.-Precision Products Div., **a thru e.**
Western Electric Corp., **a.**
Wickfield, Inc., **b, d, e.**
Winder Aircraft Corp. of Florida, **a, c.**
Wolverine Diesel Power Co., **a thru e.**
Worthington Corp., **a, d, e.**

POWER SUPPLIES

a. AC
b. DC
c. Emergency, Mobile
d. 400 Cps
e. High Voltage
f. Klystron
g. Magnetic
h. Regulated
i. Seals
j. Transmitter
k. Transistor
l. Variable
m. Voltage Regulated

ACDC Electronics, Inc., **a thru e, g, h, j, k, m.**
ACF Electronics Div., ACF Industries Inc., **g.**
ACF Industries Inc., **a, b, g, h.**
ADC Inc., **a, b, d, e, h, j thru m.**
AMP Inc., **e, f.**
Acme Electric Corp., **a, b, d, f, g, h, j, l, m.**
Admiral Corp., **k.**
***AEROJET-GENERAL CORP., a, b, d.**
Aerotest Laboratories, Inc., **a, b, d.**
Air Logistics Corp., **a thru d, h, k, l, m.**
Air Reduction Sales Co., Div.-Air Reduction Co. Inc., **a, b.**
Airborne Accessories Corp., **d.**
Aircom Inc., **b, f, m.**
***AIRESEARCH MFG. OF ARIZONA, a, b, d.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP. a, b, d, h, k, l, m.**
Airpax Electronics Inc., Cambridge Div., **a, d.**
Airpax Electronics Inc., Seminole Div., **a, d.**
Alfred Electronics, **a, b, f, l, m.**
All American Engrg. Co., **a, b, g, m.**
Allegany Instrument Co., Inc., **a, b.**
Allen Electric & Equipment Co., **b, k.**
Allied International Corp., **a thru d.**
Allis-Chalmers, **a, b, c, g, m.**
American Electronic Labs., Inc., **b, h.**
American Electronics, Inc., **a, b, d, e, g, h, k, l.**
American Rectifier Corp., **b, c, e, g, h, l, m.**
American Research & Mfg. Corp., **a, b, c, e, g, h, i, k, l, m.**
American Speedlight Corp., **k.**
American Tradair Corp., **k.**
Arnold Magnetics Corp., **b, d, h, k, m.**
***ARNOUX CORP., a, b, d, e, g thru k, m.**
Associated Engineers, Inc., **a, b.**
Associated Research, Inc., **a, b, e, h, m.**
Associated Specialties Co., **m.**
Astra Tech, **b.**
Autotronics Inc., **b.**
B & F Instruments, Inc., **b, m.**
Barwood Electronics Inc., **a, b, d.**
Beech Aircraft Corp., **b.**
Behlman Engrg. Co., **a, d, l.**
Belock Instrument Corp., **a, b, d, h, k, m.**
Bendix Aviation Corp., **a,** b, d.
Bendix Aviation Corp., Cincinnati Div., **a, b, d, e, g, h, j, l, m.**
Bendix Utica Div., Bendix Aviation Corp., **a, b, d.**
Bergen Labs., Inc., **h, k, m.**
Beva Lab., Inc., **b, e, h.**
A. Biederman, Inc., **j.**
Bogue Electric Mfg. Co., **a thru h, j thru m.**
Arthur E. Booth Co., **a, b, l.**
Brach Mfg. Corp., **a, b, d, e, g, h, k, m.**
Bruno-New York Industries Corp., **b, e, h, m.**
Budd Lewty Electronics, Inc., **a, b, e, h, j thru m.**
CBS Laboratories, Div.-Columbia Broadcasting System, **j.**
CG Electronics Corp., **b, j.**
Caledonia Electronics & Transformer Corp., **e, k, m.**
Carol Electronics Corp., **a, c, m.**
Carson Mach & Supply Co., **c.**
Caterpillar Tractor Co., Engine Div., **c, d.**
Caterpillar Tractor Co., Industrial Engine Plant, **c, d.**
Central Transformer Co., **e.**
Chalco Engrg. Corp., **a, b, d, h, k, l, m.**
Chance Vought Aircraft, Inc., **a, b, d, h, j, l, m.**
Chatham Electronics Div.-Tung-Sol Electric Inc.,**b.**
Clegg Labs., Div.-Clegg, Inc., **b, e, f, h, j, l, m.**
Coil Co. of America, **a, b, d, e, g, l, m.**
G. L. Collins Corp., **a, h, l, m.**
Collins Radio Co., **a, b, c, e, j, k.**
Colorado Research Corp., **b, k, m.**
***COMMERICAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., a, b, d thru h, l, m.**
Communication Measurements Lab., Inc., **a, d, h, l, m.**
Computer Engrg. Associates, Inc., **a, b, c, g, h, k, l, m.**
Connecticut Hard Rubber Co., The, **i.**
Consolidated Airborne Systems, Inc., **a, d, m.**
Consolidated Diesel Electric Corp., **a thru d.**
***CONSOLIDATED ELECTRODYNAMICS CORP., a, b, d, h, k.**
Consolidated Vacuum Corp., **b.**
Control Circuits Inc., **g.**
Control Electronics Co., Inc., **j, m.**
Cornell-Dubilier Electric Corp., **a, b, c, h, k.**
Cosmic Instruments Inc., **a, b, j, m.**
Cubic Corp., **f.**
Curtiss-Wright Corp., Santa Barbara Div., **a, b.**
Daven Co., The, **a thru e, h, j thru m.**
Davenport Mfg. Co., **a, b, d, e, h, l, m.**
Joe Davidson & Associates, **a thru e, h, k, l, m.**
Daystrom, Inc., Control Systems Div., **b, m.**
Dayton Aircraft Products, Inc., **e.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **a thru d, g, h, k, l, m.**
Del Electronics Corp., **a, b, d, e, g, h, k, l, m.**
Delco Radio Div.-General Motors Corp., **a, b, d, h, k, l, m.**
***DEL MAR ENGRG. LABS., b, e, h.**
Delson Corp., **b, e, h, l.**
Deltron Inc., **a, b, d thru h, j thru m.**
Deluxe Coils Inc., **e.**
Djeco, Div.-Djordjevic Engrg. Co., **a, b, d, e, g, h, i, k, l, m.**
Dressen-Barnes Corp., **b, h, k, l, m.**
Dresser Electric Co., **b, e.**
Du Kane Corp.
Dynamic Controls Co., **a, b, g, h, k, l, m.**
Dynamics Instrumentation Co., **b, k, l.**
Dynatronics, Inc., **b, h.**
Eagle-Picher Co., The, **b.**
Edgerton, Germeshausen & Grier, Inc., **e.**
Eicor Div.-Scranton, **a, b, d, h, k, m.**
Elcor, Inc., **b, e, h, k, l, m.**
Electric Machinery Mfg. Co., **d.**
Electric Engrg. Works, **a, d, e, f.**
Electro Instruments, Inc., **b, h, k, l, m.**
Electro Powerpacs, Inc., **a.**
Electro Precision Corp., **h.**
Electro Products Labs., Inc., **b, k, m.**
Electronic Brazing Co., **e.**
Electronic Measurements Co., Inc., **b, h, k, l, m.**
Electronic Specialty Co., **a, b, h, m.**
Electrosolids Corp., **a, b, d, h, k, m.**
Elin Div., International Electronic Research Corp., **a, d, e, h, m.**
Empire Products Sales Corp., **a, f, l.**
Endevco Corp., **m.**
Engrg. Specialties, **k.**
***ENGIS EQUIPMENT CO., a, b, h, m.**
Ensco, Inc., **b, h, k, l, m.**
***EQUIPMENT DIV., RAYTHEON CO.,a, b, d thru h, j thru m.**
Eureka Williams Corp., **b.**
FXR, Inc., **e, f, j, m.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **a, b, d, h, l, m.**
Fairfield Engrg. Corp., **a, b, d, g, l, m.**
Fonsteel Metallurgical Corp., **b, h, m.**
Farwest Mfg. Div., Inc., **a thru d, k, l, m.**
Ferrotran Electronics Co., Inc., **a, b, d, f, k, l, m.**
Fidelity Instrument Corp., **a, b, d, h, l, m.**
Film Capacitors, Inc., **a, b, d, e, h, l.**
Filtron Co., Inc., **a, d, e.**
Fla. Aircraft Radio & Marine, **a, b, d, e, j.**
Flight Support, Inc., **a thru d, h, l, m.**
Flite-Tronics, Inc., **a, b, h, k, m.**
John Fluke Mfg. Co., Inc., **b, e, f, h, k, l, m.**
Food Machinery & Chemical Corp., Ordnance Div., **b, m.**
Foto-Video Labs., Inc., **a, b, c, d, e, h, m.**
Freed Transformer Co., Inc., **a, b.**
GPL Div.-General Precision, Inc., **h.**
Gates Electronic Co., **b, g, h, k, l, m.**
Gates Radio Co., **b, e, j thru m.**
General Devices, Inc., **a, b, d, g, h, j, k.**
General Electric Co., **a, b, e thru h, k, l, m.**
General Electric Co., Apparatus Sales Div., **a thru e, h, j thru m.**
General Instrument Corp., Defense & Engrg. Products Group, **a thru d, h, j, thru m.**
General Magnetics, Inc., **a, b, g.**
General Radio Co., **a, h, l, m.**
Georator Corp., **a thru d, l, m.**
Paul E. Gerst & Co., **a, b, d, g, h, l, m.**
Gilfillan Bros. Inc., **a, b, d, f, j, m.**
Gremco, Inc., **a thru d, h.**
Gyrex Corp., The, **a, d.**
Hagan Chemicals & Controls Inc., **h.**
Hallamore Electronics Co., Div.-Siegler Corp., **b, h.**
Hammarlund Mfg. Co., The, **b, m.**
Hammett-Mercury-Rex Div., **a thru m.**
George E. Harris & Co., Inc., **a, b, d, h, m.**
Harrison Labs., Inc., **b, e, h, k, l, m.**
Hathaway Instruments, Inc., **a, d.**
Hazeltine Electronics Div.-Hazeltine Corp., **j.**
Hertner Electric Co., The, **a, b, d, e.**
Hewlett-Packard Co., **b, e, f, h, k, l, m.**
Hobart Brothers Co., **a, b, c.**
Hol-Gar Mfg. Corp., **a thru d, m.**
Hoover Electric Co., **a, b.**
Hoover Electronics Co., **a, b, k, m.**
Huyck Systems Co., **a, b, k.**
ITI Electronics, Inc., **a, b, k, l, m.**
ITT Federal Div., International Telephone & Telegraph Corp., **a thru f, h, j thru m.**
Iconix Inc., **e.**
Industrial Test Equipment Co., **a, d, h, l, m.**
Industron Corp., **e, j.**
Infrared Industries, Inc., **b.**
Intercontinental Dynamics Corp., **b, h.**
Intercontinental Electronics Corp., **b, g, m.**
***INTERELECTRONICS CORP., a, b, d, e, g, h, j thru m.**
International Electronics Research Corp., **a, d, h, l, m.**
International Fermont Machinery Co., Inc., **a thru e.**
Interstate Electronics Corp., **a, b, e, h.**
Jack & Heintz, Inc., **a, b, d, g, h, k, m.**
James Electronics Inc., **b, k.**
Jeta, Inc., **a thru d, m.**
Johnson Electronics Inc., **a, b, c, f, h, j, k, m.**
Jordon Electronics, Div.-Victoreen Instrument Co., **a, b, d, e, h, k, m.**
Kahn & Co., Inc., **b.**
Kato Engrg. Co., **a thru e, g, h, l, m.**
Kay Electric Co., **f.**
Keithley Instruments, Inc., **b, e, h, m.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **b, h, m.**
Kepco, Inc., **b thru h, k, l, m.**
Kin Tel Div.-Cohu Electronics, Inc., **b,h,m.**
Kingston Electronics-Div.-Kingston Industries Inc., **b.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **a, b, d, g, h, m.**
Lambda Electronics Corp., **b.**
Leach Corp., **a thru e, g, h, k, l, m.**
Lear, Inc., **a thru d, h, k, l, m.**
Lee Electric & Mfg. Co., **b, c, e, g, h, k, l, m.**
Leece-Neville Co., The, **a, b, c, h, m.**
Leemath Inc., **a, b, e, l, m.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **a thru e, g, h, k, l, m.**
Levinthal Electronic Products, Inc., **e, f, j.**
Lincoln Electric Co., The, **a, c.**
Lockheed Electronics Co., Stavid Div., **b, d, k.**
MB Electronics, **a, b, k.**
MEG Products, Div.-Mandrel Industries, Inc., **a, b, d, k, l, m.**
Madigan Corp., **a thru d, h, j, k, m.**
Magnetic Circuit Elements, Inc., **a, b, d, g, h, m.**
Magnetic Controls Co., **a, b, d, g, h, k, m.**
Magnetic Instruments Co. Inc., **e, m.**
Magnetic Research Corp., **a, b, d, g, k, m.**
Maico Electronics, Inc., **b, m.**
P. R. Mallory & Co. Inc., **a, b, k.**
Manhattan Lighting Equipment Co., Inc., **m.**
Manson Labs., Inc., **a, b, d, e, f, h, j, l, m.**
***MARTIN CO., THE, DENVER DIV., a, b, d, h, j, l, m.**
Master Specialties Co., **a, b, k.**
W. L. Maxson Corp., The, **h, k.**
Micro Gee Products, Inc., **a, b, g, h, k, l, m.**
Midwestern Instruments, Inc., **b.**
James Millen Mfg. Co. Inc., **b, e, j.**
Sanford Miller Co., **b.**
Milro Controls Co., Inc., **a, b, d, e, g, h, m.**
Mira Corp., The, **b, h, k, m.**
Model Rectifier Corp., **b, d, h, k, l, m.**
Modern Design Div.-H. C. Schloer, Inc., **b, d, h, k, m.**
Moran Instrument Corp., **b, e, h.**
Motor Generator Corp., **a thru d, h, m.**
Motoresearch Co., **a, b, d, e, g, h, m.**

Motorola, Inc., **a, b, d thru h, j thru m.**
Heinz Mueller Eng. Co. Inc., **b.**
Mullenbach Div.-Electric Machinery Mfg. Co., **b, h, m.**
Multi-Amp Electronic Corp., **a, b.**
NJE Corp., **a, b, e thru h, k, l, m.**
Norda Microwave Corp., The, **f.**
National Co., Inc., **b, e, f, h, j thru m.**
Navigation Computer Corp., **b, h, k.**
Neff Instrument Corp., **b, k, l, m.**
Networks Electronic Corp., **a, b, d, g, h, k, l, m.**
New London Instrument Co. Inc., **e, l, m.**
New York Transformer Co. Inc., **a, b, d, g, h, m.**
Northeast Scientific Corp., **b, e, f, h, l, m.**
Northrop Corp.
Northwestern Electric Co., **a, b, h.**
Nuclear-Chicago Corp., **m.**
Paul Nurches Co., **b, f, h, k, l, m.**
Nutron Mfg. Co. Inc., **a thru d, g, h, k, l, m.**
D. W. Onan & Sons Inc., **a, b, c.**
Opad Electric Co., **a thru h, j thru m.**
Otis Elevator Co., Defense & Industrial Div., **e, m.**
Otis Elevator Co., Defense & Industrial Div., **e, m.**
Owen Labs., Inc., **b, h, k, m.**
Pacific Automation Products, Inc., **a, b, k, l, m.**
Pacific Magnetic Corp., **a, b, d, g.**
Packard Bell Computer Corp., **k, m.**
Paco Electronics Co., Inc., **m.**
Pass & Seymour, Inc., Defense Div.,
Patterson Moos Research, Div.-Leesona Corp., **b, e, m.**
Pegasus Labs., Inc., **b, k.**
Penn Keystone Corp., **h, m.**
Performance Measurements Co., **b, k, m.**
Perkin Engrg. Corp., **a, b, e, g, h, k, l, m.**
Permoflux Products Co., **b, d, e, m.**
Peschel Electronics, Inc., **a, b, d, e, l.**
Pesco Products Div., Borg-Warner Corp., **a, b.**
Pesco Products Div., Borg-Warner Corp., Calif., **a thru d, h, k, m.**
Piasecki Aircraft Corp., **b, l, m.**
Plastic Capacitors, Inc., **b, d, e, h, l, m.**
Polarad Electronics Corp., **f.**
Polytechnic Research & Development Co., Inc., **f.**
Power Supplies Inc., **a, b, d, e, g, h, k, m.**
Precise Development Corp., **a, b, m.**
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.,**a, b, d.**
Pressman Associates Inc., **b, k, m.**
Process & Instruments, **b.**
Projects Unlimited, Inc., **b, h.**
Quan-Tech Labs., Inc., **b, h, k, l, m.**
RS Electronics Corp., **e, f, k.**
Radex Corp., **e.**
Radiaphone Co. Inc., **k.**
Radiation, Inc., **e, f, h, j, k, m.**
Radiation Instrument Development Lab., Inc., **e.**
Radio City Products Co. Inc., **b, e, h, l.**
***RADIO CORP. OF AMERICA**
***RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY b, d, h.**
Radio Development & Research Corp., **a thru e, h, k, l, m.**
Radio Frequency Co., Inc., **e.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **a thru d, h, j thru m.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **a, b, d, h, k, m.**
Redmond Co., Inc., Sub.-Controls Co. of America, **a, b, d.**
Reflectone Electronics, Inc., **k, m.**
Resitron Labs., Inc., **e.**
Riverbank Labs., Dept.-Engrg., **a.**
J. R. Robbins Co., **k.**
S & G. Mfg. Corp., **b, c.**
Safety Electrical Equipment Corp., **a, b, d, h, l, m.**
Sage-Craft, Inc., **b, g.**
Sangamo Electric Co., **a, b, d, e, h, m.**
Schaevitz Engrg., **a, b.**
Sciaky Brothers, Inc., **a, b, e, m.**
Scientific Electric Inc., **a, b, e, h, l, m.**
Scientific-Atlanta, Inc., **e, l.**
Secode Corp., **b.**
Sensitive Research Instrument Corp., **a, b, l, m.**
Servomechanisms, Inc., **a, b, d, e, g.**
Servo-Tek Products Co., **b, m.**
Signal Equipment Co., Inc., **a, d, l.**
Small Motors Inc., **a, b, d.**
Solar Aircraft Co., **b.**
Sonotone Corp., **b, h, k, m.**
Sorensen & Co., Inc., **a, b, d, e, g, h, l, m.**
Southwest Research Institute, **a, b, d, e, g, h, k, l, m.**
Southwestern Industrial Electronics Co.
Specialty Electronics Development Corp., **a, m.**
Specific Products, **l.**
Spectrol Electronics Corp., **a thru d, h, k, m.**
Spellman High Voltage Co., **b, e, h, l, m.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **f.**
Standard Electronics Div.-Reeves Instrument Corp., **a, b, d, e, h, j thru m.**
State Testing Laboratory Inc., **b, l.**
Statham Development Corp., **b, m.**
Statham Instruments, Inc., **m.**
Stewart & Stevenson Services, Inc., **a thru d.**
Stewart-Warner Electronics Div., **a, b, h, k.**
Stromberg-Carlson Div.-General Dynamics Corp., **b.**
Sunair Electronics, Inc., **a, b, d, k.**
Sundstrand Turbo, **a, b, d.**
Superior Electric Co., The, **a, b, l.**
TRG, Inc., **k, m.**
Taffet Electronics, Inc.
Talley Corp., The, **a, b, d.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, b, d, m.**
Technical Apparatus Builders, **a, b, e, h, k, m.**
Technical Materiel Corp., The
Telechrome Mfg. Corp., **a, b, d, e, h, j thru m.**
Telectro Industries Corp., **a thru e, g, j, l, m.**
Telex, Inc., **a, b, d, g.**
Tel-Instrument Electronics Corp., **d, h, l.**
Telkor, Inc., **a, b, d, h, k, l, m.**
Thermador Electrical Mfg. Co., **a, b, d, g, h, k, l, m.**
Thompson Ramo Wooldridge Inc., **a, b, d, m.**
Torwico Electronics, Inc., **a, b, d, g, h, m.**
Traid Corp., **b.**
Trans Electronics, Inc., **a, b, d, e, g, h, k, l, m.**
Transformer Specialty Co., **g.**
Transistor Devices Inc., **a, b, e, h, k, l, m.**
Trans-Sil Corp., **b, e, h, l, m.**
Trans-Sonics, Inc., **b.**
Tresco, Inc.
Tung-Sol Electric, Inc., **a, b, d.**
United Aircraft Products, Inc., **i.**
U. S. Industries, Inc., **a, b, h, m.**
Universal Electronics Co., **b, d, g, h, k, l, m.**
Universal Transistor Products Corp., **a thru h, j thru m.**
Valor Instruments, Inc., **b, c, d, h, k, l, m.**
Varo Mfg. Co., Inc., **a thru h, j thru m.**
Vickers Inc., Electric Products Div., **a, b, d, g, h, l, m.**
Vickers, Inc., Mich., **a thru d, h, l, m.**
Video Instruments Co., Inc., **b, h, k, l, m.**
Viking Industries Inc., **b, m.**
Virginia Electronics Co., Inc., **a, b, c, e, h, j, k, m.**
Wahlgren Magnetics, Div.-Marshall Industries, **a, b, d, g, h, k.**
Wallson Associates, Inc., **a, b, d thru h, j thru m.**
Weltronic Co., **a, b.**
Wesrep Corp., **a, b, h, l, m.**
Westinghouse Electric Corp., **a thru f, h, j thru m.**
Wheeler Electronics Corp., Sub.-Sperry Rand Corp., **a, b, h, k, l, m.**
Wickes Engrg. & Construction Co., **a thru e, g, h, j thru m.**
Wincharger Corp., Sub.-Zenith Radio Corp., **m.**
Winder Aircraft Corp. of Florida, **a, b, l, m.**
Wolverine Diesel Power Co., **a thru e, h, k, l, m.**
Worthington Corp., **a, b, d.**
Zacharias Electronics Corp., **b, h, m.**

PRECIPITATORS, ELECTROSTATIC

Bendix Utica Div., Bendix Aviation Corp.
Dayton Aircraft Products Inc.
Del Electronics Corp.
General American Transportation Corp.
Koppers Co., Inc., Metal Products Div.
Mamco Corp.
Radex Corp.
Small Motors Inc.
Spellman High Voltage Co.
Westinghouse Electric Corp.

PRE-SELECTORS

FXR, Inc.
General Instrument Corp.,:Defense & Engrg. Products Group
Interstate Electronics Corp.
Meridian Metalcraft, Inc.
Motorola, Inc.
National Co., Inc.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Republic Aviation Corp., Missile Systems Div.

PRESSES, METAL FORMING

Cyril Bath Co., The
E. W. Bliss Co.
California Stamping & Mfg. Co.
Chambersburg Engrg. Co.
Cincinnati Milling Machine Co., The
Cincinnati Shaper Co., The
Henry & Miller Industries, Inc.
High Speed Hammer Co., Inc., The
Hughes Tool Co., Aircraft Div.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co.
Niagara Machine & Tool Works
Oliver Corp., The-A. B. Farquhar Div.
Richard Philip Co.
Pines Engrg. Co. Inc.
Pioneer Industries Div., Almar-York Co. Inc.
Portland Copper & Tank Works Inc.
Rotex Punch Co., Inc.
Rucker Co., The
Joseph T. Ryerson & Son, Inc.
Sheridan-Gray, Inc.
F. J. Stokes Corp.
Roland Teiner Co. Inc.
Verson Allsteel Press Co.
Whitney Metal Tool Co.

PRESSURE INSTRUMENTS

Aero Research Instrument Co. Inc.
Aerotec Industries Inc., Aircraft Equipment Div.
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alloy Bellows Inc.
American Instrument Co., Inc.
Amthor Testing Instrument Co., Inc.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Bendix Aviation Corp.-Montrose Div.
A. Biederman, Inc.
***BRISTOL CO., THE**
Budd Co., The
Colvin Labs., Inc.
Consolidated Controls Corp.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Custom Component Switches Inc.
Daystrom Inc., Pacific Div.
Dynametrics Corp.
Dynisco, Inc.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
Edwards High Vacuum Ltd.
Ellison Draft Gage Co., Inc.
Fischer & Porter Co.
Gilmore Industries, Inc.
Glassco Instrument Co.
B. F. Goodrich Aviation Products
Gulton Industries, Inc.
Hagan Chemicals & Controls Inc.
Haskel Engrg. & Supply Co.
Helicoid Gage Div., American Chain & Cable Co., Inc.
E. Vernon Hill & Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co.
Leslie Co.
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Industrial Div.
Pacific Scientific Co.
Photocon Research Products
Rahm Instruments Div.-American Machine & Metals
Reed Instrument Co.
Reed Research Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Rosemount Engrg. Co.
Scanivalve Co.
Servomechanisms, Inc.
Southwest Research Institute
Space Components, Inc.
Standard Controls, Inc.
Statham Instruments, Inc.
***TABER INSTRUMENT CORP.**
Technology Instrument Corp.
Trans-Sonics, Inc.
Trimount Instrument Co.
Ultradyne, Inc.
United Aircraft Products, Inc.
United Electric Controls Co.
Weksler Instruments Corp.
Westport Development & Mfg. Co., Inc.

PRESSURIZATION UNITS

Accessory Products Co., Div.-Textron Inc.
Aero-Test Equipment Co., Inc.
***AiRESEARCH MFG. OF ARIZONA**
Airtron, Div.-Litton Industries
American Instrument Co., Inc.
American Machine & Foundry Co., Government Products N. Y.
American Research Corp.
Applied Dynamics Corp.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp.
Bendix Utica Div., Bendix Aviation Corp.
Brooks & Perkins, Inc.
Budd Lewyt Electronics, Inc.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Cornelius Co., The, Aero Div.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Futurecraft Corp.
B. H. Hadley, Inc.
Hamilton Standard, Div.-United Aircraft Corp.
Hydra-Power Corp.
Kahn & Co., Inc.
Kemp Aero Products
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Thomas J. Long, Inc.
Mc Cormick Selph Associates
Micro Gee Products, Inc.

Edw. Renneburg & Sons Co.
Research Controls
Robertshaw-Fulton Controls Co., A & I Div.
S & G Mfg. Corp.
Southwest Research Institute
Trinity Equipment Corp.
United Electric Controls Co.
Wells Industries Corp.

PRINTED CIRCUITS

ACF Electronics Div., ACF Industries Inc.
Adept Industries Inc
Advance Industries, Inc.
All American Engrg.Co.
American Printed Circuits Co., Inc.
Arthur Ansley Mfg. Co.
***ARNOUX CORP.**
Associated Engineers, Inc.
Belock Instrument Corp.
Blonder-Tongue Labs., Inc., Special Products Div.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Budd Co., The
CBS Electronics, Div.-Columbia Broadcasting System Inc.
CG Electronics Corp.
Chalco Engrg. Corp.
Chance Vought Aircraft, Inc.
Chemical Micro Milling Co.
Colorado Research Corp.
Corning Glass Works
Croname Inc.
Delco Radio Div.-General Motors Corp.
Electralab Printed Electronics Corp.
Electronic Circuits
Elektro-Serv Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Gates Radio Co.
General Plastics Corp.
Gladding, McBean & Co.
Globe Electrical Mfg. Co.
B. F. Goodrich Aviation Products
Graphik Circuits, Div.-Cinch Mfg. Co.
Gulton Industries, Inc.
Hansen Electronics Co.
Howard B. Jones Div.-Cinch Mfg. Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
La Pointe Industries Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
Lytle Corp.
P. R. Mallory & Co. Inc.
Mitronics Inc.
Modern Design Div.-H. C. Schloer, Inc.
Molded Insulation Co.
Motorola, Inc.
National Co., Inc.
National Scientific Labs., Inc.
Navigation Computer Corp.
Northrop Corp
Packard-Bell Electronics Corp.
Piasecki Aircraft Corp.
Q-Circuits, Div.-Etching Co. of Calif.
***RADIO CORP. OF AMERICA**
***RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY**
Rogers Corp.
St. Regis Paper Co., Panelyte Div.
Sibley Co., The
Sillcocks-Miller Co.
Space Components, Inc.
Sunair Electronics, Inc
Taylor Fibre Co.
Technograph Printed Electronics, Inc.
Techron Corp.
Thompson Ramo Wooldridge Inc.
Tingstol Co.
Trepac Corp. of America

PROBES

a. Crystal
b. High Frequency
c. High Voltage
d. Measurement
e. Microwave
f. Pitot Static
g. Pressure
h. Temperature

Advanced Electronics, Inc., **g, h.**
Aircom Inc., **a, e.**
Airtron, Div.-Litton Industries, **e.**
***ARNOUX COR**P., **h.**
Baird-Atomic, Inc., a
Barber-Colman Co., h.
Bendix Aviation Corp., f, g, h.
Bogart Mfg. Corp., **e.**
Branson Instruments, Inc., **a.**
Calvert Electronics Inc., **b, c.**
Chance Vought Aircraft, Inc., **e.**
Consolidated Controls Corp., **h.**
Control Circuits Inc., **h.**
Crescent Engrg. & Research Co., **h.**
Curtiss-Wright Corp., Princeton Div., **a.**
Daven Co., The, **a thru d.**
Decker Corp., The, **d.**
Demornay-Bonardi, **e.**
Diamond Antenna & Microwave Corp., **e.**
Dorne & Margolin,Inc., **e.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **g, h.**
Edwards High Vacuum Ltd., **b.**
Eljay Corp., **e.**
FXR, Inc., **a, e.**
Fenwal Inc., **h.**
Flow Corp., **g.**
General Communication Co., **e.**
General Electric Co., Apparatus Sales Div., **h.**
General Instrument Corp., Defense & Engrg. Products Group, **e.**
Gulton Industries, Inc., **h.**
Hammett-Mercury-Rex Div., **a.**
Harco Labs., Inc., **f, g, h.**
Hewlett-Packard Co., **a, e.**
Hickok Electrical Instrument Co., The, **a, b.**
ITI Electronics, Inc., **a, b.**
Illinois Testing Laboratories, Inc., **h.**
Interstate Electronics Corp., **a, b, d.**
J-V-M Microwave Co., **e.**
Javex Electronics, **c.**
Kahn & Co., Inc., **g, h.**
Joseph Kaye & Co., **f, g, h.**
Keithley Instruments, Inc., **c.**
Wayne Kerr Corp., **d, h.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc., **h.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **f, g, h.**
Langley Corp., **h.**
Leeds & Northrup Co., **d, h.**
***LEWIS ENGRG. CO., THE, h.**
Meridian Metalcraft, Inc., **e.**
Microlab, **e.**
Microphase Corp., **e.**
Minco Products, Inc., **h.**
Mitchell Camera Corp., **d, g, h.**
Narda Microwave Corp., The, **e.**
Omega Labs., Inc., **e.**
Paco Electronics Co., Inc., **a thru d.**
Pemco Inc., **f, g, h.**
Phaostron Instrument & Electronic Co., **c.**
Philips Electronic Instruments
Pioneer Industries Div., Almar-York Co. Inc., **a, d.**
Polytechnic Research & Development Co., Inc., **a, e.**
Precise Development Corp., **b, c, d.**
Projects Unlimited, Inc., **a, b.**
Pyrometer Instrument Co., Inc., **h.**
***RADIO CORP. OF AMERICA, a thru e.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **e.**
Rantec Corp., **e.**
Revere Corp. of America, Sub., Nepture Meter Co., **h.**
Rosemount Engrg. Co., **f, g, h.**
Sage Labs., Inc., **e.**
Scientific-Atlanta, Inc., **e.**
Southwest Research Institute, **g, h.**
Specialty Electronics Development Corp., **e.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **e.**
B. K. Sweeney Mfg. Co., **h.**
TRG, Inc., **a, b, e.**
***TABER INSTRUMENT CORP., g, h.**
Technicraft, Div.-Electronic Specialty Co., **e.**
Thermo Electric Co., Inc., **h.**
Transco Products, Inc., **e.**
Trimount Instrument Co., **d.**
Unison Products, Inc., **b.**
Unit Process Assemblies, Inc., **b.**
Victor R. F. & Microwave Co., **a, e.**
Victory Engrg. Corp., **h.**
Wacline, Inc., **e.**
Waste King Corp., Technical Products Div., **f, g, h.**
Waveline, Inc., **e.**
Yellow Springs Instrument Co., The, **h.**
Young Development Div., Hercules Powder Co., **d.**

PROCESSING EQUIPMENT, MOTION PICTURE

Belock Instrument Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Dejur-Amsco Corp., Electronic Sales Div.
Gordon Enterprises
Hazeltine Electronics Div.-Hazeltine Corp
Hi-Speed Equipment, Inc.
J. A. Maurer, Inc.
Metal Fabricators Corp.
Pfaudler Div., Pfaudler Permutit Inc
Viewlex, Inc.

PROPELLANT CASES, SOLID ROCKET

ACF Industries Inc.
Aerocal Div., Aeronca Mfg. Corp.
***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
Allison Div., General Motors Corp.
Aluminum Co. of America
Amcel Propulsion Inc.
American Car & Foundry Div., ACF Industries, Inc.
American Potash & Chemical Corp., National Northern Div
American Tubing Co., Inc.
American Welding & Mfg. Co., The
Arde-Portland, Inc.
Armament Div.-Universal Match Corp.
Atlantic Research Corp.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Beech Aircraft Corp.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bermite Powder Co.
E. W. Bliss Co.
Brunswick Balke Collender Co., The, Defense Products Div.
A. M. Byers Co.
Chance Vought Aircraft, Inc.
Continental Diamond Fibre Corp.
Cromer Mfg. & Engrg., Inc.
Curtiss-Wright Corp.-Wright Aeronautical Div.
Douglas Aircraft Co., Inc.
***EXCELCO DEVELOPMENTS INC.**
Food Machinery & Chemical Corp., Ordnance Div.
Gabriel Co., Rocket Power-Talco
Garlock Packing Co.
General Electric Co., Rocket Engine Section
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.,
Hahn & Clay
Hercules Powder Co., Chemical Propulsion Div.
Hughes Tool Co., Aircraft Div.
ITE Circuit Breaker Co., Special Products Div.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Intercontinental Mfg. Co., Inc.
Kaiser Fleetwings, Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lamtex Industries Inc.
Le Fiell Mfg. Co.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lukens Steel Co.
Lycoming Div., Avco Corp.
Mc Cormick Selph Associates
McGregor Mfg. Corp.
Menasco Mfg. Co
***MINNESOTA MINING & MFG. CO.**
Narmco Mfg. Co.
National Tube Div.-United States Steel Corp.
Norris-Thermador Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Portland Copper & Tank Works Inc.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Pressed Steel Tank Co.
Raybestos-Manhattan, Inc.
Republic Aviation Corp., Missile Systems Div.
Solar Aircraft Co.
Spaceatomics Div., The Budd Co.
Stamping Div.-Rockwell Standard Corp.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Synthane Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
H. I. Thompson Fiber Glass Co.
Thompson Ramo Wooldridge Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Rubber Co.
United States Steel Corp.
Western Design, Div.-U. S. Industries, Inc.
Young Development Div., Hercules Powder Co.

PROPELLANT TANKS

ACF Industries Inc.
Aerocal Div., Aeronca Mfg. Corp.
***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
Allison Div., General Motors Corp.
Aluminum Co. of America
Arde-Portland, Inc.
Armament Div.-Universal Match Corp.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
Benson Mfg. Co.
Bermite Powder Co.
Bethlehem Steel Co.
A. M. Byers Co.
California Stamping & Mfg. Co.
Chicago Bridge & Iron Co.
Cromer Mfg. & Engrg., Inc.

Curtiss-Wright Corp.-Wright Aeronautical Div.
Douglas Aircraft Co., Inc.
***EXCELCO DEVELOPMENTS INC.**
Food Machinery & Chemical Corp., Ordnance Div.
Foster Wheeler Corp.
Hahn & Clay
Intercontinental Mfg. Co., Inc.
Joclin Mfg. Co., The
Lamtex Industries Inc.
Le Fiell Mfg. Co.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
McGregor Mfg. Corp.
***MINNESOTA MINING & MFG. CO.**
National Tube Div.-United States Steel Corp.
Nooter Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pressed Steel Tank Co.
Pry Welding & Mfg., Inc.
A. O. Smith Corp., Smith-Erie Div.
Spaceatomics Div., The Budd Co.
Standard Steel Corp., Cambridge Div.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Struthers Wells Corp.
Temco Aircraft Corp.
Uni-Flex Mfg. & Engrg. Inc.
United Aircraft Products, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
United States Chemical Milling Corp.
United States Steel Corp.
Westholt Mfg. Inc.

PROPELLANTS, LIQUID ROCKET

Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Allied Chemical Corp., General Chemical Div.
Allied Chemical Corp., Nitrogen Div.
American Potash & Chemical Corp., National Northern Div.
Becco Chemical Div.-Food Machinery & Chemical Corp.
Bermite Powder Co.
Callery Chemical Co.
Cerium Metals & Alloys Div.-Ronson Metals Corp.
Chlor-Alkali Div.-Food Machinery & Chemical Corp.
FMC Chlor-Alkali Div.
Food Machinery & Chemical Corp., Ordnance Div.
Foster Wheeler Corp.
General Electric Co., Rocket Engine Section
Hughes Tool Co., Aircraft Div.
Hummel Chemical Co., Inc.
Liquid Carbonic Div.-General Dynamics Corp.
***MARTIN CO., THE, DENVER DIV.**
Monsanto Chemical Co.
National Cylinder Gas, Div.-Chemetron Corp.
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pennsalt Chemicals Corp.
Rocketdyne Div.-North American Aviation, Inc.
Shell Chemical Co., Indsl. Chemical Div.
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Stauffer Chemical Co.
United Technology Corp.

PROPELLANTS, SOLID ROCKET

***AEROJET-GENERAL CORP.**
Allied Chemical Corp., Nitrogen Div.
Amcel Propulsion Inc.
American Latex Products Corp.
American Potash & Chemical Corp., National Northern Div.
American Rocket Co.
Amoco Chemicals Corp.
Atlantic Research Corp.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Callery Chemical Co.
Cerium Metals & Alloys Div.-Ronson Metals Corp.
Chlor-Alkali Div.-Food Machinery & Chemical Corp.
Continental Aviation & Engrg. Corp.
Food Machinery & Chemical Corp., Epoxy Dept.
Food Machinery & Chemical Corp., Ordnance Div.
Gabriel Co., Rocket Power-Talco
General Electric Co., Rocket Engine Section
B. F. Goodrich Aviation Products
Grand Central Rocket Co.
Hercules Powder Co., Chemical Propulsion Div.
Hughes Tool Co., Aircraft Div.
Hummel Chemical Co., Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Mc Cormick Selph Associates
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pennsalt Chemicals Corp.
Propellex Chemical Div., Chromalloy Corp.
Rocketdyne Div.-North American Aviation, Inc.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation
Southwest Research Institute
Standard Oil Co. of Indiana
Stauffer Chemical Co.
Topper Mfg. Co., Inc.
United States Rubber Co.
United Technology Corp.

PROPULSION SYSTEMS

***AEROJET-GENERAL CORP.**
Allison Div., General Motors Corp.
Amcel Propulsion Inc.
American Rocket Co.
Arde-Portland, Inc.
Atlantic Research Corp.
Bell Aircraft Corp., Niagara Frontier Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bermite Powder Co.
Clevite Ordnance, Div.-Clevite Corp.
Continental Aviation & Engrg. Corp.
Cosmic Instruments Inc.
Joe Davidson & Associates
Douglas Aircraft Co., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Gabriel Co., Rocket Power-Talco
General Electric Co., Rocket Engine Section
B. F. Goodrich Aviation Products
Grand Central Rocket Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hercules Powder Co., Chemical Propulsion Div.
High Voltage Engrg. Corp.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lockheed Aircraft Corp., Missiles & Space Div.
***MARTIN CO., THE, DENVER DIV.**
Mc Cormick Selph Associates
Napier Engines Inc.
Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pesco Products Div.-Borg-Warner Corp.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Propellex Chemical Div., Chromalloy Corp.
Republic Aviation Corp., Missile Systems Div.
Rocketdyne Div.-North American Aviation, Inc.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Temco Aircraft Corp.
United States Rubber Co.
United Technology Corp.
Western Gear Corp.-Precision Products Div.
Young Development Div., Hercules Powder Co.

PSYCHOGALVANOMETERS

Electro-Medical Lab., Inc.
U. S. Plastic Molding Corp.
Yellow Springs Instrument Co., The

PSYCHROMETERS

General Scientific Equipment Co.
E. Vernon Hill & Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Palmer Thermometers, Inc.
Southwest Research Institute
Universal Dynamics Corp.

PUBLIC ADDRESS SYSTEMS

Blonder-Tongue Labs. Inc., Special Products Div.
Du Kane Corp.
Executone, Inc.
Fla. Aircraft Radio & Marine
Gates Radio Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
M. V. Palmer, Inc.
J. J. Powers Co.
Specialty Electronics Development Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.

PULSATION CONTROL

Auto-Control Labs. Inc.
Southwest Research Institute
Task Corp.

PUMPS

a. Air
b. Alcohol
c. Booster
d. Combination Air & Hydraulic
e. Fuel
f. Hydraulic, Fixed Displacement
g. Hydrogen Peroxide
h. Liquid Nitrogen
i. Liquid Oxygen
j. Metering
k. Oil
l. Oxygen Transfer
m. Pneumatic
n. Speed Density Metering
o. Transfer
p. Turbine
q. Vacuum
r. Water Injection
s. Wobble

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, e, q.**
ACF Industries Inc., **a, b, e, k, m, q, r.**
Adel Precision Products of Calif., Div.-General Metals Corp., **b, c, e, f, k, o, p, r, s.**
***AEROJET-GENERAL CORP., e, g, h, l.**
Agricultural Aviation Engineering Co. Inc., **b, c, o, r.**
Air Products, Inc., **h, i.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **h, i.**
Aircraft Accessory Turbine Dept.-General Electric Co., **c, e, f, i, p.**
***AiRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, d, h, i, m, p, r.**
Alsop Engrg. Corp., **b, c, e, k, o.**
American Brake Shoe Co., **f.**
American Brake Shoe Co., Kellogg Div., **f, k.**
American Instrument Co., Inc., **a, c, d, f, j, l, m, o, q.**
Applied Dynamics Corp., **a, f, k, m, q.**
Associated Control Equipment, Inc., **j, m.**
Associated Engrg. & Mfg. Corp., **q.**
Basic Tool Industries, Inc., **i.**
Beach-Russ Co., **a, c, q.**
Bell & Gossett Co., Marlow Pumps Div., **b, c, e, k, o.**
Bendix Aviation Corp., **a, b, c, e thru i, k, m, p, r.**
***BENDIX AVIATION CORP., HAMILTON DIV., e, f, g, j, k, n, o.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., e, g, n, r.**
Bendix Utica Div., Bendix Aviation Corp., **a, b, c, e, f, g, j, k, m, p, q, r.**
Binks Mfg. Co., **o.**
Blackmer Pump Co., **k, o.**
Bowser Inc., Defense Div., **j.**
Byron Jackson Pumps, Inc., **b, e, g, h, i, k, l, o, p.**
Carson Mach & Supply Co., **c, d, k.**
J. C. Carter Co., The, **b, c, e, g, h, i, l, o, r.**
Central Scientific Co., **q.**
Chempump Div., Fostoria Corp., **c, e, g, h, i, k, o.**
Christie Machine Works, **c, e.**
Clark Bros. Co., Div.-Dresser Operations, Inc., **a, q.**
Clark Equipment Co., **f.**
Commercial Shearing & Stamping Co., **f.**
***CONSOLIDATED ELECTRODYNAMICS CORP., q.**
Consolidated Vacuum Corp., **q.**
Cornelius Co., The, Aero Div., **a, d, f, m, q.**
Curtiss-Wright Corp., Santa Barbara Div., **e, j, m, p, r.**
Joe Davidson & Associates, **e, k, o.**
Deming Co., The, **k, o, p, s.**
Denison Engrg. Div., American Brake Shoe Co., **d, f.**
Eastern Industries Inc., **a, b, c, e, f, k, m, o thru r.**
Eco Engrg. Co., **b, g, h, j.**
Edwards High Vacuum Ltd., **c, q.**
Fischer & Porter Co., **j.**
Fisher Scientific Co., Maryland, **q.**
Fuller Co., **a, q.**
Futurecraft Corp., **c.**
Gardner-Denver Co., **a, m, o, q.**
Garwin, Inc., **a, e, q.**
Gar Wood Industries Inc., **f, s.**
General Electric Co., Apparatus Sales Div., **c, p.**
General Electric Co., Rocket Engine Section, **b, e, i.**
General Vacuum Corp., **q.**
Genisco, Inc., **f.**
Gorman-Rupp Co., The, **o.**
Goulds Pumps Inc., **b, c, e, g, h, i, k, l, o, r.**
Great Lakes Mfg. Corp., **a, b, d, e, f, h, k, m, o, q, r.**
Hamilton Standard, Div.-United Aircraft Corp., **e, f.**
Harman Equipment Co., **e, k.**
Haskel Engrg. & Supply Co., **a, c thru m, q, s.**
Hevi-Duty Electric Co., Div.-Basic Products Corp., **q.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., **q.**
Highland Engrg. Co., **c.**
Hills-Mc Canna Co., **j.**
A. F. Holden Co., The, **k.**
Joy Mfg. Co., **q.**
Joseph Kaye & Co., **d.**
Kemp Aero Products, **e, f.**
Kerns Mfg. Corp., **b, c, f, j, q.**
Kobe Inc., **f, k.**
Lapp Insulator Co., Inc., Radio Specialties Div., **j.**
Lawrence Pumps Inc., **e, g, h, i, l.**
Lear, Inc., **a thru m, o thru s.**

Ledeen Inc., **d.**
Leiman Brothers, Inc., **a, c, q.**
Linde Co., Div.-Union Carbide Corp., **h, i.**
Litton Engrg. Labs., **q.**
M. C. Mfg. Co., **a, e.**
M-D Blowers, Inc., **a, m, q.**
Marquardt Corp., The, **d, e, m.**
McGregor Mfg. Corp., **h, i.**
Mico Instrument Co., **q.**
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc., **c, f, r.**
Nelson Vacuum Pump Co., **q.**
New York Air Brake Co., The, Watertown Div., **f.**
Newton Hydraulic Tooling Co., **d, f.**
W. H. Nichols Co., **f, j, k.**
Northern Ordnance Inc., Sub.-Northern Pump Co., **c, e, f, j, k.**
Oil-Dyne, Inc., **f.**
Owatonna Tool Co. Precision Hydraulic Div., **f.**
Oxygen Equipment & Service Co., **q.**
Peerless Pump Div., Food Machinery & Chemical Corp., **e, g, i, k, p, r.**
Pesco Products Div.-Borg-Warner Corp., **a, c, e, f, h, i, o, q, r.**
Richard Philip Co., **d.**
Pratt & Whitney Aircraft Div., United Aircraft Corp., **p.**
Protectoseal Co., The, **b, e, k, o.**
Pryor Mfg. Co., **b, e, r.**
Pyles Industries, Inc., **f, j, o.**
Quincy Compressor Co., **q.**
Reda Pump Co., **c, k, m, p, r.**
Republic Mfg. Co., **f, j, k, s.**
Resitron Labs., Inc., **q.**
J. R. Robbins Co., **f thru i.**
Rocketdyne Div.-North American Aviation, Inc., **e, g, h, i.**
Milton Roy Co., **d, j.**
Rucker Co., The, **c.**
Ruthman Machinery Co., The, **k.**
S & G Mfg. Corp., **a, m, r.**
Sargent Engrg. Corp., **f.**
Sier-Bath Gear & Pump Co., Inc.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., **d, m.**
A. O. Smith Corp., Smith-Erie Div., **j.**
Solar Aircraft Co., **p.**
South Wind Div., Stewart Warner Corp., **e.**
Southwest Research Institute, **b, c, e, o, r.**
Southwestern Industries, Inc.
Standard Steel Corp., **h, i, l, o.**
Standard Steel Corp., Cambridge Div., **e, g, h, i, l.**
Stewart-Warner Corp., Alemite Div., **c, q.**
F. J. Stokes Corp., **a.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **b thru l, o, p, r.**
Sundstrand Turbo, **i.**
Superior Air Products Co.
Tapco Group, Thompson Ramo Wooldridge Inc., **c, e, h, i, o, p, r.**
Task Corp., **a, b, c, e, h, j, m, o.**
Temperature Engrg. Corp., **q.**
Thompson Ramo Wooldridge Inc., **c, e, h, i, o, p, r.**
United Aircraft Products, Inc., **s.**
United States Steel Corp., **e.**
Vacuum Specialties Co., Inc., **q.**
Vanton Pump & Equipment Corp., **o.**
Veeco Vacuum Corp., **q.**
Vickers Inc., **f.**
Vickers Inc., Div.-Sperry Rand, **c, e, f.**
Vickers, Inc., Mich., **d, e, f, j, k, o.**
Viking Pump Co., **b, c, e, f, j, k, o.**
Wallace & Tiernan Inc., **j.**
Wayne Pump Co., The, Div.-Symington Wayne Corp., **e, m.**
***WEATHERHEAD CO., THE d, f, m.**
W. M. Welch Scientific Div., W. M. Welch Mfg. Co., **a, q.**
Wells Industries Corp., **c.**
Western Design, Div.-U. S. Industries, Inc., **c, d, f.**
Whittaker Controls, Div.-Telecomputing Corp., **e.**
Worthington Corp., **a, c, d, f thru i, k, l, m, o, p, q.**

PUNCH PRESSES

Acromark Co., The
Amerac Inc.
California Stamping & Mfg. Co.
Carl Hirschmann Co., Inc.
Niagara Machine & Tool Works
Oliver Corp., The-A. B. Farquhar Div.
Rotex Punch Co., Inc.
Joseph T. Ryerson & Son, Inc.
F. J. Stokes Corp.
U. S. Industries, Inc.
Wales Strippit Inc., Unit of Houdaille Industries, Inc.
Whitney Metal Tool Co.
Wiedemann Machine Co.

PUNCHES

***ACE DRILL BUSHING CO. INC.**
H. D. Allen Mfg.
Allied Products Corp.
Cyril Bath Co., The
Bergen Carbide Co.
Billings & Spencer Co., The
Custom Tool & Mfg. Co.
M. A. Ford Mfg. Co., Inc.
G-C Electronics Co.
Henry & Miller Industries, Inc.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
***MARTIN CO., THE, DENVER DIV.**
Owatonna Tool Co. Precision Hydraulic Div.
Proto Tool Co.
Rotex Punch Co., Inc.
Joseph T. Ryerson & Son, Inc.
Squiers Gage Co.
U. S. Industries, Inc.
Vlchek Tool Co.
Wales Strippit Inc., Unit of Houdaille Industries, Inc.
Whitney Metal Tool Co.
Wiedemann Machine Co.

PYROMETERS, OPTICAL

Blonder-Tongue Labs. Inc., Special Products Div.
Eisler Engrg. Co., Inc.
Engelhard Industries, Inc.
Epic, Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
Instrument Development Labs., Inc.
Leeds & Northrup Co.
Pyrometer Instrument Co., Inc.
Pyrotector Inc.

PYROMETERS, RADIATION

Blonder-Tongue Labs. Inc., Special Products Div.
***BRISTOL CO., THE**
Epic, Inc.
***MARTIN CO., THE, DENVER DIV.**
Minneapolis-Honeywell Regulator Co., Industrial Div.
Pyrometer Instrument Co., Inc.

PYROMETERS, RESISTANCE

Blonder-Tongue Labs. Inc., Special Products Div.
***BRISTOL CO., THE**
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General Controls Co.
General Electric Co., Apparatus Sales Div.
Gray Instrument Co.
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Minneapolis-Honeywell Regulator Co., Industrial Div.
Pyrometer Instrument Co., Inc.
Rosemount Engrg. Co.
Technique Associates Div., Duncan Electric Co., Inc.
Temperature Engrg. Corp.
Thermo Electric Co., Inc.

QUARTZ, FUSED

Associated Engrg. & Mfg. Corp.
Bram Metallurgical Chemical Co.
Corning Glass Works
Dell Optics Co., Ltd.
Diamond Drill Carbon Co., The
Emerson & Cuming, Inc.
Engelhard Industries, Inc.
***ENGIS EQUIPMENT CO.**
General Electric Co., Lamp Glass Dept.
Hammett-Mercury-Rex Div.
Mica Fabricating Co.
Monsanto Chemical Co.
Quartzite Processing Inc.
Republic Lens Co., Inc.
Semi-Elements, Inc.
Sheridan-Gray, Inc.
Thermal American Fused Quartz Co., Inc.
Topper Mfg. Co., Inc.
Ultra-Violet Products, Inc.
Westinghouse Electric Corp.
Zenith Optical Laboratory

RACKS

a. Cabinet
b. Disc Storage
c. Equipment
d. Mounting & Relay

A & E Metal Specialties Inc., **c.**
A&P Metal Products Mfg. Corp., **a.**
Abalon Precision Mfg. Corp., **a, d.**
Aerocal Div., Aeronca Mfg. Corp., **a, c.**
Albano Co. Inc.
Alden Products Co., **a, d.**
Allied Plastics Supply Corp., **d.**
Alpitec, Inc., **a thru d.**
Amco Engrg. Co., **a, c, d.**
American Beryllium Co., **a, c.**
American Conveyor Co.
Anchor Specialty Mfg. Co. Inc., **a, c, d.**
Arch Gear Works Inc.
Artisan Metal Works Co., **a, c, d.**
Associated Co., Inc., **d.**
Barrett-Cravens Co., **b, c.**
Basic Tool Industries, Inc., **a.**
Benson Mfg. Co., **a, c.**
Bethlehem Steel Co., **b, c.**
Binkley Co., The
S. Blickman, Inc., **a, c, d.**
Brooks & Perkins, Inc., **a, c, d.**
Brunswick Balke Collender Co., The, Defense Products Div., **c.**
Bud Radio, Inc., **a, d.**
Burr-Brown Research Corp., **c.**
Butler Mfg. Co.
Calcor Corp., **a thru d.**
California Stamping & Mfg. Co., **a.**
Albert H. Cayne Equipment Corp., **a, c.**
Clark Equipment Co., **c.**
Collins Radio Co., **a.**
Colonial Aircraft Corp., **a, c, d.**
Computer Systems, Inc., **d.**
Conrad & Moser, **a, c, d.**
Craig Systems, Inc., **c, d.**
Cutler Metal Products Co., **a thru d.**
Dahlstrom Metallic Door Co., **a, c, d.**
Daystrom, Inc., Military Electronics Div., **a, d.**
Deluxe Metal Products Co., **a, b, c.**
Devco Engrg. Inc., **a, c.**
Donnelly Mfg. Co., **a.**
Dudwallen Mfg. Co., Inc., The, **a thru d.**
Electronic Engrg. Co. of California, **d.**
Eljay Corp.
Elzee Metal Products Co., Inc., **a thru d.**
Falstrom Co., **a, c, d.**
Farwell Metal Fabricating, **a thru d.**
Fouch Electric Mfg. Co., Inc., **a.**
Gates Radio Co., **a, b, c.**
General Metal Products Co., **a, c, d.**
Gramm Trailer Corp., **c.**
Gremco, Inc., **a.**
Halliburton, Inc., Mfg. Div., **a, b.**
Hoffman Engrg. Corp., **a.**
Ludwig Honold Mfg. Co., **a.**
Hughes Tool Co., Aircraft Div., **a, c, d.**
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Intercontinental Mfg. Co., Inc., **c, d.**
Kellett Aircraft Corp., **a, d.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **d.**
Kirk & Blum Mfg. Co., The, **a, d.**
***LAVELLE AIRCRAFT CORP., c.**
Lofstrand Co., The, **a, c.**
R. H. Lynch Mfg. Co., **a, d.**
Lyon Metal Products, Inc., **a, b, c.**
MEG Products, Div.-Mandrel Industries, Inc., **a, c, d.**
***MARTIN CO., THE, DENVER DIV., a, c, d.**
Mechanical Handling Systems Inc., **c.**
Metal Fabricators Corp., **a.**
Mid-West Metal Products, Inc., **a thru d.**
Muckle Mfg. Co., **a, c.**
Northeast Metals Industries, Inc., **a, c, d.**
Northeastern Engrg. Inc., **a, c.**
Nutron Mfg. Co. Inc., **a, d.**
P. B. R. Mfg. Co., **a thru d.**
Philips & Davies Inc., **a thru d.**
Piasecki Aircraft Corp., **a thru d.**
Pneumatil Corp., **a, c, d.**
Portland Copper & Tank Works Inc., **a thru d.**
Premier Metal Products Co., **a, c, d.**
REF Mfg. Corp., **a thru d.**
Radio City Products Co. Inc., **c, d.**
Rapids-Standard Co., Inc., The, **c.**
Ravenna Metal Products, Div.-Standard Screw Co., **a thru d.**
Republic Steel Corp., **a, b, c.**
Rimak, Inc., **a thru d.**
H. M. Scott Co., The, **a thru d.**
Skydyne, Inc.
Stackbin Corp., **a, d.**
Standard Electronics Div.-Reeves Instrument Corp.
Standard Pressed Steel Co., **a.**
Taffet Electronics, Inc., **c.**
Technical Materiel Corp., The, **a, c.**
Temco Aircraft Corp., **a, c.**
Twin Coach Co., Aircraft-Missiles, **c.**
Unified Industries, Inc., **a, c, d.**
United Aircraft Products, Inc., **a, c.**
United States Chemical Milling Corp., **a, c, d.**
United States Instrument Corp., **a, c, d.**
Weber Aircraft Corp., **a.**
Wells Industries Corp., **a, c, d.**
Albert Wesling & Sons Inc., **c.**
Western Devices Inc., **a.**
Westholt Mfg. Inc., **a.**
Wickes Engrg. & Construction Co., **a, c.**
Winder Aircraft Corp. of Florida, **a thru d.**
Wolverine Diesel Power Co., **a, d.**
Wyco Metal Products, **a, d.**

RADAR, AIRBORNE

Admiral Corp.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Airtron, Div.-Litton Industries
Allied International Corp.
American Machine & Foundry Co., Government Products, N. Y.
American Tradair Corp.
Autonetics, Div.-North American Aviation, Inc.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chance Vought Aircraft, Inc.
Collins Radio Co.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Military Electronics Div.
*DEL MAR ENGRG. LABS.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
GPL Div.-General Precision, Inc.
Gabriel Co., The, Gabriel Electronics Div.
General Bronze Electronics Corp.
General Electric Co., Light Military Electronics Dept.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
Goodyear Aircraft Corp.
Gorham Electronics-Div.-Gorham Mfg. Co.
Gray Mfg. Co., The
Guided Missile Div., The Firestone Tire & Rubber Co.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Lab. for Electronics, Inc.
Lear, Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lockheed Electronics Co., Stavid Div.
W. L. Maxson Corp., The
Moran Instrument Corp.
Motorola, Inc.
National Co., Inc.
Norden Div., United Aircraft Corp.
Philco Corp.-Govt. & Industrial Group
RS Electronics Corp.
Radalab Inc.
Radiation, Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Republic Aviation Corp., Missile Systems Div.
Sanders Associates, Inc.
Specialty Electronics Development Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Stewart-Warner Electronics Div.
Strand Engrg. Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
TRG, Inc.
Texas Instruments Inc.

RADAR BEACONS

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Admiral Corp.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Airtron, Div.-Litton Industries
Amerac Inc.
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
Applied Electronics Corp. of N. J.
Avien, Inc.
Beacon Steel Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Chance Vought Aircraft, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Military Electronics Div.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Eastman Kodak Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Ferrotran Electronics Co., Inc.
Gabriel Co., The, Gabriel Electronics Div.
General Communication Co.
General Devices, Inc.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hallamore Electronics Co., Div.-Siegler Corp.
Hallicrafters Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
J-V-M Microwave Co.
Lear, Inc.
Lel, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lockheed Electronics Co., Stavid Div.
W. L. Maxson Corp., The
Moran Instrument Corp.
Motorola, Inc.
National Co., Inc.
Packard-Bell Electronics Corp.
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
RS Electronics Corp.
Radalab Inc.
Radio City Products Co. Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Rantec Corp.
Resdel Engrg. Corp.
Special Products Dept., Melpar, Inc.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Stewart-Warner Electronics Div.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.
Tamar Electronics, Inc.
Telectro Industries Corp.
Telerad Mfg. Corp.
Texas Instruments Inc.

RADAR, PRECISION APPROACH

Advance Industries, Inc.
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Daystrom, Inc., Military Electronics Div.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
General Instrument Corp., Defense & Engrg. Products Group
Gilfillan Bros. Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Lab. for Electronics, Inc.
Litton Industries, Maryland Div.
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
*RADIO CORP. OF AMERICA
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Stewart-Warner Electronics Div.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.

RADAR, SURVEILLANCE

Advance Industries, Inc.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
American Machine & Foundry Co., Government Products, N. Y.
Autometric Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
CBS Laboratories, Div.-Columbia Broadcasting System
Chance Vought Aircraft, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Military Electronics Div.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Eastman Kodak Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Foto-Video Labs., Inc.
Gabriel Co., The, Gabriel Electronics Div.
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Ordnance Dept.
General Instrument Corp., Defense & Engrg. Products Group
General Mills, Inc.
Gilfillan Bros. Inc
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Intercontinental Electronics Corp.
Lab. for Electronics, Inc.
Litton Industries, Maryland Div.
Lockheed Electronics Co., Stavid Div.
W. L. Maxson Corp., The
Miller Associates
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Reeves Instrument Corp.
Sanders Associates, Inc.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Strand Engrg. Co.
Stromberg-Carlson Div.-General Dynamics Corp.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
TRG, Inc.
Texas Instruments Inc.
Thompson Ramo Wooldridge Inc.
Westinghouse Electric Corp.

RADAR TEST SETS

Admiral Corp.
Advance Industries, Inc.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
Aircom Inc.
Aircraft Armaments, Inc.
Airtron, Div.-Litton Industries
Allied International Corp.
Amerac Inc.
American Machine & Foundry Co., Government Products, N. Y.
Applied Electronics Corp. of N. J.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix-Pacific Div., Bendix Aviation Corp.
Broadview Research Corp.
Bruno-New York Industries Corp.
Budd Lewyt Electronics, Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chance Vought Aircraft, Inc.
Chemalloy Electronics Corp.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom, Inc., Military Electronics Div.
*DEL MAR ENGRG. LABS.
Designers for Industry, Inc.
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Allen B. Du Mont Labs., Inc.
Dunn Engrg. Associates Inc.
Dynatronics, Inc.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Electron-Radar Products
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Products Sales Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Foto-Video Labs., Inc.
GPL Div.-General Precision, Inc.
General Communication Co.
General Instrument Corp., Defense & Engrg. Products Group
General Mills, Inc.
Gilfillan Bros. Inc.
Gray Mfg. Co., The
Hallamore Electronics Co., Div.-Siegler Corp.
Hazeltine Electronics Div.-Hazeltine Corp.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.

J-V-M Microwave Co
*KEARFOTT DIV., GENERAL PRECISION, INC.
*KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS
Lab for Electronics, Inc.
Levinthal Electronic Products, Inc.
Lieco, Inc.
Litton Industries, Maryland Div.
Lockheed Electronics Co., Stavid Div.
Madigan Corp.
Marconi Instruments
W. L. Maxson Corp., The
Motorola, Inc.
Narda Microwave Corp., The
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Pitometer Log Corp.
Polarad Electronics Corp.
RS Electronics Corp.
Radalab Inc.
Radiation, Inc.
Radio City Products Co. Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc
Reeves Instrument Corp.
Resdel Engrg. Corp.
Specialty Electronics Development Corp.
Spectra Electronics Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stewart-Warner Electronics Div
Stromberg-Carlson Div.-General Dynamics Corp
Sun Electric Corp., Aeronautical Div.
TRG, Inc
Taffet Electronics, Inc.
Telectro Industries Corp
Texas Instruments Inc.
Westinghouse Electric Corp.

RADIATION DETECTORS

Advance Industries, Inc.
American Machine & Foundry Co., Government Products, N. Y.
American Tradair Corp.
Bendix Aviation Corp
Bendix Aviation Corp., Cincinnati Div
Corning Glass Works
Curtiss-Wright Corp., Princeton Div.
Dejur-Amsco Corp., Electronic Sales Div
Eastman Kodak Co.
Eberline Instrument Corp
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Products Sales Corp.
General Electric Co., Missile & Space Vehicle Dept., Po
Infrared Industries, Inc.
International Electronic Research Corp.
Interstate Electronics Corp.
Land-Air Inc., Sub.-California Eastern Aviation, Inc
NUMEC-Nuclear Materials & Equipment Corp
Nuclear Development Lab
Nuclear-Chicago Corp
Ohmart Corp., The
Patterson Moos Research, Div.-Leesona Corp.
Philips Electronic Instruments
Piasecki Aircraft Corp.
Precision Radiation Instruments, Inc.
Radalab Inc
Radiation Instrument Development Lab., Inc.
St. John X-Ray Laboratory
Sil cocks Miller Co
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Strand Engrg. Co.
TRG, Inc
Telechrome Mfg. Corp.
Tracerlab Inc.
Victoreen Instrument Co.
Westinghouse Electric Corp
N. Wood Counter Lab

RADIATION EQUIPMENT, NUCLEAR

American Electronics, Inc., Nuclear Div
American Machine & Foundry Co., Government Products Group
American Machine & Foundry Co., Government Products, N. Y.
Bendix Aviation Corp
Bendix Aviation Corp., Cincinnati Div
Cadillac Plastic & Chemical Co.
Curtiss-Wright Corp., Princeton Div
Eberline Instrument Corp.
Elcor, Inc
Emertron, Sub.-Emerson Radio & Phonograph Corp
General Electric Co., Apparatus Sales Div
High Voltage Engrg. Corp.
International Electronic Research Corp.
Interstate Electronics Corp.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
Moran Instrument Corp.
NUMEC-Nuclear Materials & Equipment Corp.
Nuclear-Chicago Corp.
Ohmart Corp., The
Patterson Moos Research, Div.-Leesona Corp.
Portland Copper & Tank Works Inc.
Radiation Instrument Development Lab., Inc.
*RADIO CORP. OF AMERICA
Ray Proof Corp
Strand Engrg. Co.
Telechrome Mfg. Corp.
Tracerlab Inc.
United States Radium Corp.
Victoreen Instrument Co.
Westinghouse Electric Corp.

RADIATORS

Allied International Corp.
Budd Lewyt Electronics, Inc.
Modine Mfg. Co.
Northrop Corp
United Aircraft Products, Inc.
Wakefield Engrg., Inc.

RADIATORS, COOLANT

Allied International Corp.
Budd Lewyt Electronics, Inc.
Griscom-Russell Co., The
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Kentucky Metal Products Co.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Worthington Corp.

RADIATORS, ENGINE-COOLING

Allied International Corp.
Blackstone Corp.
Budd Lewyt Electronics, Inc.
Griscom-Russell Co., The
Kentucky Metal Products Co.
Modine Mfg. Co.
Southwest Research Institute
Standard-Thomson Corp., Clifford Mfg. Co. Div.
United Aircraft Products, Inc.

RADIATORS, OIL-COOLING

Allied International Corp.
Budd Lewyt Electronics, Inc
Griscom-Russell Co., The
Kentucky Metal Products Co
Modine Mfg. Co.
South Wind Div., Stewart Warner Corp.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
United Aircraft Products, Inc.
York Div., Borg-Warner Corp.

RADIO COMPASS INDICATORS

Allied International Corp.
Bendix Aviation Corp.
A. Biederman, Inc.
Bruno-New York Industries Corp
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Collins Radio Co.
Courier Products, Div.-Model Engrg. & Mfg., Inc.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Lear, Inc.
Motorola, Inc.
National Co., Inc.
Radalab Inc.

RADIO DIRECTION FINDERS

ACF Industries Inc.
Allied International Corp.
Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
Collins Radio Co.
Control Electronics Co., Inc.
Dorne & Margolin, Inc
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Fla Aircraft Radio & Marine
General Electric Co., Heavy Military Electronics Dept.
General Instrument Corp., Defense & Engrg. Products Group
Hoover Electronics Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Intercontinental Electronics Corp
Lear, Inc.
Litton Industries, Maryland Div
Madigan Corp.
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Schaevitz Engrg.
Simmonds Aerocessories, Inc.
Southwest Research Institute
Specialty Electronics Development Corp.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Stewart-Warner Electronics Div.

RADIOACTIVITY EQUIPMENT

American Machine & Foundry Co., Government Products, N. Y.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Budd Co., The
Eberline Instrument Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Flight Refueling, Inc
Instrumentation Associates, Inc.
Instrument Div., The Budd Co.
Interstate Electronics Corp.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
NUMEC-Nuclear Materials & Equipment Corp.
Nuclear Measurements Corp.
Nuclear-Chicago Corp
Ohmart Corp., The
Radiation Instrment Development Lab., Inc.
St. John X-Ray Laboratory
Telechrome Mfg. Corp
Tracerlab Inc.
United States Radium Corp.
Westinghouse Electric Corp.

RADIOSONDES

Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
Budd Lewyt Electronics, Inc.
CBS Laboratories, Div.-Columbia Broadcasting System
Chance Vought Aircraft, Inc
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Instrument Corp., Defense & Engrg. Products Group
Hallicrafters Co., The
ITT Federal Div., International Telephone & Telegraph Corp.
Molded Insulation Co.
Motorola, Inc.
National Co., Inc.
Piasecki Aircraft Corp.
Radalab Inc.
*RADIO CORP. OF AMERICA
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Southwest Research Institute
TRG, Inc.
Telechrome Mfg. Corp.

RADOMES

Allied International Corp
American Agile Corp.
American Insulator Corp.
*ANDREW CORP.
Atkins & Merrill, Inc
Bendix Aviation Corp.
Birdair Structures, Inc.
Carborundum Co., The
Chance Vought Aircraft, Inc.
Coors Prdcelain Co.
Corning Glass Works
Craig Systems, Inc.
Dalmo Victor Co., Div.-Textron, Inc.
C. R. Daniels, Inc.
Dayton Rubber Co., The
Debell & Richardson Inc.
Diamond Antenna & Microwave Corp.
Dorne & Margolin, Inc.
Dura Plastics of N. Y., Inc.
Duracote Corp.
Eljay Corp.
Eubanks Industries, Inc.
Gabriel Co., The, Gabriel Electronics Div.
Goodyear Aircraft Corp.
Honeycomb Co. of America, Inc.
*HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.
Irving Air Chute Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
H. Koch & Sons
Lamtex Industries Inc.

Lone Star Plastics Co. Inc.
Thomas J. Long, Inc.
Lunn Laminates, Inc.
Mc Millan Companies, The
Mc Millan Lab., Inc.
*MINNESOTA MINING & MFG. CO.
Mycalex Corp. of America
Narmco Mfg. Co.
National Beryllia Corp.
Norton Co., New Products Dept.
Olympic Plastics Co., Inc.
Parsons Corp., Special Products Div.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Plastics Distributor of New England
Prewitt Aircraft Co.
REF Mfg. Corp.
*RADIO CORP. OF AMERICA
Reeves Bros. Inc., Vulcan Rubber Div.
Republic Aviation Corp., Missile Systems Div.
Seaman Products, Div.-Seaman Paper Co.
Specialty Electronics Development Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Stewart-Warner Electronics Div.
Structural Fibers, Inc.
TRG, Inc.
H. I. Thompson Fiber Glass Co.
Topper Mfg. Co., Inc.
Twin Coach Co., Aircraft-Missiles
United States Chemical Milling Corp.
Universal Moulded Products Corp.
Universal Unlimited, Inc.

REACTORS, SATURABLE

ACDC Electronics, Inc.
American Research & Mfg. Corp.
Atlas Engrg. Co. Inc.
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.
CGS Labs., Inc.
Carol Electronics Corp.
Chicago Standard Transformer Corp.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Djeco, Div.-Djordjevic Engrg. Co.
Electro Engrg. Works
*EQUIPMENT DIV., RAYTHEON CO.
Fairchild Engrg. Corp.
General Electric Co., Apparatus Sales Div.
Donald C. Harder Co.
George E. Harris & Co. Inc.
Lab. For Electronics, Inc.
Lear, Inc.
Lumen, Inc.
Penn-East Engrg. Corp.
Southwestern Industrial Electronics Co.
Standard Electronics Div.-Reeves Instrument Corp.
Telex, Inc.
Torwico Electronics, Inc.
Transformer Design, Inc. of Milwaukee
Tresco, Inc.
Universal Toroid Coil Winding, Inc.
Vari-L Co., Inc.
Westinghouse Electric Corp.
Wickes Engrg. & Contruction Co.

READOUT DEVICES, COMPUTER

ACF Electronics Div., ACF Industries Inc.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Aircraft Instruments Co.
American Electronics, Inc.
American Electronics, Inc., Taller-Cooper Div. & Data Systems Div.
Ampex Data Products Co.
Baird-Atomic, Inc.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Benson-Lehner Corp.
Bowmar Instrument Corp.
Broadview Research Corp.
Budd Lewyt Electronics, Inc.
Burroughs Corp.
Burroughs Gorp., Electronic Tube Div.
Burton-Rodgers, Inc.
Chance Vought Aircraft, Inc.
Datex Corp.
Delco Radio Div.-General Motors Corp.
Allen B. Du Mont Labs., Inc.
Electro Instruments, Inc.
Electronics Div.-The National Cash Register Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
Gulton Industries, Inc.
Huyck Systems Co.
Industrial Electronic Engineers, Inc.
Lab. For Electronics, Inc.
Madigan Corp.
Marco Industries Co.
Milman Engrg. Co.
Motorola, Inc.
Non-Linear Systems, Inc.
Northrop Corp.
Pacific Optical Corp., Div.-Chicago Aerial Industries
Packard Bell Computer Corp.
Philco Corp.-Govt. & Industrial Group
Potter Instrument Co., Inc.
Precision Specialties, Inc.
*RADIO CORP. OF AMERICA
Servomechanisms, Inc.
Special Products Dept., Melpar, Inc.
Stewart-Warner Electronics Div.
Tally Register Corp.
Trio Laboratories, Inc.
Wang Labs., Inc.
Westinghouse Electric Corp.

RECEIVERS

a. AM & FM Communication
b. AM Fixed Frequency
c. Command, Guidance & Destruct
d. Communication
e. Direction Finding, Navigation
f. Distance Measuring, Navigation
g. Diversity
h. Fixed Frequency
i. FM
j. FM Multiplex
k. Frequency Shift
l. Infrared
m. Microwave
n. Mobile
o. Portable & Mobile
p. Radar
q. Radiation
r. Radio, Hand Powered Emergency
s. Radio, Navigation
t. Remote Pickup, Fixed
u. Selective Signalling, Navigation
v. Short Wave, Fixed
w. Short Wave, Portable
x. Single Side Band
y. Transistor Operated
z. UHF
a-1. VHF
b-1. WWV

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, n.
ACF Electronics Div., ACF Industries Inc., e, f, m.
ACF Industries Inc., l, m.
A. R. F. Products, Inc., m.
Adler Electronics, Inc., d, m, z, a-l.
Admiral Corp., p.
Advance Industries, Inc., e, f, p.
*AEROJET-GENERAL CORP., l.
Aeronautical Electronics, Inc., a, b, h, i, n, o, z, a-l.
Aeronca Mfg. Corp.-Aerospace Div., p.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., m, p.
Aircom Inc., m, z, a-l, b-l.
Airtron, Div.-Litton Industries, m
Allied International Corp., b thru f, h, k, n, o, p, s, v thru z, a-l.
Alto Scientific Co., Inc., i, m, z, a-l.
Amerac Inc., h, m, p.
American Missile Products Co., Inc., a, i.
American Optical Co., Instrument Div., l.
Antlab Inc., m.
Applied Electronics Corp. of N. J., i.
Applied Research Inc., h, i, j, z, a-l.
*ARNOUX CORP., d, o.
Automatic Radio Mfg. Co., Inc., b, i, w, y.
Avco Corp., Crosley Div., c, d.
Avco Corp.-Research & Advanced Development Div., d, x, z.
Babcock Radio Engrg., Inc., c, i, z.
Barry Electronics Corp., x.
Rex Bassett, Inc., d, h.
Beckman Instruments, Inc., Berkeley Div., b-l.
Bendix Aviation Corp., a thru q, s, u, x, y, z.
Bendix Aviation Corp., Cincinnati Div., a, d, h, i, k, q, a-l.
Bendix Radio Div., Bendix Aviation Corp., d, e, f, h, i, n, o, a-l.
Blonder-Tongue Labs. Inc., Special Products Div., l, z, a-l.
Broadview Research Corp.
Bruno-New York Industries Corp., e.
Budd Lewt Electronics, Inc., a thru p, r thru z.
Budelman Electronics Corp., a, d, h, i, j, m, z, a-l.
Burton-Rodgers, Inc., a, b, d, h, i, k, o, z, a-l.
CBS Laboratories, Div.-Columbia Broadcasting System, a, l.
CG Electronics Corp., b, c, i, m, z, a-l.
CGS Labs., Inc., d.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., e, i, m, y.
Chance Vought Aircraft, Inc., p, t, y.
Clegg Labs., Div.-Clegg, Inc., a, b, d, h, i, v, x, a-l, b-l.
Collins Radio Co., a, b, d thru j, m thru p, s, u thru a-l.
Communications Co., a, b, d, h, i, n, r, x, z, a-l.
Communications Research Co., b, d, g, h, s, x, a-l.
Control Electronics Co., Inc., e, m, s.
Crosby-Teletronics Corp., g, i, j, x.
Cubic Corp., f.
Daven Co., The, a thru d, h, o, v, w, z, a-l.
Daystrom, Inc., Military Electronics Div., a, o.
De Havilland Aircraft of Canada, Ltd., Special Products Div., l.
Delco Radio Div.-General Motors Corp., a, d, i, n, o, p, y, z, a-l.
*DEL MAR ENGRG. LABS., c, h, p, z, a-l.
Designers for Industry, Inc., a thru d, i, j, m thru p, r, v thru z, a-l, b-l.
Allen B. Du Mont Labs., Inc., a thru j, l, n, o, p, s, v thru z, a-l.
Dynatronics, Inc., g, j, z, a-l.
Eastman Kodak Co., l.
Eclipse-Pioneer Div., Bendix Aviation Corp., f.
Electromation Co., Div.-Del Mar Engrg. Labs., a thru f, h thru k, m thru s, u thru z, a-l, b-l.
Electronic Applications, Inc., d, i, j, m, n, t, z, a-l.
Electronic Specialty Co., c.
Electro-Voice, Inc., o, w, x, y.
Emertron, Sub.-Emerson Radio & Phonograph Corp., a, c thru f, i thru s, v, w, x, z, a-l, b-l.
Empire Products Sales Corp., m, p.
*EQUIPMENT DIV., RAYTHEON CO., a, c thru f, l, p, s.
FXR, Inc., m.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., m, p.
Fla. Aircraft Radio & Marine, a, d, e, r, s, a-l.
Flush Wall Radio Co., a.
GPL Div.-General Precision, Inc., d, f, g, i, k, u.
Gates Radio Co., b, v, x.
General Communication Co., m.
General Electric Co., Heavy Military Electronics Dept., a, c, d, k, m, p.
General Electric Co., Light Military Electronics Dept., d, z.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Instrument Corp., Defense & Engrg. Products Group, a thru k, m thru p, s, t, u, x, y, z, a-l.
Gilfillan Bros. Inc., c, m, p.
Globe Electronics, Div.-Textron Electronics, Inc., o, v, y.
Gonset Div.-Young Spring & Wire Corp., a, b, d, h, i, n, v, w, x, z, a-l.
Gorham Electronics-Div.-Gorham Mfg. Co., p, z, a-l.
Guided Missile Div., The Firestone Tire & Rubber Co., p.
Hallamore Electronics Co., Div.-Siegler Corp., a, z, a-l.
Hallicrafters Co., The, c, d, m, x, y.
Hammarlund Mfg. Co., The, d, k, v, x.
Hammett-Mercury-Rex Div., m.
Hazeltine Electronics Div.-Hazeltine Corp., c thru f, m, p, z, a-l.
Houston Fearless Corp., d, h, v thru z.
ITI Electronics, Inc., b, e, h, s, y, z, a-l.
ITT Federal Div., International Telephone & Telegraph Corp., a thru k, m thru p, s, y, z, a-l.
Infrared Industries, Inc., l.
Instruments for Industry, Inc., z, a-l.
Interstate Electronics Corp., z, a-l.
Kahn Research Labs., Inc., x.
*KEARFOTT DIV., GENERAL PRECISION, INC., p.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., d.
Lab. for Electronics, Inc., f, p.

Land-Air Inc., Sub.-California Eastern Aviation, Inc., **a thru e, h, i, n, o, y, z, a-l.**
Lavoie Labs., Inc., **b-l.**
Lear, Inc., **a thru f, h thru l, n, o, p, s, y, z, a-l.**
Lel, Inc., **a thru d, h, i, m thru p, v thru z, a-l.**
Lenkurt Electric Co., Inc., **j, m, n.**
Librascope Div., General Precision, Inc., **l.**
Litton Industries, Maryland Div., **c thru g, p, s.**
Lockheed Aircraft Corp., Missiles & Space Div., **c.**
Lockheed Electronics Co., Stavid Div., **p, z, a-l.**
Loral Electronics Corp., **m, p, z, a-l.**
MEG Products, Div.-Mandrel Industries, Inc., **a, c, d, h, i, j, n, o, x, y, z, a-l.**
Madigan Corp., **a, e thru j, n, r thru z, a-l.**
***MAGNAVOX CO., THE, a, d, e, i, o, p, s, z.**
P. R. Mallory & Co. Inc., **a, e, h, i, o, x, z, a-l.**
Marconi Instruments, **a, b, d, i, x, z, a-l.**
***MARTIN CO., THE, DENVER DIV., c, d, f, h thru k, m, n, o, v, x, y, z, a-l.**
Mason Electric Corp., **a thru e, h thru k, m, n, o, q, t, v thru z, a-l.**
W. L. Maxson Corp., The, **e, g, k, m, p.**
Motorola, Inc., **a thru k, m thru p, r thru z, a-l.**
Munston Electronic Mfg. Corp., **e, y, a-l.**
National Co., Inc., **a thru z, a-l, b-l.**
Nems Clarke Co., Div.-Vitro Corp. of America, **a, b, d, h, i, z, a-l.**
Northrop Corp.
Packard-Bell Electronics Corp., **a, d, e, f.**
Paco Electronics Co., Inc., **b, i, j.**
M. V. Palmer, Inc., **b, h, j, l, m, v, x.**
Paraplegics Mfg. Co. Inc., **c, d.**
Patterson Moos Research, Div.-Leesona Corp., **l.**
Permoflux Products Co., **o, r, s.**
Philco Corp.-Govt. & Industrial Group, **a thru q, v thru z, a-l, b-l.**
Piasecki Aircraft Corp., **a, d.**
Polarad Electronics Corp., **m.**
Precise Development Corp., **a, i.**
Production Research Corp., Sub.-Radio Condenser Co., **d, l, m, o, r.**
Projects Unlimited, Inc., **n, o, y, b-l.**
Pyroferric Co. Inc., **l.**
RS Electronics Corp., **c, h, i, m, p, y, z, a-l.**
Radalab Inc., **a thru i, k, m thru p, r, s, t, v thru z, a-l, b-l.**
Radiaphone Co. Inc., **c, d.**
Radiation, Inc., **h, j, m, p, y, z, a-l.**
Radio City Products Co. Inc., **d, e, x, z, a-l.**
***RADIO CORP. OF AMERICA, a thru z, a-l, b-l.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a thru e, h thru p, r, s, v thru z, a-l.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **a thru k, m thru p, s, t, u, x, y, z, a-l.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **c.**
Rantec Corp., **m.**
Raven Industries Inc., **c, o, y.**
Republic Aviation Corp., Missile Systems Div., **a, c, l, m, n, u, y, z, a-l.**
Resdel Engrg. Corp., **c, f, h, p, z, a-l.**
Santa Barbara Research Center, **l.**
Schaevitz Engrg., **e.**
Scientific-Atlanta, Inc., **g, m, z, a-l.**
H. H. Scott, Inc., **i.**
Seiscor, Div.-Seismograph Service Corp., **e, f, o, r, s, y.**
Simmonds Aerocessories, Inc., **e, h, o, z, a-l.**
Southwest Research Institute
Specialty Electronics Development Corp., **f, m, p.**
Specific Products, **b-l.**
Spectra Electronics Corp., **l, o, y, z, a-l, b-l.**
Spectralab Instruments, **m.**
Sperry Gyroscope Co., Div.-Sperry Rand Corp., **f, s.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **m.**
State Testing Laboratory Inc., **n.**
Stewart-Warner Electronics Div., **a thru e, i, m, p, y, z.**
Strand Engrg. Co., **m, p.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, c thru f, i, m thru p, s, u thru z, a-l.**
Summers Gyroscope Co., **z.**
Sunair Electronics, Inc., **d.**
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., **m, p.**
TRG, Inc., **l, m, p, q, s.**
Tamar Electronics, Inc., **a, c, e, i, m, p, x, z, a-l.**
Tapco Group, Thompson Ramo Wooldridge Inc.
Technical Materiel Corp., The, **d, g, h, k, x.**
Technology Instrument Corp., **b, h, o, u.**
Telechrome Mfg. Corp., **h, i, b-l.**
Telectro Industries Corp., **a, d, e, i, o.**
Telerad Mfg. Corp., **m.**
Texas Instruments Inc., **l thru p.**
Thompson Ramo Wooldridge Inc., **c.**
United Shoe Machinery Corp., **m, p.**
U. S. Industries, Inc., **p, q.**
U. S. Science Corp., Div.-Topp Industries, Inc., **a-l.**
Virginia Electronics Co., Inc., **a, b, d, e, h, n, o, s, v, w, y.**
Vocaline Co. of America Inc., **z.**
Voi-Shan Electronics, **y.**
Wells Industries Corp., **l, t.**
Westinghouse Electric Corp., **a, d, g thru j, m, n, p, x.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **z, a-l.**
Winder Aircraft Corp. of Florida, **a, d, e.**

RECEIVING EQUIPMENT, VHF OMNIRANGE

Allied International Corp.
Bendix Aviation Corp.
Bendix Radio Div., Bendix Aviation Corp.
CG Electronics Corp.
Collins Radio Co.
Daystrom, Inc., Military Electronics Div.
Designers for Industry, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fla. Aircraft Radio & Marine
General Instrument Corp., Defense & Engrg. Products Group
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Litton Industries, Maryland Div.
MEG Products, Div.-Mandrel Industries, Inc.
Motorola, Inc.
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Southwest Research Institute
Stromberg-Carlson Div.-General Dynamics Corp.
Telectro Industries Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.

RECORDERS

a. Antenna Pattern
b. Binaural Tape
c. Code
d. Data
e. Depth
f. Disc
g. Disc Magnetic
h. Electronic Rotary Stylus
i. Electronic Self-Balancing Recorders & Indicators
j. Facsimile
k. Film
l. Film Stripe, Magnet
m. Film Thickness
n. Flight Data
o. Fluid Conductivity, Electronic
p. Frequency
q. Frequency Response
r. Humidity, Electronic
s. Liquid Level, Electronic
t. Magnetic
u. Materials Thickness, Electronic
v. Mechanical
w. Millivolt
x. Moisture, Electronic
y. Oscillograph
z. Oxygen
a-l. Polar
b-l. Potentiometer
c-l. Power Level
d-l. Pressure, Electronic
e-l. Sound Level
f-l. Specific Gravity, Electronic
g-l. Strain
h-l. Tape & Wire
i-l. Telemetering
j-l. Temperature, Electronic
k-l. Timing
l-l. Torque, Electronic
m-l. Transient
n-l. Vacuum
o-l. Vibration
p-l. Weight, Electronic
q-l. XY

ACF Industries Inc., **q-l, q-l.**
ASCOP Div., Electro-Mechanical Research, Inc., **n.**
Acton Laboratories Inc., **y.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **a, a-l.**
Alfax Paper & Engrg. Co. Inc., **d, j, i-l.**
American Electronics, Inc., **t, h-l, k-l.**
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., **i-l, k-l.**
American Instrument Co., Inc., **r, x, j-l.**
American Machine & Foundry Co., Government Products, N. Y., **d, m-l.**
American Missile Products Co., Inc., **i-l, k-l.**
Ampex Data Products Co., **d, t, i-l, m-l, o-l.**
Amthor Testing Instrument Co., Inc., **v.**
Antlab Inc., **a, a-l, c-l, e-l, o-l, q-l.**
Applied Electronics Corp. of N. J., **c, d.**
Arcair Co., **k-l.**
***ARNOUX CORP., i-l, j-l.**
Associated Engrg. & Mfg. Corp., **h-l.**
Automatic Timing & Controls, Inc., **i, d-l, g-l, l-l, p-l, q-l.**
Autonetics, Div.-North American Aviation, Inc., **n.**
Avien, Inc., **j-l.**
B & K Instruments, Inc., **i, q, a-l, e-l, o-l.**
Bach Auricon, Inc., **d, k, l, n.**
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., **i, w, d-l, g-l, l-l.**
Barnes Development Co., **d.**
Beckman Instruments, Inc., Berkeley Div., **d, p, k-l.**
Beckman-Systems Div., **d.**
Belock Instrument Corp., **d.**
Bendix Aviation Corp., **a, c, d, e, n, s, x, i-l.**
Benson-Lehner Corp., **b, c, d, k, n, t, h-l, q-l.**
Bergen Labs., Inc., **l-l.**
***BRISTOL CO., THE, i, r, w, b-l, i-l, j-l, q-l.**
Brush Instruments, Div.-Clevite Corp., **d, y.**
Budd Co., The, **d, j, a-l.**
Budd Lewyt Electronics, Inc., **d.**
Burr-Brown Research Corp., **j-l.**
Bytrex Corp., **i, w, g-l, l-l, p-l.**
CBS Laboratories, Div.-Columbia Broadcasting System, **t, h-l.**
CG Electronics Corp., **a, d, n, i-l.**
California Computer Products, Inc., **q-l.**
Calvert Electronics Inc., **w.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **l, t, y, h-l.**
Century Electronics & Instruments, Inc., **d, n, w, y, b-l, i-l.**
Clevite Ordnance, Div.-Clevite Corp., **e, v, h-l.**
Computer Systems, Inc., **b-l, q-l.**
Consolidated Airborne Systems, Inc., **i, s, p-l.**
***CONSOLIDATED ELECTRODYNAMICS CORP., d, n, t, x, y, d-l, g-l, h-l, i-l, o-l.**
Control Data Corp., **g.**
Convair Instruments, Convair Div.-General Dynamics Corp., **d-l.**
Crown International Div.-International Radio & Electronics Corp., **t.**
Curtiss-Wright Corp., Princeton Div., **i, u, w, j-l, q-l.**
DBM Research Corp., **k-l.**
Dalmo Victor Co., Div.-Textron, Inc., **t.**
Daystrom Inc., Weston Instruments Div., **i, p, r, u, v, w, b-l, d-l.**
Dejur-Amsco Corp., Electronics Sales Div., **w, b-l, h-l.**
Designers for Industry, Inc., **j, y, h-l, i-l.**
Digital Sensors Inc., **k-l.**
Allen B. Du Mont Labs., Inc., **y, j-l.**
Dynatronics, Inc., **d, i-l.**
Eastman Kodak Co., **d, k thru n, i-l.**
Edwards Engrg. Co., **b, d, n, q, t, e-l, h-l, j-l.**
Edwards High Vacuum Ltd., **n-l.**

Electric Autolite Co., The, j-l.
Electro Instruments, Inc., c, d, p, v, w, q-l.
Electromation Co., Div.-Del Mar Engrg. Labs., b thru e, k, l, p, t, v, d-l, e-l, g-l, i-l.
Electro-Medical Lab., Inc., y.
Electronic Applications, Inc., b, p, q, c-l.
Emerton, Sub.-Emerson Radio & Phonograph Corp., n, q, r, t, u, v, a-l, e-l, i-l, o-l.
Epic, Inc., w, y, o-l.
Esterline-Angus Co., The, p, w, n-l.
Fenske, Fedrick & Miller, Inc., p.
Fischer & Porter Co., s, d-l, j-l.
Fisher Scientific Co., Maryland, w, b-l, j-l.
Flight Research, Inc., d, n, y.
Ford Instrument Co., Div.-Sperry Rand Corp., i-l.
Foxboro Co., The, o, r, s, x, b-l, d-l, f-l, g-l, j-l, n-l.
GPL Div.-General Precision, Inc., d, k, n.
Gates Radio Co., t, h-l.
General Aniline & Film Corp., Ansco Div., k.
General Communication Co., f-l.
General Controls Co., b-l, d-l, j-l, n-l.
General Electric Co., Apparatus Sales Div., i, p, u, w, c-l, k-l.
General Kinetics Inc., h-l.
General Radio Co., c-l, e-l.
Gilmore Industries, Inc., d, i, w, g-l, j-l, l-l, p-l, q-l.
Gordon Enterprises, k, n, y, h-l, k-l, o-l.
Gray Mfg. Co., The, t, h-l.
Gulton Industries, Inc., d, n, p, d-l, i-l, j-l, o-l.
Hagan Chemicals & Controls, Inc., d, v, d-l, j-l.
Haledy Electronics Co., s.
Hallicrafters Co., The, d.
Hammett-Mercury-Rex Div., d.
Hathaway Instruments, Inc., d, k, n, v, y, g-l.
Hays Corp., The, i.
Hewlett-Packard Co., d, y, q-l.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., n-l.
Houston Instrument Corp., q-l.
Howe Scale Co., The, p-l.
Image Instruments, Inc., d.
Impact-O-Graph Corp., The, o-l.
Industrial Instruments Inc., o.
Instrumentation Associates, Inc., z.
International Radio & Electronics, b, d, i, n, p, q, t, e-l, h-l, i-l, k-l, m-l.
Kay Electric Co., d, g, p, q, e-l, i-l, m-l, o-l.
Kellogg Switchboard & Supply Co., Communications Div.- IT&T Corp.
Lab. for Electronics, Inc., f, g.
Lane Electronics Mfg. Corp., f, t, h-l.
Leach Corp., b, d, n, p, t, i-l.
Lear, Inc., i, n, o, r, s, q-l.
Leeds & Northrup Co., a, d, o, r, s, w, z, a-l, b-l, c-l, g-l, i-l, j-l, p-l, q-l.
Librascope Div., General Precision, Inc., d, q-l.
Edwin A. Lipps Engrg., t.
Lockheed Aircraft Corp., Missiles & Space Div., h-l, i-l.
Loral Electronics Corp., q-l.
MB Electronics, o-l
Madigan Corp., d, i, n, i-l.
Magnasync Corp., d, l, t, h-l, i-l.
Maico Electronics, Inc., d, g, t, h-l.
Martin-Decker Corp., d, v, d-l, n-l, p-l.
Mason-Neilan. n-l.
Massa Div.-Cohu Electronics, Inc., y, g-l, m-l, o-l.
J. A. Maurer, Inc., k.
W. L. Maxson Corp., The, l.
Micro Gee Products, Inc., n, q.
Midwestern Instruments, Inc., b, d, j, n, y, h-l, i-l.
Milgo Electronic Corp., q-l.
Mincom Div., Minnesota Mining & Mfg. Co.,
Mine Safety Appliances Co., z.
Minicord Corp. of America, h-l.
Minneapolis-Honeywell, Heiland Div., y.
Minneapolis-Honeywell Regulator Co., Industrial Systems Div., d, n, q, t, h-l, i-l.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., b, d, i, o, p, r, s, t, w, x, y, b-l, d-l, f-l, g-l, h-l, j-l, p-l.
***MINNESOTA MINING & MFG. CO., b, d, t, h-l, i-l.**
Moran Instrument Corp., d.
Motorola, Inc., c, i-l, q-l.
Muirhead Instruments Inc., j.
NUMEC-Nuclear Materials & Equipment Corp. p-l.
New England Scientific Instruments Co., r, w, c-l, m-l.
Northeastern Engrg. Inc., p.
Northrop Corp., k, n, p, q, i-l, o-l.
Offner Electronics Inc., y, g-l, i-l, m-l.
Optomechanisms Inc., k, o-l.
Orbitran Co., Inc., p-l.
Oxygen Equipment & Service Co., z.
Packard-Bell Electronics Corp., t.
Panoramic Radio Products, Inc., o-l.
Philco Corp.-Govt. & Industrial Group, c, d, i-l.
Photovolt Corp., w.
Photron Instrument Co., d, n, q, y, g-l, o-l.
Potter Aeronautical Corp., p, f-l.
Potter Instrument Co., Inc., b, c, d, g, l, n, p, q, t, h-l, i-l, j-l.
Presin Co., d.
Production Research Corp., Sub.-Radio Condenser Co., d, i-l.
Pyrometer Instrument Co., Inc., j-l.
Radalab Inc., a.
Radiaphone Co. Inc., i-l.
Radiation, Inc., h, i-l, q-l.
***RADIO CORP. OF AMERICA, a thru d, f, g, j thru n, p, q, t, u, e-l, i-l, n-l.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, j, t, h-l.**
Raymond Engrg. Lab., Inc., h-l.
J. B. Rea Co., t.
Research, Inc., w, d-l, g-l, j-l, p-l.
Resitron Labs., Inc., n-l.
Robertshaw-Fulton Controls Co., A & I Div., i.
Rockwood Sprinkler Co., Div.-The Gamewell Co., b-l.
Rosemont Engrg. Co., d-l, j-l.
Milton Roy Co., m, s, z.
Sangamo Electric Co., f, a-l, h-l.
Schaevitz Engrg., m, u, l-l, p-l.
Scientific & Process Instruments Div.-Beckman Instruments, Inc., b-l.
Scientific-Atlanta, Inc., a, a-l.
Seeburg Corp., The, j, n, i-l.
Seiscor, Div.-Seismograph Service Corp., q-l.
Serdex, Inc., r, j-l.
Servo Consultants Ltd., q, a-l.
Soroban Engrg., Inc., c, d, v, h-l.
Southwest Research Institute
Southwestern Industrial Electronics Co., y, e-l, i-l, o-l.
Sperry Piedmont Co., Div.-Sperry Rand Corp., e.
Stewart-Warner Electronics Div., d, j, v.
F. J. Stokes Corp., n-l.
Stromberg-Carlson, San Diego, General Dynamics Corp., d, j, k.
Sun Electric Corp., Aeronautical Div., o-l.
Systron Corp., d, i, p, b-l, k-l.
TRG, Inc., a.
Talley Register Corp., q-l.
Tapco Group, Thompson Ramo Wooldridge Inc., t.
Technitrol Engrg. Co., d, j.
Technology Instrument Corp., y.
Telechrome Mfg. Corp., d, i, i-l.
Telectro Industries Corp., a thru d, j, t, y.
Television Utilities Corp., k.
Telex, Inc., g, t, p-l.
Texas Instruments Inc., d, g, i, w, b-l.
Thermo Electric Co., Inc., i, r, s, w, d-l, f-l, j-l.
Thompson Ramo Wooldridge Inc., t.
Trimount Instrument Co., s.
Universal Dynamics Corp., r, x, d-l.
Viewlex, Inc., b, k, y, h-l.
Wang Labs., Inc., c, d.
Waste King Corp., Technical Products Div., d, n, v.
Weksler Instruments Corp., n-l.
Wells Industries Corp., o, r, s, x, b-l, f-l, j-l.
Western Union Telegraph Co., The, j.
Westronics Inc., a, e, i, o thru s, v thru y, b-l thrug g-l, l-l thru p-l.
Yellow Springs Instrument Co., The, d, w, j-l.

RECTIFIER POWER UNITS

ADC Inc.
Allen Electric & Equipment Co.
American Rectifier Corp.
***ARNOUX CORP.**
Bendix Aviation Corp.
Boque Electric Mfg. Co.
Bradley Semiconductor Corp.
Chalco Engrg. Corp.
Clark Electronic Laboratories
Continental Electronics Mfg. Co., Sub.-Ling-Altec Electronics Inc.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Delco Radio Div.-General Motors Corp.
Djeco, Div.-Djordjevic Engrg. Co.
Dresser Electric Co.
Electronic Devices Inc.
Fansteel Metallurgical Corp.
Flight Support, Inc.
General Electric Co., Apparatus Sales Div.
General Instrument Corp., Defense & Engrg. Products Group
Gonset Div.-Young Spring & Wire Corp.
Gremco, Inc.
Hammett-Mercury-Rex Div.
ITT Components Div., International Telephone & Telegraph Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
***INTERELECTRONICS CORP.**
Jack & Heintz, Inc.
Kahn & Co., Inc.
Lear, Inc.
Leece-Neville Co., The
Leland Airborne Products, Div.-American Machine & Foundry Co.
Macarr, Inc.
P. R. Mallory & Co., Inc.
***MARTIN CO., THE, DENVER DIV.**
Sanford Miller Co.
Model Rectifier Corp.
Motoresearch Co.
Mullenbach Div.-Electric Machinery Mfg. Co.
Opad Electric Co.
Otis Elevator Co., Defense & Industrial Div.
M. V. Palmer, Inc.
Perkin Engrg. Corp.
Peschel Electronics, Inc.
Pesco Products Div., Borg-Warner Corp., Calif.
Power Supplies Inc.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Solar Aircraft Co.
Specialty Electronics Development Corp.
Stewart & Stevenson Services, Inc.
Talley Corp., The
Technical Apparatus Builders
Telechrome Mfg. Corp.
Telkor, Inc.
Trans-Sil Corp.
Varo Mfg. Co., Inc.
Virginia Electronics Co., Inc.
Westinghouse Electric Corp.
Wickes Engrg. & Construction Co.
Winder Aircraft Corp. of Florida

RECTIFIERS

a. Copper Oxide
b. Electronic Tube
c. Germanium
d. Mercury Arc
e. Metal Sulphide
f. Metallic Oxide
g. Metallic, Power Supplies
h. Metallic Stack
i. Photoelectric
j. Selenium
k. Silicon
l. Titanium
m. Tube
n. Tube Rectifying Units

Aerolux Light Corp., m.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., j.
Allied Research Products, Inc., j, k.
Allis-Chalmers, c, d, j, k.
American Rectifier Corp., g, h, j, k.
Barco, Inc., j, k.
Barry Electronics Corp., j.
Bendix Aviation Corp., c, k, m.
Bendix Aviation Corp.-Semiconductor Products, Red Bank Div., k.
Bogue Electric Mfg. Co., k.
Bradley Semiconductor Corp., a, g, h, j, k.
Britton Electronics Corp., j, k.
CBS Electronics, Div.-Columbia Broadcasting System, Inc., b, m.

Calvert Electronics Inc., **b, k, m, n.**
Central Electronic Mfrs., Div.-Nuclear Corp. of America, **b, m.**
Chatham Electronics Div.-Tung-Sol Electric Inc., **j, k.**
Clevite Transistor Products, Div.-Clevite Corp., **k.**
Columbus Electronics Corp., **k.**
Conant Labs., **a, j.**
Continental Electric Co., **b, d, m.**
Continental Electronics Mfg. Co., Sub.-Ling-Altec Electronics Inc., **b, d, j, k, m, n.**
Cosmic Instruments Inc., **j.**
Dallons Semiconductor, Div.-Dallons Labs., **k.**
Daven Co., The, **n.**
Daystrom Inc., Weston Instruments Div., **a.**
Delco Radio Div.-General Motors Corp., **c, k.**
Djeco, Div.-Djordjevic Engrg. Co., **b, c, g, h, j, k, m, n.**
Eicor Div.-Scranton, **g.**
Eitel-McCullough, Inc., **m.**
Electronic Devices, Inc., **g, h, j.**
***EQUIPMENT DIV., RAYTHEON CO., n.**
Fansteel Metallurgical Corp., **g, h, j, k.**
Fla. Aircraft Radio & Marine, **a, b, m, n.**
Gates Electronic Co., **g, j, k.**
General Electric Co., Apparatus Sales Div., **c, d, j, k.**
General Electric Co. Ltd. of England, **a, b, j, k, m.**
General Instrument Corp., Semiconductor Div., **k.**
Gordon Enterprises, **h, j, k.**
Hammett-Mercury-Rex Div., **a thru n.**
Hanson-Van Winkle-Munning Co., **a, c, j, k.**
George E. Harris & Co., Inc., **c, j, k.**
Hermetic Seal Corp. & Thermal Controls, Inc., **b.**
Hoffman Electronics Corp., Semiconductor Div., **k.**
Hughes Semiconductor Div.-Hughes Aircraft Co., **k.**
ITT Components Div., International Telephone & Telegraph Corp., **j, k, m.**
Industron Corp., **n.**
***INTERELECTRONICS CORP., g.**
International Rectifier Corp., **c, h thru k.**
Kuthe Labs., Inc., **b.**
Lear, Inc., **b, k, m, n.**
Leece-Neville Co., The, **c, j, k.**
G. H. Leland, Inc., **j.**
P. R. Mallory & Co., Inc., **a, e, k.**
***MARTIN CO., THE, DENVER DIV., n.**
Sanford Miller Co., **g, h, j, k.**
Motorola, Inc., **c, k.**
NUMEC-Nuclear Materials & Equipment Corp., **f.**
North American Electronics Inc., **k.**
Northrop Corp.
Opad Electric Co., **a, b, c, e thru n.**
Peschel Electronics, Inc., **n.**
***RADIO CORP. OF AMERICA, b, c, i, j, k, m, n.**
Radio Development & Research Corp., **g, h, j, k.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **j, k.**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., b, m.**
Rectico, Inc., **a, d thru h, j, k.**
Resitron Labs., Inc., **m.**
Sargent Engrg. Corp., **k.**
Sarkes Tarzian, Inc., Semiconductor Div., **h, j, k.**
***SEMICONDUCTOR DIV., RAYTHEON CO., c, k.**
Semi-Elements, Inc., **a, c, k.**
Southwest Research Institute
Standard Rectifier Corp, **k.**
Sylvania Electric Products Inc., Sylvania Electronic Tubes Div., **k.**
Sylvania Semiconductor Div., Sylvania Electric Products Inc., **k.**
Technical Apparatus Builders, **a, j, k.**
Telechrome Mfg. Corp., **c, j.**
Texas Instruments Inc., **i, k.**
Thermosen Inc., **b, m.**
Transitron Electronic Corp., **h, k.**
Trans-Sil Corp., **e thru h, k.**
Tung-Sol Electric, Inc., **b, f, g, h, j, k, m, n.**
Udylitet Corp., The, **j, k.**
U. S. Semiconductor Products Div.-United Industrial Corp., **k.**
Vickers Inc., Electric Products Div., **h, j, k.**
Wells Industries Corp., **i.**
Weltronic Co., **b, g, n.**
Westinghouse Electric Corp., **b, c, d, f, g, h, j, k, m, n.**
Winder Aircraft Corp. of Florida, **n.**

REDUCERS, SHAFT

Acme Industrial Co.
Amatom Electronic Hardware Co., Inc.
Custom Products Corp.
Guidance Controls Corp.
Indiana Gear Works, Inc.
Jan Hardware Mfg. Co., Inc.
Lovejoy Flexible Coupling Co.
Richard Philip Co.
Tube-Turns Div., Chemetron Corp.
Western Gear Corp.-Precision Products Div.
Worthington Corp.

REFLECTORS, RADAR

Ainslie Corp.
***ANDREW CORP.**
Bendix Aviation Corp.
Blaw-Knox Equipment, Div.-Blaw-Knox Co.
Brooks & Perkins, Inc.
Joe Davidson & Associates
***DEL MAR ENGRG. LABS.**
Diamond Antenna & Microwave Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
General Bronze Electronics Corp.
General Electric Co., Ordnance Dept.
Gilfillan Bros. Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Kling Metal Spinning & Stamping Co.
***LAVELLE AIRCRAFT CORP.**
Lockheed Electronics Co., Stavid Div.
Lunn Laminates, Inc.
Narmco Mfg. Co.
Northrop Corp.
Parsons Corp., Special Products Div.
Phoenix Products Co.
Plastic Age Sales, Inc.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Sanders Associates, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
C. W. Torngren Co., Inc.
Tower Construction Co.
Transco Products, Inc.
Winder Aircraft Corp. of Florida
Zippertubing Co., The

REFRIGERATION EQUIPMENT, AIRBORNE

Aeroquip Corp., Jackson Div.
Air Products, Inc.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alco Valve Co.
Bar-Ray Products, Inc.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
Cameraflex Div., The Federal Mfg. & Engrg. Corp.
Cryogenerators, Inc.
Joe Davidson & Associates
Dean Products, Inc.
Drayer Hanson Div.-Crane Co.
Great Lakes Mfg. Corp.
Hallicrafters Co., The
Hamilton Standard, Div.-United Aircraft Corp.
Monrovia Aviation Corp.
Murphy & Miller Inc.
Northrop Corp.
On Mark Couplings, Inc.
Ready-Power Co., The
Recony Div.,-Vinco Corp.
Southwest Research Institute
Stearns-Roger Mfg. Co., The
Stratos, Div.-Fairchild Engine & Airplane Corp.
Torrington Mfg. Co. Inc., The, Specialty Blower Div.
United Aircraft Products, Inc.
Western Div., Aeroquip Corp.
York Div., Borg-Warner Corp.

REFRIGERATION EQUIPMENT, GROUND

Accessory Controls & Equipment Corp.
Aeroquip Corp., Jackson Div.
Aero-Test Equipment Co., Inc.
Air Products, Inc.
***AIRSEARCH MFG. CO. DIV.-THE GARRETT CORP.**
Alco Valve Co.
American Instrument Co., Inc.
Associated Testing Labs., Inc.
Atlas Engrg. Corp.
Auto-Control Labs. Inc.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co.
Budd Lewyt Electronics, Inc.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Consolidated Diesel Electric Corp.
Cryogenerators, Inc.
Joe Davidson & Associates
Dean Products, Inc.
Drayer Hanson Div.-Crane Co.
Ellis & Watts Products, Inc.
Frick Co.
Gardner Leboratory, Inc.
Great Lakes Mfg. Corp.
Gremco, Inc.
George E. Harris & Co., Inc.
Highland Engrg. Co.
C. G. Hokanson Co., Inc.
Hughes Tool Co., Aircraft Div.
***ITEMCO, INC.**
Jamison Cold Storage Door Co.
Lear, Inc.
M-D Blowers, Inc.
Monrovia Aviation Corp.
On Mark Couplings, Inc.
D. W. Onan & Sons, Inc.
Pioneer Industries Div., Almar-York Co., Inc.
Pre-Flite Industries Corp.-Sub.-Avco Mfg., Corp.
Ready-Power Co., The
Recony Div.,-Vinco Corp.
Southwest Research Institute
Stearns-Roger Mfg. Co., The
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tenney Engrg., Inc.
Thermo King Corp.
Torrington Mfg. Co., Inc., The, Specialty Blower Div.
Trane Co., The
United Aircraft Products, Inc.
Vilter Mfg. Co., The
Webber Engrg. Corp.
Webber Mfg. Co., Inc.
Wenzlau Engrg. Co.
Western Devices Inc.
Western Div., Aeroquip Corp.
Westinghouse Electric Corp.
Whitlock Mfg. Co., The
Worthington Corp.
York Div., Borg-Warner Corp.

REGULATORS

a. Air
b. Air Combustion
c. Air Pressure
d. Battery Charging
e. Cable Tension
f. Coolant
g. Demand Oxygen
h. Fluid Flow
i. Frequency
j. Fuel Flow
k. Fuel Pressure
l. Generator
m. Hydraulic Pressure
n. Liquid Level
o. Manifold Pressure
p. Oil Cooler
q. Oil Pressure
r. Oil Pump Flow
s. Oil Temperature
t. Oxygen
u. Temperature
v. Vacuum Systems
w. Voltage Frequency
x. Voltage Regulators & Stabilizers
y. Water Injection
z. Water Metering

ACF Industries Inc., **b, c, i thru l, q, w thru z.**
Accessory Controls & Equipment Corp., **a, c.**
Accessory Products Co., Div.-Textron Inc., **a, c, h, j, k, n, p, q, t, v, y.**
Acme Electric Corp., **x.**
Acme Industrial Co., **h.**
Acoustica Associates, Inc., **h, n.**
Actuation Research Corp., **a, c, h, k, m.**
Adel Precision Products of Calif., Div.-

General Metals Corp., m, q, r.
Aero Supply Mfg. Inc., b, f, h, j, k, n, q, r, y.
Aeroscience, Inc., x.
Aerotec Industries Inc., Aircraft Equipment Div., a, b, c, h, j, k, m, n, q, t.
Air Products, Inc., g, t.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., a, c, g, j, k, o, t.
Air Speed Tool Co., a.
Airaterra, t.
Airborne Research & Development Corp., c, k, m.
*AIRESEACH MFG. OF ARIZONA, a, c, h, j, k, p, q, t, u.
*AIRESEACH MFG. CO., DIV-THE GARRETT CORP., a, c, h, i, j, l, p, s, u.
Alco Valve Co., f.
Allied International Corp., f, h, j, k, m, p thru s.
American Electronics, Inc., i, u, w.
American Instrument Co., Inc., a, c, h, m, q, u.
American Rectifier Corp., x.
American Research & Mfg. Corp., x.
Applied Dynamics Corp., a, c.
Arkay Engrg., Inc., x.
Arkwin Industries, Inc., a, c, m.
Aro Equipment Corp., The, g, t.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., a, c, g, n, t.
Atlas Engrg. Co., Inc., x.
Automation Products, Inc., n.
Avien, Inc., u.
Bar-Ray Products, Inc., u.
Bastian-Blessing Co., The, a, c, h, t.
Bellofram Corp., a, c.
Bellows-Valvair Divs., a, c.
Benbow Mfg. Corp., a, h, j, m, t.
Bendix Aviation Corp., a, c, g, h, j thru m, t thru y.
Bendix Aviation Corp., Cincinnati Div., i.
Bendix Aviation Corp., Pioneer-Central Div., g, n, t.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., h, j, k, u, y, z.
Bendix-Pacific Div., Bendix Aviation Corp., c, m.
Bendix Utica Div., Bendix Aviation Corp., a, c, h, j, k.
A. Biederman, Inc., g, j, k, o, t, u.
Binks Mfg. Co., a, c, h.
Bogue Electric Mfg. Co., d, i, l, n, u, w, x.
Brooks Rotameter Co., h, j.
Budd Lewyt Electronics, Inc., w, x.
CBS Electronics, Div.-Columbia Broadcasting System, Inc., x.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., j.
Captive Seal Corp., a, c, h, j, k, m thru t, v.
Carleton Aviation Co., Inc., a, b, h, j, k, m, t, v, y.
J. C. Carter Co., The, h, j, k, m, n, o, y.
A. W. Cash Valve Mfg. Corp., c, k, m, q, s thru v.
Central Transformer Co., x.
Chalco Engrg. Corp., w, x.
Cleco Air Tools, Div.-Reed Roller Bit Co., a.
Clegg Labs., Div.-Clegg, Inc., x.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., i, x.
Components Corp., c, k, m.
Conoflow Corp., a, c, h, j, v.
Consolidated Airborne Systems, Inc., i, n.
Consolidated Controls Corp., a, c, h, j, k, m.
Consolidated Diesel Electric Corp., w, x.
Cornelius Co., The, Aero Div., a, c, h, m, v.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., a, c, j, k, m.
Custom Component Switches Inc., h, k, m, o, q, s, t.
Datascan Inc., x.
Daven Co., The, x.
Davenport Mfg. Co., x.
De Havilland Aircraft of Canada, Ltd., Special Products Div., w.
Delco Radio Div.-General Motors Corp., i, w, x.
Deltron Inc., x.
Dieco Div.-Djordjevic Engrg. Co., d, x.
Dorsett Electronic Labs., Inc., w, x.
R. C. Dudek & Co., x.
Dynamic Controls Corp., c, h thru n, s, u, w.
Eastern Industries Inc., c, f, h, j, k, m, p thru s, v.
Eclipse Fuel Engrg. Co., b, j, k, u.
Edwards High Vaccum Ltd., v.
Electric Autolite Co., The, x.
Electric Regulator Corp., d, i, l, u, w, x.
Electro Precision Corp., w.
Electrol Inc., a, h, m.
Essex Mfg., Co., Inc., c.
Farwest Mfg. Div., Inc., x.
Fenwal, Inc., f. s. u.
Fidelity Instrument Corp., i, w, x.
Fisher Governor Co., a, b, c, n, t.
Flight Refueling, Inc., h, j, k, n, o, t.
Fluid Power Inc., a, g, t.
Fluid Regulators Corp., h, j, m.
Ford Instrument Co., Div.-Sperry Rand Corp., w, x.
Futurecraft Corp., a, c, f, g, h, k, m, q, t.
GPL Div.-General Precision, Inc., i, w.
Garwin, Inc., a, v.
Gates Radio Co., x.
General Controls Co., a, c, u.
General Electric Co., l, w.
General Electric Co., Apparatus Sales Div., h, i, l, u, w, x.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Magnetics, Inc., w, x.
General Radio Co., x.
General Regulator Corp., k.
Paul E. Gerst & Co., l, w, x.
Gilfillan Bros. Inc., c, m.
Gits Brothers Mfg. Co., a.
Great Lakes Mfg. Corp., c, k, m, q.
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., u.
Grove Valve & Regulator Co., a, c, h.
Guidance Controls Corp., e.
Gulton Industries, Inc., u, w, x.
B. H. Hadley, Inc., a, b, f, g, h, j, k, m, n, o, q, t.
Hamilton Standard, Div.-United Aircraft Corp., a, c, u.
Hammel-Dahl Div.-General Controls Co., c, h, n, q, r, u, z.
Hammett-Mercury-Rex Div., d, w, x.
George E. Harris & Co., Inc., l, q, w, x.
Haskel Engrg. & Supply Co., a, b, c, h, m.
Hass Instrument Corp., The, v.
Herlo Corp., k, m.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., v.
Highland Engrg. Co., a.
E. Vernon Hill & Co., u.
Hoffman Electronics Corp., Semiconductor Div., x.
Hoke Inc., a, c, h, k, o, t.
Hoover Electronics Co., x.
Howe Scale Co., The, h.
Huyck Systems Co., c, h, j, k, m.
Walter J. Hyatt Co., The, c, h, j, k, m, q, t, v.
Hydra-Power Corp., m, y.
Hydraulic Research & Mfg. Co., h, m.
Instrulab, Inc., x.
Integral Corp., h, m.
Intercontinental Dynamics Corp., c, v.
International Electronic Research Corp., h, j.
International Rectifier Corp., x.
Interstate Engrg. Corp., a, k, m.
Jack & Heintz, Inc., w, x.
Janitrol Aircraft Div.-Midland-Ross Corp., a, b, c, f, h, j, k, m, n, p, q, s thru v.
Jordan Electronics, Div.-Victoreen Instrument Co., w.
Kemp Aero Products, a, c, h, j, k, m, q, r.
Kepco, Inc., x.
Kidde Aero-Space Div., Walter Kidde & Co., Inc., a, c.
Kieley & Mueller, Inc., a, c, h, j, k, m, n, t, v, z.
Kollmans Instrument Corp., Sub.-Standard Coil Products Co., Inc., c.
Langley Corp., u.
Lear, Inc., a thru d, f thru p, s, u, v, x, y.
Lee Electric & Mfg. Co., d, w, x.
Leece-Neville Co., The, d, l, x.
Leland Airborne Products, Div.-American Machine & Foundry Co., d, l, w, x.
*WALLACE O. LEONARD, INC., a, c, g, h, j, k, m, n, q, r, t, v.
Leslie Co., c, f, k, m, n, q, r, s, u.
Linde Co., Div.-Union Carbide Corp., t.
Line Material Industries-McGraw-Edison Co., x.
Liquid Carbonic Div.-General Dynamics Corp., g, t.
Liquidometer Corp., The, n.
Lundy Mfg. Corp., a, j, w.
M. C. Mfg. Co., a, c, h, m.
Magnetic Circuit Elements, Inc., i, u, w.
Magnetic Instrument Co., Inc., n.
Magnetic Research Corp., w, x.
Manning & Lewis Eng. Co., p.
Marotta Valve Corp., a, c, h, j, k, m, o, q, t.
*MARTIN CO., THE, DENVER DIV., d, h, k, m, u, w, x.
Mason-Neilan, a, c, h, j, k, n, q, r, s, u.
Mead Specialties Co., Inc., a, c.
Milro Controls Co., Inc., w.
Mira Corp., The, t.
J. J. Monaghan Co., Inc., t.
C. A. Morgren Co., a, c, m, t, z.
National Co., Inc., x.
National Cylinder Gas, Div.-Chemetron Corp., a, g, t.
National Welding Equipment Co., a, g, k, o, t.
Networks Electronic Corp., w, x.
Newark Controls Co., c, m, n, v.
Ernest Norrman Laboratories, i.
North American Electronics Inc., x.
Northrop Corp., e, i, u, w, x.
OPW-Jordan, a, c, k, n, p, q, s, u.
Ohio Chemical & Surgical Equip. Co., Div.-Air Reduction Co., Inc., t.
Oil-Dyne, Inc., m.
Opad Electric Co., x.
Otis Elevator Co., Defense & Industrial Div., w, x.
Oxygen Equipment & Service Co., g, t, v.
Ozone Metal Products Corp., m, q, r.
Pacific Scientific Co., e.
Parker-Hannifin Corp., a, c, h, j, k, m, o, q, r, t.
Peacock Engrg. & Mfg. Co., m.
Performance Measurements Co., w.
Perkin Engrg. Corp., x.
Richard Philip Co., t.
Pitometer Log Corp., i.
Pneu-Hydro Valve Corp., a, b, c, f, g, h, j, k, m, p, q, s, t.
Potter Aeronautical Corp., h, i, j, z.
Power Supplies Inc., l.
Powers Regulator Co., The, u.
Projects Unlimited, Inc., u.
Puritan Aerospace Div.-Puritan Compressed Gas Corp., g, t.
Pyrometer Instrument Co., Inc., u.
Radiation, Inc., x.
Radiation Research Corp., x.
*RADIO CORP. OF AMERICA
Randall Engrg. Corp., a, c, h, m.
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., x.
Reaction Motors Div., Thiokol Chem. Corp., k, o, t.
Republic Mfg. Co., c, m, q.
Research Controls, a, b, c, h, j, k, n, r, y, z.
Research, Inc., m, u.
Revere Corp. of America, Sub., Neptune Meter Co., j, n, u.
J. R. Robbins Co., m.
Robertshaw-Fulton Controls Co., A & I Div., a, c, g, h, o, t.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div., c, h, k, n, o, s, u, v.
Ronson Hydraulic Units Corp., a, c, m.
Milton Roy Co., n, z.
Roylyn Inc., t.
S-P Mfg. Corp., The, a.
Safety Electrical Equipment Corp., d, i, l w, x.
Sargent Engrg. Corp., m.
Scott Aviation Corp., t.
Servo-Tek Products Co., x.
Sierra Engrg. Co., g, t.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., a, c, h, j, m, n, o, q.
Sirvalco Systems Corp., a, c, g, h, j, k, m t.
Skyvalve, Inc., a, c, h, j, k.
A. O. Smith Corp., Smith-Erie Div., j, k, m.
Sorensen & Co., Inc., i, w, x.
Southwest Research Institute, a, b, c, f, g, h, j, k, m thru u, y, z.
Southwestern Valve Corp., c, h, j, k, m, t.
Specialty Electronics Development Corp., x.
Standard Electronics Div.-Reeves Instrument Corp., w, x.

Stevens Mfg. Co., Inc., **u.**
Stewart-Warner Corp., Alemite Div., **a, c.**
F. J. Stokes Corp., **v.**
A. U. Stone & Co., Inc., **a, c, f, h, j, k, m, p, q, r, z.**
Stratos, Div.-Fairchild Engine & Airplane Corp., **a, c, h, j.**
Sun Electric Corp., Aeronautical Div., **h, k, m.**
Superior Electric Co., The, **x.**
Superior Pneumatic & Mfg., Inc., **a, c.**
Tapco Group, Thompson Ramo Wooldridge Inc., **h thru l, x.**
Tel-Instrument Electronics Corp., **x.**
Texas Instruments Inc., **u.**
Thompson Ramo Wooldridge Inc., **h thru l, x.**
Torwico Electronics, Inc., **x.**
Transistor Devices Inc., **x.**
Transitron Electronic Corp., **x.**
Uehling Instrument Co., **n.**
United Aircraft Products, Inc., **a, c, f, h, j, k, m, p thru s, u, v, y.**
United Control Corp., **n, p, s, u.**
United Electric Controls Co., **q, u, v.**
U. S. Industries, Inc., **x.**
Universal Transistor Products Corp., **w, x.**
Valor Instruments, Inc., **x.**
Vap-Air Aeronautical Products Div., Vapor Heating Corp., **x.**
Varo Mfg. Co., Inc., **a, h, i, j, l, m, u, w, x.**
Vickers Inc., Electric Products Div., **i, w, x.**
Vickers, Inc., Mich., **h, j, k, m, s.**
Victoreen Instrument Co., **x.**
Vinson Mfg. Co., Inc., **a, c, g, h, j, k, m, t, v, z.**
Voi-Shan Electronics, **w, x.**
Wallson Associates, Inc., **v, w, x.**
Waterman Hydraulics Corp., **h, j, r, y, z.**
Weatherhead Co., The, **a, c, h, j, m, n.**
Wells Industries Corp., **n.**
Weltronic Co., **w, x.**
Western Sky Industries, **m, t.**
Westinghouse Electric Corp., **i, j, l, w, x.**
Westline Products Div.-Western Lithograph Co., **a.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **x.**
Whittaker Controls, Div.-Telecomputing Corp., **a, g, j, k, l, t.**
Wickes Engrg. & Construction Co., **d, i, l, w, x.**
Wolverine Diesel Power Co., **d, x.**
Worthington Corp., **a, b, c, f, g, h, j thru m, q, r, s, u thru x.**
Yellow Springs Instrument Co., The, **u.**
Zacharias Electronics Corp., **x.**
Zep Aero, **g, t.**

REINFORCED PLASTICS

Agricultural Aviation Engineering Co., Inc.
Air Logistics Corp.
American Aerophysics Corp.
American Printed Circuits Co., Inc.
American Research & Mfg. Corp.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Atkins & Merrill, Inc.
L. J. Barwood Mfg. Co., Inc.
Bjorksten Research Labs. for Industry, Inc.
Bonny Mfg. Corp.
Brook Molding Corp.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Butler Mfg. Co.
Chemplast, Inc.
Cincinnati Milling Machine Co., The
Clark Equipment Co.
Clevite Ordnance, Div.-Clevite Corp.
Colonial Aircraft Corp.
Continental Diamond Fibre Corp.
Cordo Chemical Corp.
Crystal-X Corp.
Custom Tool & Mfg. Co.
Dalmo Victor Co., Div.-Textron, Inc.
Dixon Corp.
Douglas Aircraft Co., Inc.
Duracote Corp.
Durez Plastics Div.-Hooker Chemical Corp.
Eastern Chemical Div.-Hooker Chemical Corp.
Eljay Corp.
Emerson Plastics Corp.
Eubanks Industries, Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Food Machinery & Chemical Corp.-Dapon Dept.
Food Machinery & Chemical Corp.-Epoxy Dept.
Food Machinery & Chemical Corp., Ordnance Div.
Franklin Fibre-Lamitex Corp.
Garlock Packing Co.
General American Transportation Corp.
General Electric Co., Missile & Space Vehicle Dept. Pa.
General Plastics Corp.
B. F. Goodrich Aviation Products
Goodyear Aircraft Corp.
Grant-Lehr Corp.
Harco Containers Div.-Harbor Boat Building Co.
Heil Process Equipment Corp.
Hercules Powder Co., Chemical Propulsion Div.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Walter J. Hyatt Co., The
Insulation Mfrs. Corp.
Johns-Manville Sales Corp.
Kelsey-Hayes Co.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
H. Koch & Sons
Lam-Ply, Inc.
Lamtex Industries Inc.
Lone Star Plastics Co., Inc.
Lunn Laminates, Inc.
Magee-Bralla & Associates
Mc Millan Companies, The
Mc Millan Lab., Inc.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
Molding Corp. of America
Narmco Mfg. Co.
National Vulcanized Fibre Co.
Naugatuck Chemical Div.-U. S. Rubber Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Northrop Corp.
Olin Mathieson Chemical Corp., N. Y.
Olympic Plastics Co., Inc.
Owens-Corning Fiberglas Corp.
Parsons Corp., Special Products Div.
Piasecki Aircraft Corp.
Plastic Age Sales, Inc.
Plastics Distributor of New England
Prewitt Aircraft Co.
REF Mfg. Corp.
Raven Industries Inc.
Raybestos-Manhattan, Inc.
Reeves Bros. Inc., Vulcan Rubber Div.
Rogers Corp.
Scientific-Atlanta, Inc.
Seaman Products, Div.-Seaman Paper Co.
Skydyne, Inc.
Specialty Electronics Development Corp.
Stahlin Bros. Inc.
Structural Fibers, Inc.
Swedlow Inc.
Snythane Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Tetrafluor, Inc.
Texstar Plastics, Div.-The Texstar Corp.
Thompson Ramo Wooldridge Inc.
Topper Mfg. Co., Inc.
Turco Products, Inc.
United States Chemical Milling Corp.
United States Rubber Co.
Westinghouse Electric Corp., Micarta Div.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.
Young Development Div., Hercules Powder Co.

RELAYS

a. Coaxial
b. Cross-Bar
c. D'Arsonval
d. Differential
e. Frequency Selective
f. High Voltage
g. Impulse
h Keying & Break-In
i. Latching
j. Mercury
k. Microwave
l. Overload
m. Overvoltage & Undervoltage
n. Photoelectric
o. Plate Circuit
p Polarized
q. Power
r. Rotary
s. Sensitive
t. Stepping
u. Subminiature
v. Telephone
w. Thermal
x. Thermostatic Delay
y. Time Delay
z. Timing
a-l. Vibrating Reed Type

***ABRAMS INSTRUMENT CORP., g, s, t.**
Acro Div., Robertshaw-Fulton Controls, **g, h, i, q, s.**
Advance Relays, Electronics Div., Elgin National Watch Co., **a, f, h, i, l, o, q, r, s, u, v, w, y.**
Aemco Inc., **f, q, u.**
Aerolite Electronics Corp.,
Agastat Timing Instruments-Elastic Stop Nut Corp. of America, **y, z.**
Airtron, Div.-Litton Industries, **k.**
Allied Control Co., Inc., **a, d, f thru i, l, m, o thru s, u, v, y.**
Allied International Corp., **a.**
American Instrument Co., Inc., **j, q, s, y.**
Amperite Co., Inc., **y.**
Arrow-Hart & Hegeman Electric Co., The, **i, l, m, q, r, y.**
Assembly Products, Inc., **c, d, l, m.**
Augat Brothers, Inc.
Automatic Electric Sales Corp., **g, i, p, r, s, t, v, y.**
Automatic Switch Co., **d, e, m, q, s, y.**
Automatic Timing & Controls, Inc., **t, y.**
Babcock Relays, Inc., **d, g, i, l, m, o thru s, u, v.**
Barber-Colman Co., **d, i, p, s.**
Baso Inc., **s, y.**
Beckman-Systems Div., **j.**
Bernco Engrg. Corp., **j.**
James G. Biddle Co., **e, a-l.**
Blonder-Tongue Labs., Inc., **w.**
Branson Corp., **g, l, m, o thru r, u, w thru z.**
***BRISTOL CO., THE, u, a-l.**
Bristol Motors Div.-Vocaline Co. of America, Inc., **y.**
CG Electronics Corp., **a-l.**
Cable Electric Products Inc., **a, q, w.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **k, x.**
Chalco Engrg. Corp., **y.**
Clark Controller Co., The., **f, i, l, m, p, w thru z.**
Comar Electric Co., **b, d, e, g, h, i, m, n, p, s, u, v, y.**
Couch Ordnance, Inc., **o, r, s, u.**
Cramer Controls Corp., **y, z.**
Curtiss-Wright Corp., Electronics Div., **i, w, y, z.**
Daystrom Inc., Weston Instruments Div., **c, d, f, i, m, n, p, q, s, u.**
Destron Co., **z.**
Don-Lan Electronics Inc., **a, k.**
Dow-Key Co., **a.**
Durakool, Inc., **j, y.**
Eagle Signal Co., **y, z.**
Ebert Electronics Corp., **i, j, l, n, q, s, w, y.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **c, d, m, o, p, r, s, w thru z.**
Eitel-McCullough, Inc.
Electro Tec Corp., **r, s.**
Electro Tec Corp., Virginia Div., **q.**
Electro-Mechanical Specialties Co., Inc., **d, e, i, l, m, o, r, t, u, y.**
Electronic Computer Co., Inc., **a-l.**
Electronic Control Corp., **n, y.**
Electronic Speciality Co., **a, d, e, u, y, z.**
Electron-Radar Products, **f, j, l, n, w, y.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **k, w, y, z.**
Exact Engrg. & Mfg. Inc., **d.**
FXR, Inc., **k.**
Fairfield Engrg. Corp., **e, q, z.**
Farmer Electric Products Co., Inc., **n.**
Filtors, Inc., **g, i, l, m, o thru s, u.**
Five Star Co., The, **q, s.**
Ford Instrument Co., Div.-Sperry Rand Corp., **q.**
G-V Controls, Inc., **e, l, m, w thru z.**
General Automatic Corp., **d, g, h, i, l thru p, s, v, y.**
General Communication Co., **a, k.**
General Controls Co., **x, y, z.**
General Electric Co., **d, i, o, p, q, s, u, v, y.**
General Electric Co., Apparatus Sales

Div., **d thru g, l, m, n, q, y, z.**
Globe Electrical Mfg. Co., **i, r, s, v, y.**
Fred Goat Co., Inc., The, **o, v.**
B. F. Goodrich Aviation Products, **d.**
Gorham Electronics-Div.-Gorham Mfg. Co., **k.**
Hagen Mfg. Co., **y, z.**
Haledy Electronics Co., **j, n, s.**
Hammett-Mercury-Rex Div., **k.**
George E. Harris & Co., Inc., **a, h, i, s thru v, x, y, a-l.**
Hart Mfg. Co., The, **g, p thru s, u.**
Hartman Electrical Mfg. Co., The, **d, e, i, l, m, p, q, s, y.**
Hathaway Instruments, Inc., **w.**
A. W. Haydon Co., The, **g, t, y, z.**
Heinemann Electric Co., **l, y.**
Hermetic Seal Corp. & Thermal Controls, Inc., **j, l, m, p, s, u, w, x, z.**
HI-G Inc., **i, m, p, r, s, u, y.**
Hillburn Electronic Prods. Co., **g, h, i, l, n thru q, s thru v.**
Hi-Spec Electronics Corp., **o, q, s.**
Honeywell, Marion Instruments Div., **c, s.**
Imtra Corp., **i, t, v.**
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp., **a.**
Industrial Timer Corp., **y, z.**
International Instruments Inc., **c.**
Jack & Heintz, Inc., **e, l, m, q, y.**
James Electronics Inc., **a, d, p, s, a-l.**
Jennings Radio Mfg. Corp., **a, f, l.**
E. F. Johnson Co., **f, q.**
Jordan Electronics, Div.-Victoreen Instrument Co., **m, y, z.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **b, d, e, g, p, t, v, y.**
Kurman Electric Co., Sub.-Crescent Petrolium Corp., **d, f, g, h, l thru q, s, u, v, y.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **r, t.**
Arthur S. La Pine & Co., **q.**
Leach Corp., **f thru i, l, m, p thru z, a-l.**
Lear, Inc., **d, i, p, q, r, t, u.**
Lee Electric & Mfg. Co., **m.**
Leetronics, Inc., **f, t.**
G. H. Leland, Inc., **r, t.**
Liquidometer Corp., The, **s.**
Livingston Electronic Corp., **w, y.**
Magnecraft Electric Co., **i, q, s, u, v, y.**
Magnetic Devices, Inc., **a, i, p, r.**
P. R. Mallory & Co., Inc., **l, u, y.**
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co., **a, c, u.**
Mason Electric Corp., **i, q, r, t, y.**
Master Specialties Co., **y.**
Microdot Inc., **a.**
Motorola, Inc., **k, a-l.**
Muirhead Instruments Inc., **d.**
National Electronics, **f, l, m, n, q, w, z.**
E. V. Naybor Labs., Inc., **l, o, q, r, u, y.**
Networks Electronic Corp., **e, f, g, w.**
Northrop Corp., **t.**
Pacific Relays, Inc., **m, o, q, s, u, y.**
Pacific Scientific Co., **g, i, o, r thru u, y, z, a-l.**
M. V. Palmer, Inc., **t, v.**
Penn Keystone Corp., **i, p, s, u.**
Peschel Electronics, Inc., **f.**
Phaostron Instrument & Electronic Co., **s.**
Phillips Control Corp., **d, f, i, l, o, q, s, u, v, y, z.**
Piqua Engrg. Inc., **d, p, q.**
Joseph Pollak Corp., **a, f, n, o, q, s, u, v, y.**
Potter & Brumfield, Div.-American Machine & Foundry Co., **f, g, i, l thru v, y.**
Price Electric Corp., **a, f, i, l, o thru v, y.**
RBM Controls Div.-Essex Wire Corp., **b, d, f, l, q, s, u, v.**
Radar Relay, Inc., **s.**
***RADIO CORP. OF AMERICA**
Reed Instrument Co., **g, p, u.**
Reed Research Inc., **g, p, u.**
Relay Sales Inc., **a, d, f thru j, l, o thru z.**
Relays, Inc., **d, f, h, m, o, s, u, v.**
Resitron Labs., Inc., **l, m.**
Revere Corp. of America, Sub., Neptune Meter Co., **a-l.**
M. H. Rhodes, Inc., **y.**
Safety Electrical Equipment Corp., **l, m.**
Secode Corp., **g, i.**
Servo-Tek Products Co., **s.**
Sigma Instruments, Inc., **d, g thru j, l thru q, s, t, u.**
Simpson Electric Co., **c.**
Space Components, Inc., **g, p, u.**
Standard Electromagnetics Div.-Cornell Dubilier Electric Corp., **a, g, h, i, n, o, q, t, u, v.**
Stewart & Stevenson Services, Inc., **m.**
Stromberg-Carlson Div.-General Dynamics Corp., **v.**
Struthers-Dunn, Inc., **a, d, f thru j, l, m, o, q thru z.**
Sun Electric Corp., Aeronautical Div., **k.**
Tapco Group, Thompson Ramo Wooldridge Inc., **a, y.**
Telechrome Mfg. Corp., **q, s, t.**
Telkor, Inc., **a-l.**
Tempo Instrument Inc., **m, y, z.**
Terado Co., **s.**
Texas Instruments Inc., **l, m, w, x.**
Thompson Ramo Wooldridge Inc., **a, y.**
Torwico Electronics, Inc., **d, e, i, l, m, p, s, y.**
Transco Products, Inc., **a, k.**
Transistor Devices Inc., **m, s, w, x, y.**
Trepac Corp. of America, **e, h, p, q, s, y, z.**
Tung-Sol Electric, Inc., **w, y.**
Twix Mfg. Co., Inc., **y.**
George Ulanet Co., **w, x, y.**
Union Switch & Signal, Div.-Westinghouse Air Brake Co., **o, r, u.**
United Control Corp., **y.**
U. S. Relay-Electronics, Div.-A. S. R. Products Corp., **b, d, e, f, i, l, m, o, p, q, s, u, v, w, y.**
United States Instrument Corp., **i, s, t, v, w.**
Vap-Air Aeronautical Products Div., Vapor Heating Corp., **f, q.**
Varo, Mfg. Co., Inc., **e, l, m, s, y, z, a-l.**
Vocaline Co. of America Inc., **y.**
Voi-Shan Electronics, **y, z.**
Wacline, Inc., **c, e.**
Wells Industries Corp., **n.**
Westinghouse Electric Corp., **d, f, i, l, m, n, q, w, y.**
Wheelock Signals Inc., **a, h, i, p, q, s, u, v.**
G. C. Wilson & Co., **y.**
Winatic Corp., The, **q.**
Zenith Electric Co., **d, q, s, y, z.**

RELEASE MECHANISMS

Aerocal Div., Aeronca Mfg. Corp.
Armament Div.-Universal Match Corp.
Associated Co., Inc.
Beckman & Whitley, Inc., Missile Products Div.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Utica Div., Bendix Aviation Corp.
Bermite Powder Co.
Bowmar Instrument Corp.
Bowser, Inc.
Burklyn Co.
Capewell Mfg. Co.
Clevite Ordnance, Div.-Clevite Corp.
Components Corp.
Conax Corp.
E. I. Du Pont De Nemours & Co., Inc.
Eastern Rotorcraft Corp.
Fae Instrument Corp.
Flight Refueling, Inc.
Gabriel Co., Rocket Power-Talco
General Logistics Div., Aeroquip Corp.
Guidance Controls Corp.
B. H. Hadley, Inc.
H. Koch & Sons
Lear, Inc.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lockheed Aircraft Corp., Missiles & Space Div.
***MARTIN CO., THE, DENVER DIV.**
McCormick Selph Associates
Northrop Corp.
Olin Mathieson Chemical Corp., Winchester-Western Div.
On Mark Couplings, Inc.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pastushin Industries, Inc.
Patterson Moos Research, Div.-Leesona Corp.
Propellex Chemical Div., Chromalloy Corp.
Research, Inc.
Robot Industries Inc.
Scott Aviation Corp.
Southwest Research Institute
Sunshine Scientific Instrument
Temco Aircraft Corp.
Weber Aircraft Corp.
Western Design, Div.-U. S. Industries, Inc.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

REMOTE PICKUP, AUDIO

Electronic Applications, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Gates Radio Co.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
H. H. Scott, Inc.

REPEATERS, MICROWAVE

Budelman Electronics Corp.
Collins Radio Co.
Joe Davidson & Associates
Designers for Industry, Inc.
Electronic Applications, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp., Defense & Engrg. Products Group
Hammett-Mercury-Rex Div.
Hazeltine Electronics Div.-Hazeltine Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Lel, Inc.
Microflect Co., Inc.
Motorola, Inc.
M. V. Palmer, Inc.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.

REPEATERS, PASSIVE MICROWAVE

Ainslie Corp.
Collins Radio Co.
Joe Davidson & Associates
Designers For Industry, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp., Defense & Engrg. Products Group
Hammett-Mercury-Rex Div.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Microflect Co., Inc.
Motorola, Inc.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.

RESERVOIRS, HYDRAULIC SYSTEMS

American Instrument Co., Inc.
Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Auto-Control Labs. Inc.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
California Stamping & Mfg. Co.
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Electrol Inc.
Flight Support, Inc.
General American Transportation Corp.
***HORKEY-MOORE ASSOCIATES, SUB. HOUSTON FEARLESS CORP.**
Hydra-Power Corp.
Janitrol Aircraft Div.-Midland-Ross Corp.
Kahn & Co., Inc.
***MARTIN CO., THE, DENVER DIV.**
Menasco Mfg. Co.
Norris-Thermador Corp.
Northeast Metals Industries, Inc.
Ozone Metal Products Corp
Richard Philip Co.
Portland Copper & Tank Works Inc.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Pressed Steel Tank Co.
REF Mfg. Corp.
Royal Jet, Div.-Royal Industries, Inc.
Rucker Co., The
Sancor Corp.

Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Simmonds Aerocessories, Inc.
Sweetland Engrg. Co.
Temco Aircraft Corp.
United Aircraft Products, Inc.
Vickers Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Vinson Mfg. Co. Inc.
***WEATHERHEAD CO., THE**
Wells Industries Corp.
Western Design, Div.-U. S. Industries, Inc.
Westholt Mfg. Inc.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.
Whittaker Controls, Div.-Telecomputing Corp.
Young Development Div., Hercules Powder Co.

RESERVOIRS, PNEUMATIC SYSTEMS

Apex Reinforced Plastics, Div.-White Sewing Machine Corp.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Cornelius Co., The, Aero Div.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Flight Support, Inc.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Joy Mfg. Co.
Kahn & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
***MARTIN CO., THE, DENVER DIV.**
McGregor Mfg. Corp.
Menasco Mfg. Co.
Northeast Metals Industries, Inc.
Portland Copper & Tank Works Inc.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Pressed Steel Tank Co.
Royal Jet, Div.-Royal Industries, Inc.
Rucker Co., The
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Simmonds Aerocessories, Inc.
Sweetland Engrg. Co.
Temco Aircraft Corp.
United Aircraft Products, Inc.
Vinson Mfg. Co. Inc.
***WEATHERHEAD CO., THE**
Wells Industries Corp.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.
Whittaker Controls, Div.-Telecomputing Corp.
Young Development Div., Hercules Powder Co.

RESINS, BONDING

Acheson Colloids Co., Div.-Acheson Industries, Inc.
Adhesive Engrg. Div.-Hiller Aircraft Corp.
Allied International Corp.
American Latex Products Corp.
Aries Laboratories, Inc.
Armstrong Products Co.
Bacon Industries, Inc.
Bendix Aviation Corp.
Carl H. Biggs Co.
Bjorksten Research Labs. for Industry, Inc.
Borden Chemical Co.
Budd Co., The
Catalin Corp. of America
Clarkson Labs., Inc., The
Cordo Chemical Corp.
Dow Corning Corp.
E. I. Du Pont De Nemours & Co. Inc.
Durez Plastics Div.-Hooker Chemical Corp.
Eastern Chemical Div., Hooker Chemical Corp.
Emerson & Cuming, Inc.
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics, Inc.
Hastings Plastics, Inc.
Hercules Powder Co., Chemical Propulsion Div.
Honeycomb Co. of America, Inc.
Insulation Mfrs. Corp.
Kish Industries, Inc.
Lam-Ply, Inc.
Marblette Corp., The
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Mitchell Rand Mfg. Corp.
Monsanto Chemical Co.
C. P. Moyen Co.
Narmco Materials Div., Narmco Industries, Inc.
National Engrg. Products, Inc.
Naugatuck Chemical Div.-U. S. Rubber Co.
Neville Chemical Co.
Permacel
Permatex Co., Inc.
Plastic Age Sales, Inc.
Portland Copper & Tank Works Inc.
Products Research Co.
Raybestos-Manhattan, Inc.
Reichhold Chemicals, Inc.
Ren Plastics, Inc.
Rezolin, Inc.
Milton Ross Metals Co., The
Silicone Products Dept., General Electric Co., Dept. C.
Silicones Div.-Union Carbide Corp.
Topper Mfg. Co., Inc.
United States Rubber Co.
Westinghouse Electric Corp., Micarta Div.

RESINS, ENCAPSULATING

Adhesive Engrg. Div.-Hiller Aircraft Corp.
Allied International Corp.
American Latex Products Corp.
Aries Laboratories, Inc.
Armstrong Products Co.
Bacon Industries, Inc.
Carl H. Biggs Co.
Biwax Corp.
Bjorksten Research Labs. for Industry, Inc.
Borden Chemical Co.
Coast Pro-Seal & Mfg. Co.
Dennis Chemical Co.
Dow Corning Corp.
E. I. du Pont De Nemours & Co. Inc.
Durez Plastics Div.-Hooker Chemical Corp.
Eastern Chemical Div., Hooker Chemical Corp.
Emerson & Cuming, Inc.
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics, Inc.
Hastings Plastics, Inc.
Insulation Mfrs. Corp.
Kish Industries, Inc.
Lam-Ply, Inc.
Marblette Corp., The
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Mitchell Rand Mfg. Corp.
Monsanto Chemical Co.
Narmco Materials Div., Narmco Industries, Inc.
National Engrg. Products, Inc.
Naugatuck Chemical Div.-U. S. Rubber Co.
Norrich Screw Machine Products
Permacel
Products Research Co.
Reichhold Chemicals, Inc.
Ren Plastics, Inc.
Rezolin, Inc.
Milton Ross Metals Co., The
Silicones Div.-Union Carbide Corp.
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Thor Ceramics, Inc.
Topper Mfg. Co., Inc.
United States Rubber Co.

RESINS, POTTING

Adhesive Engrg. Div.-Hiller Aircraft Corp.
Allied International Corp.
American Latex Products Corp.
Aries Laboratories, Inc.
Armstrong Products Co.
Bacon Industries, Inc.
Carl H. Biggs Co.
Biwax Corp.
Bjorksten Research Labs. for Industry, Inc.
Borden Chemical Co.
Coast Pro-Seal & Mfg. Co.
Dennis Chemical Co.
Dow Corning Corp.
Durez Plastics Div.-Hooker Chemical Corp.
Emerson & Cuming, Inc.
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics, Inc.
B. F. Goodrich Aviation Products
Hastings Plastics, Inc.
Hercules Powder Co., Chemical Propulsion Div.
Insulation Mfrs. Corp.
Kish Industries, Inc.
Lam-Ply, Inc.
Marblette Corp., The
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.**
Mitchell Rand Mfg. Corp.
Monsanto Chemical Co.
Narmco Materials Div., Narmco Industries, Inc.
National Engrg. Products, Inc.
Naugatuck Chemical Div.-U. S. Rubber Co.
Norrich Screw Machine Products
Pennsalt Chemicals Corp.
Permacel
Plastic Age Sales, Inc.
Products Research Co.
Reichhold Chemicals, Inc.
Ren Plastics, Inc.
Rezolin, Inc.
Milton Ross Metals Co., The
Silicones Div.-Union Carbide Corp.
Special Products Dept., Melpar, Inc.
Thor Ceramics, Inc.
Topper Mfg. Co., Inc.
United States Rubber Co.

RESINS, SYNTHETIC

Allied International Corp.
American Latex Products Corp.
Aries Laboratories, Inc.
Bacon Industries, Inc.
Carl H. Biggs Co.
Biwax Corp.
Bjorksten Research Labs. for Industry, Inc.
Borden Chemical Co.
Budd Co., The
Catalin Corp. of America
Ciba Products Corp.
Clarkson Labs., Inc., The
Coast Pro-Seal & Mfg. Co.
Dayton Rubber Co., The
Dow Chemical Co., The
Dow Corning Corp.
E. I. Du Pont De Nemours & Co. Inc.
Duracote Corp.
Durez Plastics Div.-Hooker Chemical Corp.
Eastern Chemical Div., Hooker Chemical Corp.
Food Machinery & Chemical Corp. Chemical & Pastics Div.
Food Machinery & Chemical Corp.-Dupon Dept.
Food Machinery & Chemical Corp.-Epoxy Dept.
Furane Plastics, Inc.
B. F. Goodrich Chemical Co.
Grant-Lehr Corp.
Hastings Plastics, Inc.
Hercules Powder Co., Chemical Propulsion Div.
Insulation Mfrs. Corp.
Kish Industries, Inc.
Marblette Corp., The
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO. CHEMICAL DIV.**
Mitchell Rand Mfg. Corp.
Monsanto Chemical Co.
Naugatuck Chemical Div.-U. S. Rubber Co.
Neville Chemical Co.
Permacel
Permatex Co., Inc.
Plastic Age Sales, Inc.
Polymer Corp., The
Raybestos-Manhattan, Inc.
Reichhold Chemicals, Inc.
Schenectady Varnish Co., Inc.
Silicone Products Dept., General Electric Co., Dept. C.
Silicones Div.-Union Carbide Corp.
Southwest Research Institute
Synthane Corp.
Topper Mfg. Co., Inc.
United States Rubber Co.
Westinghouse Electric Corp., Micarta Div.

RESISTANCE THERMOMETER BULBS

Aero Research Instrument Co., Inc.
***ARNOUX CORP.**
Bergen Labs., Inc.
Convair Instruments, Convair Div.-General Dynamics Corp.
Thomas A. Edison Ind. Instrument Div.

Mc Graw-Edison Co.
Electronic Processes Corp. of California
Foxboro Co., The
Garwin, Inc.
Illinois Testing Laboratories, Inc.
Lewis Engrg. Co., The
Minco Products, Inc.
Rosemount Engrg. Co.
Trans-Sonics, Inc.
United Control Corp.

RESISTORS

a. Boroncarbon
b. Carbon Film
c. Decade
d. Deposited Carbon
e. Encapsulated
f. Film
g. Fixed Composition
h. Fixed Wire-Wound
i. Glass
j. High-Frequency
k. High-Temperature
l. High-Voltage
m. Miniature Variable
n. Negative Temperature Coefficient
o. Photo Sensitive
p. Precision
q. Printed Circuit
r. Printed Strip
s. Rectilinear
t. Silicone
u. Subminiature
v. Tape
w. Temperature Sensitive
x. Variable, Miniature
y. Variable Wire Wound
z. Wire Wound

Ace Coil & Electronics Co., e, p, z.
Adept Industries Inc., q, r.
Aerovox Corp., a, b, d, e, h, k, p, z.
Allies Products Corp., d, e, n, p.
Associated Engineers, Inc., h, z.
Barber-Colman Co., w.
Blonder-Tongue Labs. Inc., Special Products Div., o.
Bourns, Inc., h, m, q, x, y, z.
Brys Instrument Co., e, h, k thru n, p, q, s, u, w thru z.
Budd Co., The, f, p.
Campbell Industries, Inc., b, d, e, p.
Carbone Corp., The, n, w.
Carborundum Co., The, k, l, n, p, w.
Carborundum Co., Refractories Div., k, n, p.
Carol Electronics Corp., h, p.
Carter Mfg. Corp., m, x, y.
Central Scientific Co., y.
Clark Controller Co., The, h, z.
Clarostat Mfg. Co., Inc., b thru f, h, i, l, m, p, q, s, u, x, y, z.
Computer Instruments Corp., b, f, j thru m, p, s, x.
Continental-Wirt Electronics Corp., b, d, e, f, h, j, m, n, p, q, y, z.
Corning Glass Works, e, f, i thru l, p, q.
Dale Products, Inc., b, d, e, h, k, l, m, p, q, u, z.
Daven Co., The, c, e, f, h thru l, n, p, u, z.
Daystrom Inc., Western Instruments Div., f, h, l, p.
Dejur-Amsco Corp., Electronic Sales Div., s, u, y, z.
Dmeter Mfg. Co., c, h, n, p, q, t, u, z.
Eastman Kodak Co., o.
Electra Mfg. Co., b, d, e, f, j, n, p, u.
Electro Instruments, Inc., c, p.
Electromath Corp., k, l, m, p, u, x, y, z.
Electro-Mec Lab., Inc., h, p, y.
Electronic Applications, Inc., d, l, p.
Electronic Brazing Co., z.
Elektro-Serv Co., r.
Erie Resistor Corp., b, d, g, u.
Fenwal Electronics, Inc., n, w.
Ferroxcube Corp. of America, k, l.
G-C Electronics Co., d.
Gamewell Co., The, m, x, y.
General Electric Co., Apparatus Sales Div., h.
General Radio Co., c, h, p, y.
General Transistor Corp., p, z.
Globar Plant, Refractories Div.-The Carborundum Co., g, j, k, l, n, u, w.
Gray Instrument Co., c, h, p, z.
Guidance Controls Corp., m, x, y, z.
Gulton Industries, Inc., w.
Hammett-Mercury-Rex Div., h, l, z.
Hansen Electronics Co., q, r, v.
Hardwick, Hindle, Inc., h, y, z.
Helipot Div.-Beckman Instruments, Inc., h, p.
Hi Q Div., Aerovox Corp., a, b, d, p, q, u.
Industrial Instruments Inc., c.
Instrument Resistors Co., c, e, h, k, p, u, z.
Instrument Div., The Budd Co., f, p, w.
Interstate Electronics Inc., b, d, f thru i, k.
Janco Corp., p.
Keystone Carbon Co., n, w.
Lear, Inc., d thru g, i, o thru r, u, w, x.
Lectrohm, Inc., h, q, t, y, z.
Leeds & Northrup Co., p.
Legris Resistor Corp., a, b, d thru h, m, p, u, x, y, z.
Lewis Engrg. Co., The, w.
P. R. Mallory & Co. Inc., b, e, h, j, k, m, q, u, x, y, z.
McMillan Companies, The, b, f.
Mepco, Inc., b thru f, h, j, k, n, p, t, u, z.
Metaplast Co., Inc., d.
Miller Electro-Research Labs., p, w.
Minco Products, Inc., w.
*MINNESOTA MINING & MFG. CO., w.
Muirhead Instruments Inc., c, h, p, z.
Mullenbach Div.-Electric Machinery Mfg. Co., h, k, p, y, z.
New England Instrument Co., y.
Non-Linear Systems, Inc., e, p.
Nucleonic Products Co., w.
Ohio Carbon Co., The, g, h, z.
Onondaga Electronics Div., Speer Carbon Co., g, q.
Phaostron Instrument & Electronic Co., b, z.
Polarad Electronics Corp., j.
Potter Aeronautical Corp., h.
Precision, Inc., e, h, p, q, w, z.
Pyrofilm Resistor Co., Inc., b, d, e, i, k, p, u.
Q-Circuits, Div.-Etching Co. of Calif., q.
*RADIO CORP. OF AMERICA
Raven Industries Inc., h.
Reon Resistor Corp., e, h, m, p, q, x, z.
Resistance Products Co., f, j, l, p, q, z.
Resistors, Inc., h, y, z.
Rinco, Inc., c, y.
Rosemount Engrg. Co., w.
Sage Electronics Corp., h.
Shallcross Mfg. Co., e, h thru l, p, q, z.
Shallite, Inc., e, h, q, z.
W. S. Shamban & Co., q.
Spectrol Electronics Corp., m, q, u, x, y, z.
Sprague Electric Co., b thru f, h, j, k, l, q, u, z.
Stackpole Carbon Co., g.
States Co., The, n.
Technical Apparatus Builders, b, d, g, h, p, z.
Technology Instrument Corp., b, d, e, f, h, j, k, m, n, p thru s, u, w thru z.
Texas Instruments Inc., b, d, e, f, j, k, n, p, q, w.
Topper Mfg. Co., Inc., e, h, p, x, y, z.
Trans-Sonics, Inc., w.
Tru-Ohm Products Div.-Model Eng. & Mfg., Inc., h, q, y.
Tucson Instrument Corp., x, y.
H. W. Tuttle & Co., h, z.
United Control Corp., w.
United Mineral & Chemical Corp., d.
U. S. Science Corp., Div.-Topp Industries, Inc., h, m, p, s, y, z.
Victoreen Instrument Co., d.
Victory Engrg. Corp., w.
Wells Industries Corp., m, q, u, x, y, z.
Westinghouse Electric Corp., h, y, z.
S. S. White Industrial Div., g.
Yellow Springs Instrument Co., The, w.

RESOLVERS

American Electronics, Inc.
American Electronics Incorporated
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp.
Bendix Aviation Corp.-Montrose Div.
Cedar Engrg. Div.-Control Data Corp.
Clifton Precision Products Co., Inc.
Computer Instruments Corp.
Conrad & Moser
Control Data Corp.
Joe Davidson & Associates
Daystrom Inc., Transicoil Div.
Daystrom Inc., Weston Instruments Div.
Diehl Mfg. Co.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
George E. Harris & Co., Inc.
IMC Magnetics Corp.
*KEARFOTT DIV., GENERAL PRECISION, INC.
Ketay Dept., Norden Div., United Aircraft Corp.
Kollsman Instrument Corp. Sub.-Standard Coil Products Co., Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
*MARTIN CO., THE, DENVER DIV.
Motorola, Inc.
Muirhead Instruments Inc.
Norden Div., United Aircraft Corp.
John Oster Mfg. Co., Avionic Div.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Packard Bell Computer Corp.
Reeves Instrument Corp.
Servo Consultants Ltd.
Victory Engrg. Corp.

RESTRICTORS, HYDRAULIC SYSTEMS

Arkwin Industries, Inc.
Arnav Aircraft Associates, Inc.
Benbow Mfg. Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Bowser, Inc.
Chance Vought Aircraft, Inc.
Electrol Inc.
B. H. Hadley, Inc.
Hydra-Power Corp.
Integral Corp.
Kemp Aero Products
Richard Philip Co.
Rimak, Inc.
Ronson Hydraulic Units Corp.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Simmonds Aerocessories, Inc.
A. U. Stone & Co., Inc.
Sweetland Engrg. Co.
United Aircraft Products, Inc.
U. S. Industries, Inc.
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Vinson Mfg. Co. Inc.
Waterman Hydraulics Corp.

RETRACTING MECHANISM UNITS

*BEAVER PRECISION PRODUCTS INC.
Bowser, Inc.
Conax Corp.
Electrol Inc.
Flight Support, Inc.
Gabriel Co., Rocket Power-Talco
B. H. Hadley, Inc.
Haskel Engrg. & Supply Co.
Jack & Heintz, Inc.
Kemp Aero Products
Lear, Inc.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Menasco Mfg. Co.
On Mark Couplings, Inc.
Ronson Hydraulic Units Corp.
Simmonds Aerocessories, Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Temco Aircraft Corp.
U. S. Industries, Inc.
Weber Aircraft Corp.
Western Design, Div.-U. S. Industries, Inc.
Western Gear Corp.-Precision Products Div

RETRACTORS, LANDING GEAR

Bowser, Inc
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Electrol Inc.
Gabriel Co., Rocket Power-Talco
Hydra-Power Corp.
Jack & Heintz, Inc.
Kemp Aero Products
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear, Inc.
Menasco Mfg. Co.
Ronson Hydraulic Units Corp.
Simmonds Aerocessories, Inc.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Sweetland Engrg. Co.
Temco Aircraft Corp.

U. S. Industries, Inc.
Weber Aircraft Corp.
Western Design, Div.-U. S. Industries, Inc.
Western Gear Corp.-Precision Products Div.

REVERBERATION UNITS

Audio Instrument Co., Inc.
Electronic Applications, Inc.
Gates Radio Co.
Industrial Acoustics Co., Inc.

RHEOSTATS

Aero Electronics Corp.
James G. Biddle Co.
Bourns, Inc.
Clark Controller Co., The
Clarostat Mfg. Co., Inc.
Continental-Wirt Electronics Corp.
Dejur-Amsco Corp., Electronic Sales Div.
General Electric Co., Apparatus Sales Div.
General Radio Co.
Lear, Inc.
Legris Resistor Corp.
P. R. Mallory & Co. Inc.
Model Rectifier Corp.
Rex Rheostat Co.
Herman H. Sticht Co., Inc.
Superior Electric Co., The
Technology Instrument Corp.
Tru-Ohm Products Div.-Model Eng. & Mfg., Inc.
Westinghouse Electric Corp.

RHODIUM

Bram Metallurgical Chemical Co.
Deringer Metallurgical Corp.
Engelhard Industries, Inc.
Gibson Electric Co.
NUMEC-Nuclear Materials & Equipment Corp.
Semi-Elements, Inc.
Technic Inc.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.

RINGS

a. Carbon Packing
b. Clamping
c. Collector
d. Expansion
e. Hydraulic Back-Up
f. Oil Sealing
g. Retainer
h. Scraper
i. Sealing
j. Shock Absorber
k. Slip
l. Slip & Brush Assembles
m. Special

Ace Products Co., **h.**
Acushnet Process Co., **f.**
Advanced Products Co., The, **i, m.**
Aero Bolt & Screw Co., Inc., **e, f, g, i.**
Aero Gasket Corp., **f.**
Aero Spares, Inc., **e, g, h.**
Airflyte Electronics Co., **k, l.**
Airhardware, Inc., **g.**
All Chrome Mfg. Co., **e, h.**
All Specs Corp., **e, g, h, i.**
Allied International Corp., **f, i.**
Allied Plastics Supply Corp., **a, e, f, i.**
Alloys Unlimited Inc., **m.**
American Felt Co., **f, g, i, j, m.**
American Standard Products, Inc., **m.**
American Welding & Mfg. Co., The, **g, m.**
Anchor Packing Co., The, **f, g.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **f.**
Associated Technical Sales Co., **h.**
Auburn Mfg. Co., The, **e, f, h, i, m.**
Bacon Industries, Inc., **m.**
Wallace Barnes Div. Associated Spring Corp., **b, d thru g, i, k, l, m.**
Best Aircraft Corp., **h, m.**
Bonny Mfg. Corp., **i.**
Breeze Corporations, Inc., **k, l.**
Capewell Mfg. Co., **m.**
Capital City Mfg. Co., Inc., **c, g, m.**
Carbone Corp., The, **a, j, k.**
Carborundum Co., The, **i, m.**
Carborundum Co., Latrobe Plant, Refractories Div., **f, i.**
Cartriseal Corp., **i.**
Chicago Rawhide Mfg. Co., **f, i.**
Continental Rubber Works, **f, i.**
C. Lee Cook Co., Airtomic Products Div., **a, b, f thru i, m.**
Crystal-X Corp., **m.**
Edgewater Steel Co., **m.**
Electro Tec Corp., **k, l.**
Electro Tec Corp., Virginia Div., **k, l.**
Electro-Miniatures Corp., **c, k, l.**
Emerson Plastics Corp., **f, g, i.**
Engelhard Industries, Inc., **c, k.**
Federal Machine Co. Inc., **m.**
Flight Refueling, Inc., **i, m.**
Fluorocarbon Co., The, **e thru i.**
Foursome Mfg. Co., Inc., **b, g.**
Futurecraft Corp., **e, i, m.**
General Devices, Inc., **k, l, m.**
General Findings & Supply Co., Industrial Div., **c, k.**
General Gasket Inc., **e, i.**
Gorham Electronics-Div.-Gorham Mfg. Co., **k, l.**
Goshen Rubber Co., Inc., **f, i.**
Graphite Metallizing Corp., **c, f, k, l.**
Greene, Tweed & Co., **e thru i.**
Gries Reproducer Corp., **m.**
Halogen Insulator & Seal Corp., **e, f, g.**
Haskel Engrg. & Supply Co., **b, e, f, g, i, j, m.**
Walter K. Jaros Aircrafters, **e thru j.**
Johns-Manville Sales Corp., **f.**
Kennametal Inc., **i.**
Kerns Mfg. Corp., **b.**
Keystone Carbon Co., **k, l.**
King Fifth Wheel Co.,
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc., **b, i.**
Koppers Co., Inc., Metal Products Div., **c, d, f, h, i, m.**
Kwikset Powered Metal Products, **c, g.**
Ladish Co., **m.**
Lear, Inc., **k, l, m.**
Machine Products Div., New Haven Trap Rock Co., **m.**
Magnetic Controls Co., **c.**
Minnesota Rubber Co., **f, i, m.**
National Carbon Co., Div.-Union Carbide Corp., **a, f, l.**
Norrich Plastics Corp., **i, m.**
Norrich Screw Machine Products, **m.**
Nuclear Development Corp. of America, **i.**
Ohio Carbon Co., The, **a, i.**
Ohlson Empire Inc., **e, g, h, k, m.**
Pacific Scientific Co., **c, k, l.**
Parker Seal Co., Div.-Parker-Hannifin Corp., **e, f, i, m.**
Penn Fibre & Specialty Co., Inc., **e thru k.**
Penn-Michigan Mfg. Corp., **c.**
Richard Philip Co., **e, g, h, m.**
Precision Lapping Co., Inc., **f.**
Precision Rubber Products Corp., **m.**
Ravenna Metal Products Div.-Standard Screw Co., **g.**
Reliable Spring & Wire Forms Co., **m.**
Roberts Toledo Rubber Co., The, **i.**
Rogers Corp., **e, i.**
Rubbercraft Corp. of California, **e, f, i, j.**
Russell Mfg. Co., **j.**
St. Marys Carbon Co., **a, f, i, k, l, m.**
Shenango Furnace Co., The, Centrifugally Cast Products Div., **d thru g, i.**
Solar Aircraft Co., **b.**
Southwest Research Institute, **d, f.**
Specialty Products Corp., **b, g.**
Speer Carbon Co., **a.**
Stackpole Carbon Co., **a, f, i.**
Stanley-Judd Div.-The Stanley Works, **g, h, i, m.**
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp., **m.**
Stillman Rubber Co., **f, i.**
Superior Carbon Products Inc., **a, c, g, h, i, k, l, m.**
Temco Aircraft Corp., **c.**
Tetrafluor, Inc., **e, g, h, i, k, m.**
Texas Instruments Inc., **c, k, l.**
Unison Products, Inc., **c, k, l.**
United Aircraft Products, Inc., **f, i.**
U. S. Plastic Molding Corp., **c, k.**
United Wire & Supply Corp., **m.**
Waldes Kohinoor, Inc., **g, m.**
Westholt Mfg. Inc., **c, m.**

RIVETS

Abbott Screw & Mfg. Co.
Adam Metal Supply Inc.
Aero Spares, Inc.
Airhardware, Inc.
All Specs Corp.
All Metal Screw Products Co., Inc.
Aluminum Co. of America
Atlas Tack Corp.
Best Aircraft Corp.
Bethlehem Steel Co.
Chase Brass & Copper Co., Inc.
Cherry Rivet Div.-Townsend Co.
Chicago Rivet & Machine Co.
Continental Screw Co.
Deringer Metallurgical Corp.
Deutsch Co., The, Electronic Components Div.
Division Lead Co.
Engelhard Industries, Inc.
Federal Screw Products Inc.
General Findings & Supply Co., Industrial Div.
Gibson Electric Co.
Gries Reproducer Corp.
H. M. Harper Co.
John Hassall, Inc.
Hi-Shear Rivet Tool Co.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
Mercury Air Parts Co., Inc.
National Rivet & Mfg. Co.
Norrich Screw Machine Products
Ohlson Empire Inc.
Olympic Screw & Rivet Corp.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Pastushin Industries, Inc.
Pioneer Aluminum Inc.
Republic Steel Corp.
Screw Corp.
Skyproducts
Star Stainless Screw Co.
Thomson, Judson L.
Townsend Co., Cherry Rivet Div.
Unified Industries, Inc.
United Shoe Machinery Corp.
Vector Electronic Co., Inc.

RIVETS, BLIND

AVDEL
Adam Metal Supply Inc.
Aero Spares, Inc.
Airhardware, Inc.
Aluminum Co. of America
Cherry Rivet Div.-Townsend Co.
Deutsch Co., The, Electronic Components Div.
Deutsch Fastener Corp.
Dill Mfg. Co., The
E. I. Du Pont de Nemours & Co. Inc.
Farwest Mfg. Div., Inc.
B. F. Goodrich Aviation Products
Hi-Shear Rivet Tool Co.
Huck Mfg. Co.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
Mercury Air Parts Co., Inc.
Norrich Screw Machine Products
Ohlson Empire Inc.
Olympic Screw & Rivet Corp.
Pastushin Industries, Inc.
Republic Steel Corp.
Skyproducts
Southco Div., South Chester Corp.
Townsend Co., Cherry Rivet Div.
United Shoe Machinery Corp.

RIVETS, EXPLOSIVE

Bermite Powder Co.
E. I. Du Pont de Nemours & Co. Inc.
Hercules Powder Co., Chemical Propulsion Div.
Walter K. Jaros Aircrafters
Ohlson Empire Inc.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Skyproducts

ROCKET LAUNCHING DEVICES

Aerocal Div., Aeronca Mfg. Corp.
Aero-Test Equipment Co., Inc.
American Machine & Foundry Co., Greenwich Engrg. Div.
***AMERICAN STEEL FOUNDARIES, HAMMOND DIV.**
Armament Div.-Universal Match Corp.
Basic Tool Industries, Inc.
Beacon Steel Corp.
***BEAVER PRECISION PRODUCTS INC.**
Beckman & Whitley, Inc., Missile Products Div.
Benbow Mfg. Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bermite Powder Co.
E. W. Bliss Co.
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.

Cromer Mfg. & Engrg., Inc.
***EXCELCO DEVELOPMENTS INC.**
Food Machinery & Chemical Corp., Ordnance Div.
Gabriel Co., Rocket Power-Talco
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hoefner Corp.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Marquardt Corp., The
W. L. Maxson Corp., The
Mechanics Research Div., American Machine & Foundry Co.
Northrop Corp.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Portland Copper & Tank Works Inc.
Republic Aviation Corp., Missile Systems Div.
Rimak, Inc.
Stamping Div.-Rockwell Standard Corp.
Standard Armament Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
Trailmobile Inc.
Twin Coach Co., Aircraft-Missiles
U. S. Pipe & Foundry Co., Steel & Tubes Div.
Welded Construction Inc.
Wells Industries Corp.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida
Young Development Div., Hercules Powder Co.

ROCKETS
***AEROJET-GENERAL CORP.**
Allison Div., General Motors Corp.
Amcel Propulsion Inc.

American Rocket Co.
Arde-Portland, Inc.
Atlantic Research Corp.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Brooks & Perkins, Inc.
Gabriel Co., Rocket Power-Talco
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Electric Co., Rocket Engine Section
B. F. Goodrich Aviation Products
Grand Central Rocket Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hahn & Clay
Hercules Powder Co., Chemical Propulsion Div.
Marquardt Corp., The
McCormick Selph Associates
Norris-Thermador Corp.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Republic Aviation Corp., Missile Systems Div.
Solid Propulsion Ops., Rocketdyne Div., North American Aviation.
Southwest Research Institute
Temco Aircraft Corp.
United Technology Corp.
***WEATHERHEAD CO., THE**
Young Development Div., Hercules Powder Co.

ROD END BEARINGS
Billings & Spencer Co., The
Honti Engrg. & Mfg. Co.
Walter K. Jaros Aircrafters
Norrich Screw Machine Products
Randall Graphite Bearings, Inc.
Raway Bearing Co., Inc.
Shafer Bearings, Chain Belt Co.
Southwest Products Co.
***STEPHENS ADAMSON MFG. CO., SEAL MASTER BEARING DIV.**

RODS, TUNGSTEN
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Alloys Unlimited Inc.
Associated Engrg. & Mfg. Corp.
Bergen Carbide Co.
Bram Metallurgical Chemical Co.
Electronic Parts Mfg. Co., Inc.
Fansteel Metallurgical Corp.
General Electric Co., Lamp Metals & Components Dept.
Universal-Cyclops Steel Corp.
Var-Lac-Oid Chemical Co.
Wah Chang Corp.
Wai Met Alloys Co.
Westinghouse Electric Corp.

ROPE, WIRE
American Chain & Cable Co., Inc.
Bergen Wire Rope Co.
Bethlehem Steel Co.
Chase Brass & Copper Co., Inc.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
General Electric Co., Lamp Metals & Components Dept.
Walter K. Jaros Aircrafters
John A. Roeblings Sons Div.
Joseph T. Ryerson & Son, Inc.
United States Steel Corp.

ROTATORS
All Products Co.
***ANDREW CORP.**
Antlab Inc.
Aronson Machine Co., Inc.
CG Electronics Corp.
Cornell-Dubilier Electric Corp.
Hoover Electric Co.
Lear, Inc.
McGregor Mfg. Corp.
Robot Industries Inc.
Scientific-Atlanta, Inc.
Talley Corp., The
Western Gear Corp.-Precision Products Div.
Wind Turbine Co.

ROTOR ASSEMBLIES, GAS TURBINE ENGINE
Allison Div., General Motors Corp.
Christie Machine Works
Clark Bros. Co., Div.-Dresser Operations, Inc.
Fenn Mfg. Co., The
General Devices, Inc.
Leach Corp.
Lycoming Div., Avco Corp.
Marquardt Corp., The
McGregor Mfg. Corp.
Napier Engines Inc.
Parker-Hartford Corp., The
Schellens-True Corp.
Solar Aircraft Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Therm, Inc.
Thompson Ramo Wooldridge Inc.
Western Design, Div.-U. S. Industries, Inc.
Western Gear Corp.-Precision Products Div.
Whiton Machine Co., The

ROTOR CASTINGS
Allison Div., General Motors Corp.
Aluminum Co. of America
American Brake Shoe Co.
Ampco Metal, Inc.
Bethlehem Steel Co.
Westinghouse Electric Corp.

ROTORS
Allison Div., General Motors Corp.
Bethlehem Steel Co.
Bogue Electric Mfg. Co.
Christie Machine Works
Clark Bros. Co., Div.-Dresser Operations, Inc.
Eicor Div.-Scranton
General Devices, Inc.
Genisco, Inc.
Paul E. Gerst & Co.
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
Parker-Hartford Corp., The
Pesco Products Div., Borg-Warner Corp., Calif.
Precision, Inc.
Schellens-True Corp.
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Whiton Machine Co., The

RUBBER
a. Conductive
b. Hard
c. Insulation
d. Natural
e. Synthetic
Abesto Corp., **a thru e.**
Acushnet Process Co., **a, d, e.**
Aero Gasket Corp., **e.**
Allied Plastics Supply Corp., **b thru e.**
American Felt Co., **e.**
American Latex Products Corp., **a thru e.**
Anchor Packing Co., The, **d, e.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc., **a thru e.**
Associated Gaskets, Inc., **a, c, d, e.**
Auburn Mfg. Co., The, **a, c, d, e.**
Colonial Rubber Co., **a, c, d, e.**
Connecticut Hard Rubber Co., The, **a, c, e.**
Continental Rubber Works, **a, c, d, e.**
Darnell Corp. Ltd., **a, b, e.**
Dayton Rubber Co., The, **e.**
Dow Corning Corp., **a, c, e.**
E. I. Du Pont de Nemours & Co. Inc., **e.**
Firestone Indsl Products Co., Div.-Firestone Tire & Rubber Co., **a, b, d, e.**
Garlock Packing Co., **a thru e.**
General Electric Co., Lamp Metals & Components Dept., **d, e.**
General Gasket Inc., **d, e.**
General Tire & Rubber Co., The, Industrial Products Div., **d, e.**
B. F. Goodrich Aviation Products, **a thru e.**
B. F. Goodrich Chemical Co., **e.**
B. F. Goodrich Industrial Products Co., **b, d, e.**
B. F. Goodrich Sponge Products, **d, e.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **a, c.**
Gordon Rubber & Packing Co. Inc., **a, b, d, e.**
Goshen Rubber Co., Inc., **a, d, e.**
Guided Missile Div., The Firestone Tire & Rubber Co., **a thru e.**
George E. Harris & Co., Inc., **d, e.**
E. F. Houghton & Co., **e.**
Huntington Rubber Mills, **a thru e.**
Kirkhill Rubber Co., **b thru e.**
Luzerne Rubber Co., **b, d, e.**
Mechanical Rubber Products Co., **d, e.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV., e.**
Minnesota Rubber Co., **c, d, e.**
J. J. Monaghan Co., Inc., **a, d, e.**
Natvar Corp., **c.**
Naugatuck Chemical Div.-U. S. Rubber Co., **a thru e.**
Newth Rubber Co., **c, d, e.**
Norrich Plastics Corp., **b,**
Parker-Hannifin Corp., **e.**
Penn Fibre & Specialty Co., Inc., **c, d, e.**
Precision Rubber Products Corp., **e.**
Raybestos-Manhattan, Inc., **a thru e.**
Reeves Brothers, Inc., **e.**
Reeves Bros. Inc., Vulcan Rubber Div., **c, d, e.**
Resistoflex Corp., **e.**
Fred T. Roberts & Co., **d, e.**
Roberts Toledo Rubber Co., The, **b, d, e.**
Rogers Corp., **b, e.**
Rubbercraft Corp. of California, **a thru e.**
Silicone Products Dept., General Electric Co., Dept. C., **c, e.**
Silicones Div.-Union Carbide Corp., **a, c, e.**
Stillman Rubber Co., **a, c, d, e.**
Swan Rubber Co., **d, e.**
Thermoid Div.-H. K. Porter Co., Inc., **a thru e.**
Union Asbestos & Rubber Co., **e.**
United States Rubber Co., **a thru e.**
Western Felt Works & Acadia Synthetic Products Div., **a, c, e.**
Wilbur & Williams Co., Inc., The, **e.**
Zippertubing Co., The, **a, e.**

RUDDERS
Aerocal Div., Aeronca Mfg. Corp.

Colonial Aircraft Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
***LAVELLE AIRCRAFT CORP.**
Monrovia Aviation Corp.
Northrop Corp.
Reynolds Metals Co., Sheffield Missile Plant
Temco Aircraft Corp.
Winder Aircraft Corp. of Florida

SAFETY EQUIPMENT
Abesto Corp.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
All American Engrg. Co.
American Latex Products Corp.
American Optical Co., Safety Products Div.
Ampco Metal, Inc.
Aro Equipment Corp., The
Avco Corp., Crosley Div.
Aviation Textile Associates
Bar-Ray Products, Inc.
S. Blickman, Inc.
Boyt Harness Co.
Brown-Line Corp.
Cambridge Filter Corp.
Capewell Mfg. Co.
David Clark Co., Inc.
Compudyne Corp.
Conax Corp.
C. R. Daniels, Inc.
Davis Instruments
Finnell System, Inc.
Fisher Scientific Co.
Fluid Power Inc.
General Scientific Equipment Co.
Gentex Corp.
Globe Automatic Sprinkler Div., The Fyr-Fyter Co.
Hamilton Watch Co., Military Products Div.
Hardman Tool & Engrg., Co.
***HAWS DRINKING FAUCET CO.**
Hocks Labs.
Industrial Acoustics Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
***MARTIN CO., THE, DENVER DIV.**
Medical Supply Co.
Mine Safety Appliances Co.
J. J. Monaghan Co., Inc.
National Cylinder Gas, Div.-Chemetron Corp.
Nuclear Development Corp. of America
Pacific Scientific Co.
Photobell Co., Inc.
Protectoseal Co., The
Reeves Bros. Inc., Vulcan Rubber Div.
Reliance Industrial Prod., Inc.
Republic Aviation Corp., Missile Systems Div.
Rose Mfg. Co.
Scott Aviation Corp.
Seiscor, Div.-Seismograph Service Corp.
Sellstrom Mfg. Co.
Sierra Engrg. Co.
Southwest Research Institute
Standard Safety Equipment Co.
Switlik Parachute Co., Inc.
U. S. Plastic Molding Corp.
Universal Transistor Products Corp.
Wells Industries Corp.
Zep Aero

SAFING, ARMING & FUZING SYSTEMS
***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
American Machine & Foundry Co.
Avco Corp., Crosley Div.
Avco Corp., Research & Advanced Development Div.
Beckman & Whitley, Inc., Missile Products Div.
Bell Aircraft Corp., Niagara Frontier Div.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Aviation Corp., York Div.
Bermite Powder Co.
Bulova Research & Development Labs., Inc.
Chance Vought Aircraft, Inc.
Cleveland Metal Specialties Co., Electronics Div.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Eastman Kodak Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fae Instrument Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
Gabriel Co., Rocket Power-Talco
General Electric Co., Missile & Space Vehicle Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Mills, Inc.
Hamilton Watch Co., Military Products Div.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Hughes Tool Co., Aircraft Div.
Integrated Dynamics Div., Globe Industries, Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
W. L. Maxson Corp., The
McCormick Selph Associates
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Patterson Moos Research, Div.-Leesona Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Raymond Engrg. Lab., Inc.
Republic Aviation Corp., Missile Systems Div.
Singer Military Products Div.-The Singer Mfg. Co.
Special Products Dept., Melpar, Inc.
Thiokol Chemical Corp., Hunter-Bristol Div.

SALT BATHS
Associated Testing Labs., Inc.
California Stamping & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Hallikainen Instruments
Hevi-Duty Electric Co., Div.-Basic Products Corp.
A. F. Holden Co., The
Temperature Engrg. Corp.

SAWS
Air Speed Tool Co.
Armstrong-Blum Mfg. Co.
W. O. Barnes Co., Inc.
Black & Decker Mfg. Co., The
Brown & Sharpe Mfg. Co.
California Stamping & Mfg. Co.
Capewell Mfg. Co.
Clausing Div.-Atlas Press Co.
Forsberg Mfg. Co., The
Handicraft Tools, Inc., Div.-X-Acto, Inc.
Miller Falls Co.
Norwalk Cutter Sharpening Co.
Simonds Saw & Steel Co.
Snap-on-Tools Corp.
L. S. Starrett Co., The
W. Whitney Stueck, Inc.
Thor Power Tool Co.

SCALES, OSCILLOSCOPE
Adept Industries Inc.
Allen B. Du Mont Labs., Inc.
Howe Scale Co., The
Jan Hardware Mfg. Co., Inc.
James Millen Mfg. Co. Inc.
Sillcocks-Miller Co.
Sun Dial Corp.

SCANNERS, REFLECTED & TRANSMITTED LIGHT
Blowers Inc.
Budd Lewyt Electronics, Inc.
CBS Laboratories, Div.-Columbia Broadcasting System
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Electro Instruments, Inc.
General Devices, Inc.
Hammett-Mercury-Rex Div.
Hass Instrument Corp., The
Instrument Development Labs., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Northrop Corp.
Optomechanisms Inc.
Philco Corp.-Govt. & Industrial Group
Scanivalve Co.
Singer Military Products Div.-The Singer Mfg. Co.
Skiatron Electronics & Television Corp.
Spectra Electronics Corp.
Television Utilities Corp.
Wells Industries Corp.

SCOOPS
Autoscrew Co., Inc.
Mercury Air Parts Co., Inc.
Star Stainless Screw Co.

SCREW DRIVERS
Albertson & Co., Inc.
Ampco Metal, Inc.
Black & Decker Mfg. Co., The
Burklyn Co.
Continental Screw Co.
Foredom Electric Co., Inc.
Gardner-Denver Co.
Handicraft Tools, Inc., Div.-X-Acto, Inc.
Hunter Tool Co.
Industrial Tools Mfg. Corp., Sub-Pendleton Tool Industries, Inc.
Mercury Air Parts Co., Inc.
Miller Falls Co.
Moody Machine Products Co., Inc.
Overload Control Co.
Owatonna Tool Co. Precision Hydraulic Div.
Proto Tool Co.
Richmont, Inc.
Snap-On-Tools Corp.
L. S. Starrett Co., The
Thor Power Tool Co.
United Shoe Machinery Corp.
Vaco Products Co.
Vlchek Tool Co.
Vlier Engrg. Corp.
Wesrep Corp.
Zephyr Mfg. Co. Inc.

SCREW, MACHINE PRODUCTS
Abalon Precision Mfg. Corp.
Abbott Screw & Mfg. Co.
Acme Industrial Co.
Actuator Products Div., Geartronics Corp.
Aero Bolt & Screw Co., Inc.
Aero Mfg. & Mach. Co., Inc.
Aero Spares, Inc.
Aero Supply Mfg. Inc.
Aero-Stat Co., The
Aerotron Supply Co.
Airhardware, Inc.
All Specs Corp.
Allied Precision Products, Inc.
Allied Products Corp.
Allmetal Screw Products Co., Inc.
Alpine Electronic Components, Inc.
Aluminum Co. of America
Amatom Electronic Hardware Co. Inc.
American Screw Co.
American Standard Products, Inc.
Ampco Metal, Inc.
Anderson, Greenwood & Co.
Anti-Corrosive Metal Products Co., Inc.
Apex Tool Co., Inc., The
Arnolt Corp.
Atlas Screw & Specialty Co.
Autoscrew Co., Inc.
Bennett-Feragen
Bergen Carbide Co.
Best Aircraft Corp.
Bland Burner Co., The
Bruce Engrg. Co.
Buchmann Spark-Wheel Corp.
Capital City Mfg. Co., Inc.
Chandler Products Corp.
Chemplast, Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Custom Products Corp.
Deutsch Co., The, Electronic Components Div.
Dill Mfg. Co., The
Doak Aircraft Co. Inc.
Dumont Engrg. Co.
Eastern Specialty Co., The
Electronic Parts Mfg. Co., Inc.
Eljay Corp.
Elzee Metal Products Co., Inc.
Emerson Plastics Corp.
Eureka Williams Corp.
Federal Screw Products Inc.
Franklin Fibre-Lamitex Corp.

Freeman, Co., The
General Aniline & Film Corp., Ansco Div.
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div.
H. M. Harper Co.
Hartford Machine Screw Co., Div.-Standard Screw Co.
Harvey Aluminum
Henry & Miller Industries, Inc.
Hobbs Mfg. Co.
Walter K. Jaros Aircrafters
K-W Engrg. Works
Keystone Bolt & Nut Corp.
Keystone Electronics Corp.
L & R Mfg. Co.
Link-Belt Co.
Massachusetts Gear Div.-Geartronics Corp.
Mayflower Mfg. Co.
Moran Co.
J. I. Morris Co.
Napoleon Products Co., The
National Screw & Mfg. Co., The
Norrich Plastics Corp.
Norrich Screw Machine Products
Nutmeg Screw Machine Products Co.
Ohlson Empire Inc.
Olympic Screw & Rivet Corp.
Richard Philip Co.
Precision Metal Products Co. Inc.
Red Devil Mfg. Co.
Research Development Mfg. Inc.
J. R. Robbins Co.
Rosan, Inc.
Scovill Mfg. Co.
Sinclair Mfg. Co.
C. M. Smillie & Co.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Herman D. Steel Co.
T. O. D. Mfg. Co. Inc.
Taft-Peirce Mfg. Co., The
Thompson-Brewer & Co. Div.-American Machine & Foundry Co.
Torrington Co., The
Voi-Shan Mfg. Co., Div.-Voi-Shan Industries, Inc.
Waltham Screw Co.
Western Automatic Machine Screw Co., Div.-Standard Screw Co.
William Whytock Co.

SCREWS, SELF-TAPPING

Abbott Screw & Mfg. Co.
Aero Spares, Inc.
Aerotron Supply Co.
Airhardware, Inc.
All Specs Corp.
Allmetal Screw Products Co., Inc.
Aluminum Co. of America
Alvo Nut & Bolt Co., Inc.
American Screw Co.
Anti-Corrosive Metal Products Co., Inc.
Atlas Screw & Specialty Co.
Best Aircraft Corp.
Camcar Screw & Mfg. Co., Div.-Textron Industries, Inc.
Central Screw Co.
Cherry Rivet Div.-Townsend Co.
Continental Screw Co.
Eaton Mfg. Co., Reliance Div.
Federal Screw Products Inc.
Gries Reproducer Corp.
H. M. Harper Co.
Holub Industries, Inc.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
J. I. Morris Co.
National Screw & Mfg. Co., The
Nylok Corp., The
Ohlson Empire Inc.
Olympic Screw & Rivet Corp.
Republic Steel Corp.
Screw Corp.
Star Stainless Screw Co.
Thompson-Brewer & Co. Div.-American Machine & Foundry Co.
Voi-Shan Mfg. Co., Div.-Voi-Shan Industries, Inc.

SCREWS, SET

Abbott Screw & Mfg. Co.
Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Aerotron Supply Co.
Airhardware, Inc.
All Specs Corp.
Allen Mfg. Co.
Allied Products Corp.
Allmetal Screw Products Co., Inc.
Aluminum Co. of America
Alvo Nut & Bolt Co., Inc.
Amatom Electronic Hardware Co. Inc.
Anti-Corrosive Metal Products Co., Inc.
Atlas Screw & Specialty Co.
Autoscrew Co., Inc.
Best Aircraft Corp.
***BRISTOL CO., THE**
Camcar Screw & Mfg. Co., Div.-Textron Industries, Inc.
Chandler Products Corp.
Chase Brass & Copper Co., Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Federal Screw Products Inc.
Gries Reproducer Corp.
H. M. Harper Co.
Hartford Machine Screw Co., Div.-Standard Screw Co.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
Mercury Air Parts Co., Inc.
Moran Co.
J. I. Morris Co.
National Screw & Mfg. Co., The
Norrich Plastics Corp.
Norrich Screw Machine Products
Nylok Corp., The
Ohlson Empire Inc.
Republic Steel Corp.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Voi-Shan Mfg. Co., Div.-Voi-Shan Industries, Inc.
Western Automatic Machine Screw Co., Div.-Standard Screw Co.

SCREWS, STANDARD

Abbott Screw & Mfg. Co.
Aero Bolt & Screw Co., Inc.
Aero Spares, Inc.
Aero-Stat Co., The
Aerotron Supply Co.
Airhardware, Inc.
All Specs Corp.
Allen Mfg. Co.
Allmetal Screw Products Co., Inc.
Aluminum Co. of America
Alvo Nut & Bolt Co., Inc.
American Screw Co.
Ampco Metal, Inc.
Anti-Corrosive Metal Products Co., Inc.
Atlas Screw & Specialty Co.
Autoscrew Co., Inc.
Best Aircraft Corp.
Birnbach Radio Co., Inc.
***BRISTOL CO., THE**
Camcar Screw & Mfg. Co., Div-Textron Industries, Inc.
Central Screw Co.
Chandler Products Corp.
Chase Brass & Copper Co., Inc.
Chicago Screw Co., The, Div.-Standard Screw Co.
Continental Screw Co.
Eaton Mfg. Co., Reliance Div.
Federal Screw Products Inc.
Gries Reproducer Corp.
H. M. Harper Co.
Hartford Machine Screw Co., Div. Standard Screw Co.
Hi-Shear Rivet Tool Co.
Walter K. Jaros Aircrafters
Keystone Bolt & Nut Corp.
Mercury Air Parts Co., Inc.
J. I. Morris Co.
National Screw & Mfg. Co., The
Nylok Corp., The
Ohlson Empire Inc.
Olympic Screw & Rivet Corp.
Republic Steel Corp.
Scovill Mfg. Co.
Screw Corp.
Standard Pressed Steel Co.
Star Stainless Screw Co.
Western Automatic Machine Screw Co., Div.-Standard Screw Co.

SEALERS, FUEL & OIL TANK

Aero-Stat Co., The
American Latex Products Corp.
Avondale Co., The
Borden Chemical Co.
Coast Pro-Seal & Mfg. Co.
Connecticut Hard Rubber Co., The
Johns-Manville Sales Corp.
Jonco Aircraft Corp., Sub.-Fairchild Engine & Airplane Corp.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-ADHESIVES, COATING & SEALERS DIV.**
Parker Seal Co., Div.-Parker Hannifin Corp.
Products Research Co.
Reeves Bros. Inc., Vulcan Rubber Div.
United Aircraft Products, Inc.
United Shoe Machinery Corp.

SEALERS, NUCLEAR

Borg-Warner Mechanical Seals, Div. Borg Warner Corp.
Flight Refueling, Inc.
Marman Div., Aeroquip Corp.
***MINNESOTA MINING & MFG. CO.**
Parker Seal Co., Div.-Parker-Hannifin Corp.
Portland Copper & Tank Works Inc.
United Aircraft Products, Inc.
U. S. Industries Inc.

SEALERS, PROTECTIVE

American Latex Products Corp.
Avondale Co., The
Borden Chemical Co.
Clarkson Labs., Inc., The
Coast Pro-Seal & Mfg. Co.
Connecticut Hard Rubber Co., The
Insulation Mfrs. Corp.
Lam-Ply, Inc.
***MINNESOTA MINING & MFG. CO.**
***MINNESOTA MINING & MFG. CO.-ADHESIVES, COATING & SEALERS DIV.**
Penetone Co., The
Permatex Co., Inc.
Products Research Co.
Sauereisen Cements Co.
Silicone Products Dept., General Electric Co., Dept. C.
Sillcocks-Miller Co.

SEALING SERVICE, HERMETIC

Aero-Stat Co., The
Alite Div., U. S. Stoneware Co.
Bearing Inspection, Inc.
A. Biederman, Inc.
Connecticut Hard Rubber Co., The
Deutsch Co., The, Electronic Components Div.
Electro-Seal Corp.
Fisher Engrg. Inc.
General Laboratory Associates, Inc.
Livingston Electronic Corp.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Milton Ross Metals Co., The
Sherman Indsl. Electronics Co., Div.-Electronic Development Inc.
Sillcocks-Miller Co.
Sphere Co. Inc., The
Torwico Electronics, Inc.
Warren Components, Div.-El-Tronics, Inc.

SEALS

a. Carbon
b. Ceramic to Metal
c. Dust Excluder
d. Grease & Oil
e. Hermetic & Pressurized
f. Hydraulic
g. Insulating
h. Metal-to-Glass
i. Missile
j. Oil
k. Pipe Joint
l. Pump
m. Pump-Mechanical
n. Shaft
o. Special Purpose

ACF Industries Inc., **k.**
A. P. M. Corp., **e.**
Acushnet Process Co., **c, d, f, j thru o.**
Advanced Products Co., The **b, d, e, f, h thru k, o.**
Aero Gasket Corp., **f, j.**
Aero Leather Products Co., **c.**
Aerolite Electronics Corp., **h.**
Aero-Stat Co., The, **d, e, f, j, o.**
Alite Div., U. S. Stoneware Co., **b, e, o.**
Allied International Corp., **e, k.**
Alloys Unlimited Inc., **b, e, h.**
Amatom Electronic Hardware Co. Inc.
American Feldmuehle Corp., **b.**
American Felt Co., **c thru g, i thru o.**
American Instrument Co., Inc., **f.**
American Latex Products Corp., **a thru o.**
American Lava Corp., **b.**
American Potash & Chemical Corp., Na-

tional Northern Div., **h.**
Anchor Packing Co., The, **j.**
Apex Tool Co., Inc., The, **d, j.**
Armstrong Cork Co., **d, f, j, m.**
***ARNOUX CORP., b, e, g, h.**
Associated Engrg. & Mfg. Corp., **h.**
Auburn Mfg. Co., The, **c, d, f, g, h, j, k, l, n, o.**
Avica Corp., **o.**
B G Corp., The, **b.**
Bacon Industries, Inc., **g.**
Wallace Barnes Div. Associated Spring Corp., **d, f, j, n, o.**
Barnes Development Co., **n.**
L. J. Barwood Mfg. Co. Inc., **b thru o.**
Bellofram Corp., **f, o.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., b, n.**
Best Aircraft Corp., **j.**
J. Bishop & Co., Platinum Works, **h.**
Bonny Mfg. Corp., **f, g, l, m, o.**
Borden Chemical Co., **b, g, k.**
Borg-Warner Mechanical Seals, Div. Borg-Warner Corp., **b, i, l thru o.**
Braun-Knecht-Heimann Co., Industrial Div., **h.**
Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., **e.**
H. H. Buggie Div., Burndy Corp., **n.**
Byron Jackson Pumps, Inc., **l thru o.**
Carbone Corp., The, **a.**
Carborundum Co., The, **b, h, o.**
Carborundum Co., Refractories Div., **b, g, n.**
Cartriseal Corp., **a, b, d, f, i, j, l, m, n.**
Caterpillar Tractor Co., Defense Products Dept., **o.**
Central Safety Equip. Co., **o.**
Centralab, Div.-Globe-Union, Inc., **b, g.**
Ceramaseal, Inc., **b.**
Chemplast, Inc., **o.**
Chicago Rawhide Mfg. Co., **a thru d, f, i, j, m, n, o.**
Clark Bros. Co., Div.-Dresser Operations, Inc., **a, j, n, o.**
Clover Industries, Inc., **c.**
Colonial Rubber Co., **f, i, j.**
Commonwealth Felt Co., **c, d, g, i, n, o.**
Components Corp., **f, i, j, k, o.**
Connecticut Hard Rubber Co., The, **d, e, g, h, i, o.**
Consolidated Vacuum Corp., **h.**
L. L. Constantin & Co., **e, h.**
Continental Felt Co., **c, d.**
Continental Rubber Works, **o.**
C. Lee Cook Co., Airtomic Products Div., **a, d, f, i, j, n, o.**
Coors Porcelain Co., **b.**
Cordo Chemical Corp., **h.**
Cornelius Co., The, Aero Div., **e, f, n, o.**
Corning Glass Works, **b, h.**
D. S. D. Mfg. Co., The, **e, f, j.**
C. R. Daniels, Inc., **d, o.**
Darcoid Co. Inc., The, **j thru n.**
Deutsch Co., The, Electronic Components Div., **e, h, o.**
Division Lead Co., **h.**
Dixon Corp., **g, i, m, n.**
John L. Dore Co., **n, o.**
Dow-Elco, Inc., **e, f, i, o.**
Du-Co Ceramics Co., **b.**
Duramic Products, Inc., **b.**
Dyna-Therm Chemical Corp., **g.**
Eco Engrg. Co., **k, l, m.**
Edwards High Vacuum Ltd., **l, n, o.**
Emerson Plastics Corp., **d, f, g, l thru o.**
Enfab Inc., **g.**
Felters Co., The, **c, j.**
Finnell System, Inc., **o.**
Fluorocarbon Co., The, **c, e, f, g, i, j, l thru o.**
Frenchtown Porcelain Co., **b, e, g.**
Fusite Corp., **h.**
Futurecraft Corp., **d, f, j.**
Garde Mfg. Co., **e.**
Garlock Packing Co., **a, c, d, f, i thru o.**
General Ceramics Div., Indiana General Corp., **b.**
Gits Brothers Mfg. Co., **a, b, d, f, i, j, l thru o.**
Gladding, McBean & Co., **b.**
B. F. Goodrich Aviation Products, **e.**
Goshen Rubber Co., Inc., **f.**
Graphite Metallizing Corp., **a, d, j, n.**
Greene, Tweed & Co., **d, f, g, i thru o.**
B. H. Hadley, Inc., **e, f, i, o.**
Halogen Insulator & Seal Corp., **f, o.**
Haskel Engrg. & Supply Co., **f, i, j, l, m, n, o.**
Helwig Carbon Products, Inc., **a.**
Herlo Corp., **e, i, j.**
Hermetic Seal Corp., **b, e, h.**
Hermetic Seal Corp. & Thermal Controls, Inc., **b, e, h, i.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., **e, g, o.**
E. F. Houghton & Co., **f.**
ITT Components Div., International Telephone & Telegraph Corp., **e, h.**
Isolantite Mfg. Corp., **b, g.**
Joclin Mfg. Co., The, **d, e, i, j, o.**
Johns-Manville Sales Corp., **c, d, f, g, j, l.**
Kennametal Inc.
Kentucky Metal Products Co., **i, n, o.**
Kollmorgen Optical Corp., **b, e, h, o.**
Koppers Co., Inc., Metal Products Div., **a, n, o.**
Lam-Ply, Inc., **b, g, h, k.**
Langley Corp., **o.**
Lapp Insulator Co., Inc., Radio Specialties Div., **b.**
Lear, Inc., **f, j, l, m, o.**
Linear, Inc., **a thru o.**
Litton Engrg. Labs., **b.**
Livingston Electronic Corp., **h, o.**
Machine Products Div., New Haven Trap Rock Co., **o.**
Magnetic Seal Corp., **b, j, m, n.**
Marman Div., Aeroquip Corp., **f, i, k, o.**
McCormick Selph Associates, **e.**
Metaplast Co., Inc., **b, h.**
***MINNESOTA MINING & MFG. CO., b, i, k.**
Minnesota Rubber Co., **d thru g, j, l thru o.**
Mitronics Inc., **b, e, g, h.**
Molding Corp. of America, **e, g.**
Morganite, Inc., **a, h.**
National Carbon Co., Div.-Union Carbide Corp., **a, d, e, f, l thru o.**
Networks Electronic Corp., **e, h.**
Norton Co., New Products Dept., **b.**
Nuclear Development Corp. of America, **e, k.**
Nureco, Inc., **b, h.**
Ohio Carbon Co., The, **a, l, n.**
Oil-Dyne, Inc., **f, l, n.**
Ordnance Research & Development Co., Div.-Bermite Powder Co., **b, e, h.**
Pacific Universal Products Corp., **h.**
Parker Seal Co., Div.-Parker-Hannifin Corp., **d thru g, i, j, l, n, o.**
Parker-Hannifin Corp., **f.**
Peerless Pump Div., Food Machinery & Chemical Corp., **l, m, n.**
Permacel, **k.**
Permatex Co., Inc., **k.**
Richard Philip Co., **c, f, n, o.**
Polymer Corp., The, **f, g, j.**
Precision Lapping Co. Inc., **b, e, h.**
Precision Rubber Products Corp., **o.**
Presstite Div., American-Marietta, **b, g, h, o.**
Raybestos-Manhattan, Inc., **d thru g, i thru l, n, o.**
Reeves Brothers, Inc., **o.**
Resistoflex Corp., **h, k.**
Resistron Labs., Inc., **e, h.**
Fred T. Roberts & Co., **o.**
Roberts Toledo Rubber Co., The, **d, f, g, m, n, o.**
Robertshaw-Fulton Controls Co., Fulton Sylphon Div., **d, e, f, j, l thru o.**
Rocketdyne Div.-North American Aviation, Inc.
Rogers Corp, **f, g.**
Milton Ross Metals Co., The, **e, h.**
Rubbercraft Corp. of California, **c, d, g.**
St. Marys Carbon Co., **a, d, j, l thru o.**
Ray A. Scharer & Co., **j.**
Schlegel Mfg. Co., **c, g, h.**
Sealectro Corp., **g.**
Sealol Corp., **a, d, e, f, i, j, l thru o.**
Sealtron Corp., **h.**
Sedco, **c.**
E. C. Smith Mfg. Co., Inc., **b.**
Southwest Research Institute.
Sparta Mfg. Co., Div.-U.S. Ceramic Tile Co., **d, f, n, o.**
Speer Carbon Co., **a.**
Sphere Co. Inc., The, **b, e.**
Stackpole Carbon Co., **a, d, j, l, m.**
Stein Seal Co., **j, m, n, o.**
Stillman Rubber Co., **d, e, f, j, k, o.**
Stonhard Co., Inc., **h, o.**
Strat-O-Seal Mfg. Co., **e.**
Superior Carbon Products Inc., **a.**
Temco Aircraft Corp., **i.**
Tetrafluor, Inc., **c, d, f, g, i thru o.**
Texas Instruments Inc., **b, h.**
Thor Ceramics, Inc., **b, g.**
Topper Mfg. Co., Inc., **b, g.**
Torwico Electronics, Inc., **e, o.**
Transco Products, Inc., **o.**
Union Asbestos & Rubber Co., **g, l, m, n.**
United Aircraft Products, Inc., **d, e, f, i thru m, o.**
United States Graphite Co., The, Div.-The Wickes Corp., **a, d, k thru o.**
United States Rubber Co., **c, d, j, k.**
Vacuum Research Co., **n, o.**
Victor Mfg. & Gasket Co., **a thru d, f, i thru o.**
Warren Components, Div.-El-Tronics, Inc., **e, h.**
Worthington Corp., **f, l thru o.**
X-Pando Corp., **b, f, h, j, k.**
Young Development Div., Hercules Powder Co., **d, f, o.**

SELECTIVE CALLING APPARATUS

Bell & Gossett Co.
Bruno-New York Industries Corp.
Collins Radio Co.
Dage Television Div., Thompson Ramo Wooldridge, Inc.
Du Kane Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Gates Radio Co.
Hammarlund Mfg. Co., The
Houston Fearless Corp.
ITI Electronics, Inc.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Motorola, Inc.
Northrop Corp.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Secode Corp.
United States Instrument Corp.
Western Union Telegraph Co., The

SENSING DEVICES

Acoustica Associates, Inc.
Aero Research Instrument Co., Inc.
American Instrument Co., Inc.
American Machine & Foundry Co., Government Products, N. Y.
American Missile Products Co., Inc.
***ARNOUX CORP.**
Barber-Colman Co.
Bendix Aviation Corp.
Bendix Aviation Corp.-Montrose Div.
Bruno-New York Industries Corp.
Bulova Research & Development Labs., Inc.
Consolidated Controls Corp.
Consolidated Vacuum Corp.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Designers for Industry, Inc.
Digital Sensors Inc.
Djeco, Div.-Djordjevic Engrg. Co.
Du Kane Corp.
Eastman Kodak Co.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electro Products Labs., Inc.
Emertron Sub.-Emerson Radio & Phonograph Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
GPL Div.-General Precision, Inc.
General Instrument Corp., Defense & Engrg. Products Group
Genisco, Inc.
Genisco, Inc., Instrument Div.
Gulton Industries, Inc.
B. H. Hadley, Inc.
Harco Labs., Inc.
Image Instruments, Inc.
Infrared Industries, Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lab. for Electronics, Inc.
Leach Corp.
Lear, Inc.
Leland Airborne Products, Div.-American Machine & Foundry Co.
***LEWIS ENGRG. CO., THE**
Liquidometer Corp., The
Lycoming Div., Avco Corp.
Magnetic Circuit Elements, Inc.

Magnetic Controls Co.
Marquardt Corp., The
Minco Products, Inc.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Semiconductor Products Div.
Motorola, Inc.
Narda Ultrasonics Corp., The
Northrop Corp.
Optomechanisms Inc.
Otis Elevator Co., Defense & Industrial Div.
Pacific Scientific Co.
Patterson Moos Research, Div.-Leesona Corp.
Philco Corp.-Govt. & Industrial Group
Philips Electronic Instruments
Production Research Corp., Sub.-Radio Condenser Co.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Revere Corp. of America, Sub., Neptune Meter Co.
Rosemount Engrg. Co.
Sanders Associates, Inc.
Santa Barbara Research Center
Southwest Research Institute
Specialties, Inc.
Specialty Electronics Development Corp.
Spectra Electronics Corp.
Statham Instruments, Inc.
Talley Corp., The
Taurus Corp.
Telechrome Mfg. Corp.
Thompson Ramo Wooldridge Inc.
Trimount Instrument Co.
Trio Laboratories, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Victory Engrg. Corp.
Wells Industries Corp.
Western Union Telegraph Co., The

SEPARATION DEVICES

Aerojet-General Corp., Downey Plant
American Machine & Foundry Co.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Bowser Inc., Defense Div.
Bulova Research & Development Labs., Inc.
Conax Corp.
Joe Davidson & Associates
Dels Tumbling Service
J. W. Dice Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Ensign-Bickford Co., The
Fae Instrument Corp.
Fram Corp.
Gabriel Co., Rocket Power-Talco
General American Transportation Corp.
General Electric Co., Missile & Space Vehicle Dept. Pa.
Hi-Shear Rivet Tool Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Warner Lewis Co., Div.-Fram Corp.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
McCormick Selph Associates
Olin Mathieson Chemical Corp., N. Y.
Olin Mathieson Chemical Corp., Winchester-Western Div.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Patterson Moos Research, Div.-Leesona Corp.
Philco Corp.-Govt. & Industrial Group
Precision Equipment Co., Inc.
Propellex Chemical Div., Chromalloy Corp
Selas Corp. of America
Temco Aircraft Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Weber Aircraft Corp.
Wells Industries Corp.

SEPARATORS, OIL

Bendix Utica Div., Bendix Aviation Corp.
Bowser Inc., Defense Div.
Briggs Filtration Co., The
Brooks & Perkins, Inc.
Genisco, Inc.
Harman Equipment Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
Kieley & Mueller, Inc.
Warner Lewis Co., Div.-Fram Corp.
Nooter Corp.
Precision Equipment Co., Inc.

SERVO MECHANISM CONTROL SYSTEMS

ACF Industries Inc.
Advance Industries, Inc.
Advance Instrument Corp.
Aero Supply Mfg. Inc.
***AEROJET-GENERAL CORP.**
Aeronautical Machinists Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRSEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Airpax Electronics Inc., Cambridge Div.
Airpax Electronics Inc., Seminole Div.
American Brake Shoe Co., Kellogg Div.
American Machine & Foundry Co.
American Machine & Foundry Co., Greenwich Engrg. Div.
Antlab Inc.
Armament Div.-Universal Match Corp.
Avien, Inc.
Ball Brothers Research Corp.
Barber-Colman Co.
Belock Instrument Corp.
Bendix Aviation Corp.
***BENDIX AVIATION CORP., HAMILTON DIV.**
Bendix Aviation Corp., Montrose Div.
Bendix Corp., The, Eclipse-Pioneer Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix-Pacific Div., Bendix Aviation Corp.
Bermite Powder Co.
Bogue Electric Mfg. Co.
Bowmar Instrument Corp.
***BRISTOL CO., THE**
Bruno-New York Industries Corp.
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
Cadillac Gage Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Coleman Electronics, Inc.
Compudyne Corp.
Consolidated Controls Corp.
Control Data Corp.
Control Technology Co.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Crescent Engrg. & Research Co.
Dalmo Victor Co., Div.-Textron, Inc.
Joe Davidson & Associates
Daystrom, Inc., Control Systems Div.
Daystrom Inc., Pacific Div.
Daystrom Inc., Transicoil Div.
Decker Corp., The
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Delco Radio Div.-General Motors Corp.
Designers for Industry, Inc.
Djeco, Div.-Djordjevic Engrg. Co.
Dynatronics, Inc.
Eastern Industries Inc.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electro Precision Corp.
Erie Resistor Corp.
Exact Engrg. & Mfg. Inc.
Fae Instrument Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Fairfield Engrg. Corp.
J. W. Fecker Div., American Optical Co.
Feedback Controls, Inc.
Fenwal Inc.
Flight Refueling, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
GAP Instrument Corp.
General Aniline & Film Corp., Ansco Div.
General Bronze Electronics Corp.
General Electric Co., Apparatus Sales Div.
General Electric Co., Light Military Electronics Dept.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Electric Co., Ordnance Dept.
General Electro-Mechanical Corp.
Gilfillan Bros. Inc.
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hammett-Mercury-Rex Div.
Hoefner Corp.
Hoover Electric Co.
Huyck Systems Co.
Hydra-Power Corp.
Hydraulic Research & Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Ideal-Aerosmith, Div.-Royal Industries, Inc.
Insco Co., Div.-Barry Controls Inc.
Integrated Dynamics Div., Globe Industries, Inc.
Interstate Electronics Corp.
Jack & Heintz, Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kelsey-Hayes Co.
Kemp Aero Products
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kollmorgen Optical Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Lear, Inc.
Leeds & Northrup Co.
***WALLACE O. LEONARD, INC.**
Librascope Div., General Precision, Inc.
Liquidometer Corp., The
Litton Industries, Inc.
Madigan Corp.
Magnetic Circuit Elements, Inc.
Marquardt Corp., The
McDonnell Aircraft Corp.
Micro Gee Products, Inc.
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Aeronautical Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Mitchell Camera Corp.
Muirhead Instruments Inc.
George L. Nankervis Co.
National Co., Inc.
Networks Electronic Corp.
Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Otis Elevator Co., Defense & Industrial Div.
Parker-Hannifin Corp.
Pegasus Labs., Inc.
Philco Corp.-Govt. & Industrial Group
Pitometer Log Corp.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Development & Research Corp.
Reeves Instrument Corp.
Republic Aviation Corp., Missile Systems Div.
Research, Inc.
Rimak, Inc.
Sanders Associates, Inc.
Sargent Engrg. Corp.
Servomechanisms, Inc.
Servo-Tek Products Co.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Singer Military Products Div.-The Singer Mfg. Co.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Spectrol Electronics Corp.
Sperry Farragut Co., Div.-Sperry Rand Corp.
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Statham Development Corp.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Talley Corp., The
Tapco Group, Thompson Ramo Wooldridge Inc.
Technology Instrument Corp.
Telechrome Mfg. Corp.
Temco Aircraft Corp.
Thermo Electric Co., Inc.
Thompson Ramo Wooldridge Inc.
Transicoil Div.-Daystrom Inc.
Trio Laboratories, Inc.
United Sensor & Control Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Varo Mfg. Co., Inc.
Vickers Inc.

Vickers Inc., Div.-Sperry Rand
Vickers Inc. Electric Products Div.
Vickers, Inc., Mich.
Vinson Mfg. Co. Inc.
Voi-Shan Electronics
Western Design, Div.-U. S. Industries, Inc.
Western Gear Corp.-Precision Products Div.
Westgate Lab., Inc.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

SERVOS, MEASUREMENT

Advance Industries, Inc.
Advance Instrument Corp.
Avien, Inc.
Bendix Aviation Corp.
Bulova Research & Development Labs., Inc.
Chance Vought Aircraft, Inc.
Control Data Corp.
Dalmo Victor Co., Div.-Textron, Inc.
Daystrom Inc., Transicoil Div.
Dynametrics Corp.
Feedback Controls, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
Guided Missile Div., The Firestone Tire & Rubber Co.
Huyck Systems Co.
Hydraulic Research & Mfg. Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Interstate Electronics Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
Leeds & Northrup Co.
Madigan Corp.
Meletron Corp.
Micro Gee Products, Inc.
Minneapolis-Honeywell Regulator Co., Boston Div.
Muirhead Instruments Inc.
National Co., Inc.
Optomechanisms Inc.
Otis Elevator Co., Defense & Industrial Div.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Philco Corp.-Govt. & Industrial Group
Reeves Instrument Corp.
Singer Military Products Div.-The Singer Mfg. Co.
Special Products Dept., Melpar, Inc.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Telechrome Mfg. Corp.
Theta Instrument Corp.
Topper Mfg. Co., Inc.
Trio Laboratories, Inc.
Western Gear Corp.-Precision Products Div.

SEXTANTS, PERISCOPE TYPE

Gordon Enterprises
Kollmorgen Optical Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.

SHAFTS, FLEXIBLE

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
Actuator Products Div., Geartronics Corp.
Albertson & Co., Inc.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Birnbach Radio Co., Inc.
Electric Autolite Co., The
B. W. Elliott Mfg. Co., Inc.
Gordon Enterprises
Jeffrey Mfg. Co., The
E. F. Johnson Co.
Lear, Inc.
Stow Mfg. Co.
Wyzenbeek & Staff, Inc.

SHAFTS, RIGID

American Nickel Alloy Mfg. Corp.
Ampco Metal, Inc.
Belmar Wheel & Machine Co., Inc.
Bethlehem Steel Co.
Birnbach Radio Co., Inc.
Capital City Mfg. Co., Inc.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Fenn Mfg. Co., The
Hupp Aviation Div.-Hupp Corp.
E. F. Johnson Co.
Kerns Mfg. Corp.
Ladish Co.
La Vezzi Machine Works
Lycoming Div., Avco Corp.
National Forge Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Richard Philip Co.
Piasecki Aircraft Corp.
Edw. Renneburg & Sons Co.
Research Development Mfg. Inc.
Joseph T. Ryerson & Son, Inc.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Superior Industrial Machine Co.
Tube-Turns Div., Chemetron Corp.
United States Chemical Milling Corp.
Utility Brass & Copper Corp.

SHEET METAL PARTS

ACF Industries Inc.
A & E Metal Specialties Inc.
Aerocal Div., Aeronca Mfg. Corp.
Aircraft Tools, Inc.
Allied Products Corp.
Allison Div., General Motors Corp.
Alloy Products Corp.
Aluminum Co. of America
Amatom Electronic Hardware Co. Inc.
American Aluminum Co.
American Brass Co., The
American Car & Foundry Div., ACF Industries, Inc.
Ampco Metal, Inc.
Anchor Metal Spinning Co., The
Anchor Specialty Mfg. Co. Inc.
Arnolt Corp.
Artisan Metal Works Co.
Associated Co., Inc.
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Cyril Bath Co., The
Belmar Wheel & Machine Co., Inc.
Benson Mfg. Co.
J. F. Bingham Mfg. Co.
Bowser, Inc.
Bram Metallurgical Chemical Co.
Brooks & Perkins, Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Bud Radio, Inc.
Budd Co., The
Buffalo Metal Container Corp.
Butler Mfg. Co.
Calcor Corp.
California Stamping & Mfg. Co.
Carborundum Metals Co., The
Chance Vought Aircraft, Inc.
Colonial Aircraft Corp.
Conrad & Moser
Craig Systems, Inc.
D K Mfg. Co.
Dahlstrom Metallic Door Co.
***DEL MAR ENGRG. LABS.**
Detroit Stamping Co.
Douglas Aircraft Co., Inc.
Dow Chemical Co., The
Dudwallen Mfg. Co., Inc., The
Eljay Corp.
Elzee Metal Products Co., Inc.
Eureka Williams Corp.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Falstrom Co.
Farwell Metal Fabricating
Fouch Electric Mfg. Co., Inc.
General Electric Co., Lamp Metals & Components Dept.
Hardman Tool & Engrg., Co.
Heldor Mfg. Co., Inc.
Helio Aircraft Corp.
Henry & Miller Industries, Inc.
Ludwig Honold Mfg. Co.
Houston Fearless Corp.
Hughes Tool Co., Aircraft Div.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Janitrol Aircraft Div.-Midland-Ross Corp.
Walter K. Jaros Aircrafters
Jeta, Inc.
Jonco Aircraft Corp., Sub.-Fairchild Engine & Airplane Corp.
Kellett Aircraft Corp.
Kerns Mfg. Corp.
Alfred B. King Co., The
Kirk & Blum Mfg. Co., The
Kling Metal Spinning & Stamping Co.
***LAVELLE AIRCRAFT CORP.**
Leemath Inc.
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
McGregor Mfg. Corp.
Meridian Metalcraft, Inc.
Metal Forming Corp., Div.-Vanadium-Alloys Steel Co.
Monrovia Aviation Corp.
Narmco Mfg. Co.
Norrich Plastics Corp.
Northeast Metals Industries, Inc.
Northrop Corp.
Parts Engrg. Co., Inc.
Penn-Michigan Mfg. Corp.
Richard Philip Co.
Phoenix Products Co.
Piasecki Aircraft Corp.
Pneumafil Corp.
Portland Copper & Tank Works Inc.
Precision, Inc.
Prestole Corp.
Protectoseal Co., The
Pry Welding & Mfg., Inc.
REF Mfg. Corp.
Edw. Renneburg & Sons Co.
Reynolds Metals Co., Sheffield Missile Plant
Rimak, Inc.
Royal Jet, Div.-Royal Industries, Inc.
Sheltered Workshops
Sheridan-Gray, Inc.
Skyline Products, Inc.
Solar Aircraft Co.
Southwestern Industrial Electronics Co.
Spaceatomics Div., The Budd Co.
Specialty Electronics Development Corp.
Spincraft, Inc.
Stalker Corp., The
Stamping Div., Rockwell Standard Corp.
Standard Armament Inc.
Superior Spinning & Stamping Co.
Roland Teiner Co. Inc.
Temco Aircraft Corp.
Thermionic Aeronautical Div.
Unified Industries, Inc.
United Aircraft Products, Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
United States Chemical Milling Corp.
Victor Tool & Mfg., Inc.
Waco Aircraft Co.
Wayne Foundry & Stamping Co.
Weber Aircraft Corp.
Wells Industries Corp.
Western Devices Inc.
Westholt Mfg. Inc.
Whitehead Stamping Co.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.
Woolf Aircraft Products, Inc.

SHEETS, METAL CLAD, PRINTED CIRCUIT

Accurate Specialties Co. Inc.
American Nickel Alloy Mfg. Corp.
Bethlehem Steel Co.
Bo Myte Co., Inc., The
William Brand, Rex Div.-American Enka Corp.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Continental Diamond Fibre Corp.
Engelhard Industries, Inc.
Formica Corp.
Franklin Fibre-Lamitex Corp.
Garlock Packing Co., The-Electronic Products
General Plastics Corp.
George E. Harris & Co., Inc.
Thomas J. Long, Inc.
Mica Insulator Div.-Minnesota Mining & Mfg. Co.
***MINNESOTA MINING & MFG. CO.**
National Vulcanized Fibre Co.
Northern Plastics Corp.
St. Regis Paper Co., Panelyte Div.
Spaulding Fibre Co., Inc.
Synthane Corp.
Taylor Fibre Co.
Temco Aircraft Corp.
Tingstol Co.
Westinghouse Electric Corp., Micarta Div.

SHEETS, MOLYBDENUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Anchor Metal Co. Inc.
Bram Metallurgical Chemical Co.
Electronic Parts Mfg. Co., Inc.
Elmet Div.-North American Philips Co., Inc.

Fansteel Metallurgical Corp.
General Electric Co., Lamp Metals & Components Dept.
Hughes Tool Co., Aircraft Div.
Stauffer Chemical Co.
Texas Instruments Inc.
Thermionic Aeronautical Div.
Universal-Cyclops Steel Corp.
Var-Lac-Oid Chemical Co.
Wah Chang Corp.
Westinghouse Electric Corp.

SHELTERS, TRAILERS, VANS

Aeronca Mfg. Corp.
Albano Co. Inc.
American Car & Foundry Div., ACF Industries, Inc.
American Rocket Co.
Avco Corp., Nashville Div.
Beacon Steel Corp.
Brooks & Perkins, Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
Craig Systems, Inc.
C. R. Daniels, Inc.
Douglas Aircraft Co., Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Fruehauf Trailer Co., Military Equipment Div.
Fred S. Gichner Iron Works, Inc.
Gramm Trailer Corp.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
International Steel Co.
Magline Inc.
***MARTIN CO., THE, DENVER DIV.**
Northrop Corp.
Perfection Div.-Hupp Corp.
Piasecki Aircraft Corp.
REF Mfg. Corp.
Rimak, Inc.
Southwest Research Institute
Southwestern Industrial Electronics Co.
F. M. Stevenson Co., Inc.
Temco Aircraft Corp.
Trailmobile Inc.
Welded Construction Inc.
Wells Industries Corp.
Wickes Engrg. & Construction Co.
Wolverine Diesel Power Co.
***WONDER BUILDING CORP. OF AMERICA**

SHIELDING

a. Cathode Ray Tube
b. Coil
c. Electrostatic
d. Heat
e. Ignition
f. Lead
g. Lead, Nuclear
h. Magnetic
i. Radiation, Ionizing
j. Radiation, Radio Frequency
k. Rubber
l. Sheet or Screen
m. Solid
n. Transformer
o. Tube

ACF Industries Inc., **g.**
Ace Engrg. & Machine Co., Inc., **c, j, l, m.**
Airtron, Div.-Litton Industries, **e.**
Alloys Unlimited Inc., **f.**
Alpha Metals, Inc., **f, g.**
American Agile Corp., **i, l, m.**
American Aluminum Co., **a.**
American Brass Co., The, **a, e, n, o.**
American Machine & Foundry Co., Government Products, N. Y., **d, i, j.**
American Smelting & Refining Co., **f.**
Anaconda Metal Hose Div., The American Brass Co., **e.**
Associated Engineers, Inc., **j.**
Atkins & Merrill, Inc., **g.**
Atlee Corp., **o.**
Auburn Mfg. Co., The, **c, j, k.**
Bar-Ray Products, Inc., **f, g.**
Belmont Smelting & Refining Works, Inc., **f, g.**
Birnbach Radio Co., Inc., **e.**
Bogart Mfg. Corp., **j.**
Breeze Corporations, Inc., **e.**
Brooks & Perkins, Inc., **i, m.**
Budd, Co., The, **g, i.**
CBS Laboratories, Div.-Columbia Broadcasting System, **a.**
Carborundum, Co., The, **d.**
Colonial Rubber Co., **k.**
Co-operative Industries, Inc., **e.**
Cordo Chemical Corp., **f.**
Corning Glass Works, **i.**
DBM Research Corp., **j.**
R. E. Darling Co., Inc., **c, d, f thru k.**
Dean Products, Inc., **d.**
Division Lead Co., **f, g, i, l, m.**
Double E Products Co., **b, c, e, h, j, n.**
Allen B. Du Mont Labs., Inc., **a.**
Elco Corp., **c, o.**
Electronic Tube Corp., **a.**
Emerson & Cuming, Inc., **g thru j, l, m.**
Enfab Inc., **d.**
Ferroxcube Corp. of America, **h.**
Firth Sterling Inc., **m.**
Flexible Metal Hose Mfg. Co., **j.**
Furane Plastics, Inc., **g, i.**
General Laboratory Associates, Inc., **e.**
Fred Goat Co. Inc., The, **c.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **i, j.**
W. R. Grace & Co., Davison Chem. Div., Nuclear Reactor Mat. Plant, **i, m.**
Hallett Mfg. Co., **b, c, e, h.**
Hammett-Mercury-Rex Div., **a.**
George E. Harris & Co., Inc., **e.**
Henry & Miller Industries, Inc., **d, h.**
IERC Div., International Electronic Research Corp., **o.**
Industrial Equipment Div., Baldwin Lima Hamilton Corp., **g.**
Industron Corp., **e.**
Interference Measurement Laboratory, Inc., **j.**
International Electronic Research Corp., **c, d, o.**
Isotopes Specialties Co., Div.-Nuclear Corp. of America, **g.**
Jan Hardware Mfg. Co., Inc., **a, b, h, o.**
Johnson Metal Hose, Inc., **e.**
Kentucky Metal Products Co., **j, l.**
Morris P. Kirk & Son, Inc., **f, g.**
Livingston Electronic Corp., **o.**
Thomas J. Long, Inc., **a, b, i, l, n.**
Magnetic Metals Co., **a, h, n, o.**
***MARTIN CO., THE, DENVER DIV., j, l.**
McCathron Boiler Works Co., Inc., **f, g.**
McMillan Companies, The, **j.**
J. E. Menaugh Co., **e.**
Metal Textile Corp. Div.-General Cable Corp., **c, j, o.**
Met-L-Wood Corp., **f.**
Micro-Circuits Co., **c.**
James Millen Mfg. Co. Inc., **a, b, c, h, j, n, o.**
Minicord Corp. of America, **h.**
***MINNESOTA MINING & MFG. CO., d, l.**
National Moldite Co., **b, h.**
Nuclear Development Corp. of America, **d, f, g, i, j, l, m.**
Nuclear Measurements Corp., **g, i.**
Nuclear-Chicago Corp., **i.**
Nureco, Inc., **d.**
Philips & Davies Inc., **g, i.**
Pittsburgh Corning Corp., **d.**
Plastics Distributor of New England, **f.**
Portland Copper & Tank Works Inc., **f, g, h.**
Ray Proof Corp., **f, g, j, k, l.**
Raybestos-Manhattan, Inc., **d.**
Reeves Brothers, Inc., **k.**
Reeves Bros. Inc., Vulcan Rubber Div., **k.**
Rimak, Inc., **a thru j, l thru o.**
Fred T. Roberts & Co., **k.**
Roberts Toledo Rubber Co., The, **k.**
St. John X-Ray Laboratory, **f, i.**
Saylor Electric Products Corp., **o.**
Servicair Co., **e.**
Sheridan-Gray, Inc., **d.**
Shielding, Inc., **i, l, m.**
Skytronics, Inc., **e.**
Southern Plastics Co., **l.**
Sphere Co. Inc., The, **n.**
Swift Textile Metalizing & Laminating Corp., **l.**
TRG, Inc., **g, i, j.**
Temco Aircraft Corp., **d.**
Thermionic Aeronautical Div., **d.**
Thermionic Products Co., **b.**
Topatron, Inc., **c, h, l.**
Tracerlab Inc., **g.**
Unified Industries, Inc., **a, b, c, e, f, h, l thru o.**
United States Rubber Co., **k.**
Westinghouse Electric Corp., **i.**
Westinghouse Electric Corp., Micarta Div., **m.**
Zippertubing Co., The, **c thru h, j, l, o.**
Zirconium Corp. of America, **d.**

SHIELDS, LEAD

Ackerman-Johnson Co.
Alloys Unlimited Inc.
Alpha Metals, Inc.
Bar-Ray Products, Inc.
Belmont Smelting & Refining Works, Inc.
Breeze Corporations, Inc.
Division Lead Co.
Hallett Mfg. Co.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
Morris P. Kirk & Son, Inc.
McCathron Boiler Works Co., Inc.
Nuclear Development Corp. of America
Nuclear-Chicago Corp.
Pacific Coast Engrg. Co.
Plastics Distributor of New England
Radiation Instrument Development Lab., Inc.
Ray Proof Corp.
Rimak, Inc.
Zippertubing Co., The

SHIMS, ADJUSTING

Allied Plastics Supply Corp.
American Felt Co.
American Silver Co., Inc.
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co., Inc.
Belmar Wheel & Machine Co., Inc.
Detroit Stamping Co.
General Gasket Inc.
Laminated Shim Co., Inc.
Unified Industries, Inc.
Victor Mfg. & Gasket Co.
Whitehead Stamping Co.
Winder Aircraft Corp. of Florida
Wrought Washer Mfg. Co.

SHIMS, LAMINATED

Aero Gasket Corp.
Allied Plastics Supply Corp.
Alloys Unlimited Inc.
American Felt Co.
Bridgeport Brass Co.
Emerson Plastics Corp.
Laminated Shim Co., Inc.
Penn Fibre & Specialty Co., Inc.
Seymour Products Corp., The
Texas Instruments Inc.
Utility Brass & Copper Corp.
Whitehead Stamping Co.
Winder Aircraft Corp. of Florida

SHIPPING CONTAINERS

ACF Industries, Inc.
Air Logistics Corp.
Aluminum Co. of America
American Car & Foundry Div., ACF Industries, Inc.
Avco Corp., Crosley Div.
Benson Mfg. Co.
Brooks & Perkins, Inc.
Buffalo Metal Container Corp.
Butler Mfg. Co.
California Stamping & Mfg. Co.
Colonial Aircraft Corp.
Commercial Services Co., Inc.
Craig Systems, Inc.
Cromer Mfg. & Engrg., Inc.
Douglas Aircraft Co., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Fruehauf Trailer Co., Military Equipment Div.
General Box Co.
Harvey Aluminum
Ludwig Honold Mfg. Co.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kellett Aircraft Corp.
Kirk & Blum Mfg. Co., The
H. Hoch & Sons
***MINNESOTA MINING & MFG. CO.**
Northrop Corp.
Nuclear Development Corp. of America
Olin Mathieson Chemical Corp., N. Y.
Opelika Welding, Machine & Supply Inc.
Parsons Corp., Special Products Div.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Pry Welding & Mfg., Inc.
REF Mfg. Corp.
Royal Jet, Div.-Royal Industries, Inc.
Temco Aircraft Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Weber Aircraft Corp.

Welded Construction Inc.
Young Development Div., Hercules Powder Co.
Zippertubing Co., The

SHOCK ABSORBER CORD & RINGS

American Latex Products Corp.
Enfab Inc.

SHOCK ABSORBER LANDING GEAR

American Latex Products Corp.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
A. M. Byers Co.
Electrol Inc.
Haskel Engrg. & Supply Co.
Hydra-Power Corp.
Kemp Aero Products
Menasco Mfg. Co.
Ronson Hydraulic Units Corp.
Western Design, Div.-U. S. Industries, Inc.

SHOCK MOUNTS

Acushnet Process Co.
Allied International Corp.
American Felt Co.
American Latex Products Corp.
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Associated Engineers, Inc.
Barry Controls Inc.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bushings, Inc.
Capital City Mfg. Co., Inc.
Convair Instruments, Convair Div.-General Dynamics Corp.
Dow-Elco, Inc.
Enfab Inc.
Farwest Mfg. Div., Inc.
Felters Co., The
General Logistics Div., Aeroquip Corp.
General Tire & Rubber Co., The, Industrial Products Div.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Kent Mfg. Co.
George E. Harris & Co., Inc.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Walter K. Jaros Aircrafters
K. W. Johnson & Co., Inc.
Kemp Aero Products
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lord Mfg. Co.
MB Electronics
Menasco Mfg. Co.
Northrop Corp.
Piasecki Aircraft Corp.
Remler Co.
Robinson Technical Products, Inc.
Rubbercraft Corp. of California
Ray A. Scharer & Co.
Southwest Research Institute
A. T. Stevens Co.
Stewart-Warner Electronics Div.
Taylor Devices, Inc.
United States Rubber Co.
Vibration Isolation Products
Western Design, Div.-U. S. Industries, Inc.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida
Zippertubing Co., The

SHOCK TUBES

Aerotest Laboratories, Inc.
American Instrument Co., Inc.
American Latex Products Corp.
Avco Corp.-Research & Advanced Development Div.
Bendix Aviation Corp.
Bermite Powder Co.
Bethlehem Steel Co.
Convair Instruments, Convair Div.-General Dynamics Corp.
Electric Steel Foundry Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Lockheed Aircraft Corp., Missiles & Space Div.
Lycoming Div., Avco Corp.
Mechanics Research Div., American Machine & Foundry Co.
National Forge Co.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Taylor Devices, Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
Zippertubing Co., The

SHOCK TUNNELS

Aerotest Laboratories, Inc.
American Instrument Co., Inc.
American Latex Products Corp.
Chicago Bridge & Iron Co.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Mechanics Research Div., American Machine & Foundry Co.
Edw. Renneburg & Sons Co.
Westinghouse Electric Corp.
Zippertubing Co., The

SHUNTS, METER

American Machine & Foundry Co., Government Products, N. Y.
Daystrom Inc., Weston Instruments Div.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
Janco Corp.
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co.
National Electronics
New England Scientific Instruments Co.
Ram Meter Inc.
Sangamo Electric Co.
Sensitive Research Instrument Corp.

SHUTTERS, MICROWAVE

Airtron, Div.-Litton Industries
Bogart Mfg. Corp.
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Gilfillan Bros. Inc.
Hammett-Mercury-Rex Div.
Microwave Associates, Inc.
Motorola, Inc.
Omega Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Waveline, Inc.

SIGNALLING DEVICES

Allard Instrument Corp.
***ARNOUX CORP.**
Bell & Gossett Co.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bermite Powder Co.
Bruno-New York Industries Corp.
Chance Vought Aircraft, Inc.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Dryomatic Corp.
Eagle Electric Mfg. Co. Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Devices, Inc.
General Electric Co., Apparatus Sales Div.
General Instrument Corp., Defense & Engrg. Products Group
Hammarlund Mfg. Co., The
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Lear, Inc.
Leetronics, Inc.
***MARTIN CO., THE, DENVER DIV.**
Motorola, Inc.
Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pacific Mercury Electronics
Philco Corp.-Govt. & Industrial Group
Racon Electric Co. Inc.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Tamar Electronics, Inc.
Western Union Telegraph Co., The

SILICATES

Anderson Chemical Co., Div.-Stauffer Chemical Co.
City Chemical Corp.
E. I. Du Pont De Nemours & Co. Inc.
Monsanto Chemical Co.
Philadelphia Quartz Co.
Semi-Elements, Inc.

SILICON

Allegheny Electronic Chemicals Co.
Belmont Smelting & Refining Works, Inc.
Bram Metallurgical Chemical Co.
Continental Rubber Works
Delta Chemical Works, Inc.
Dow Corning Corp.
E. I. Du Pont De Nemours & Co. Inc.
Foote Mineral Co.
Harmon, Lichtenstein & Co.
Hummel Chemical Co., Inc.
Insulation Mfrs. Corp.
Kemet Co., Div.-Union Carbide Corp.
Merck & Co., Inc., Electronic Chemicals Div.
Monsanto Chemical Co.
National Carbon Co., Div.-Union Carbide Corp.
National Metallurgical Corp.
***RADIO CORP. OF AMERICA**
Semi-Elements, Inc.
Semimetals, Inc.
Texas Instruments Inc.
Union Carbide Metals Co., Div.-Union Carbide Corp.
Vanadium Corp. of America
Var-Lac-Oid Chemical Co.
Wai Met Alloys Co.
Zenith Optical Laboratory

SILICONE GREASES

American Grease Stick Co.
George Basch Co., The
Dow Corning Corp.
Ed-Berl Products, Inc.
Edwards High Vacuum Ltd.
Insulation Mfrs. Corp.
National Engrg. Products, Inc.
Silicone Products Dept., General Electric Co., Dept. C.
Silicones Div.-Union Carbide Corp.

SILICONE OILS

George Basch Co., The
Delta Chemical Works, Inc.
Dow Corning Corp.
Ed-Berl Products, Inc.
Edwards High Vacuum Ltd.
Insulation Mfrs. Corp.
Silicone Products Dept., General Electric Co., Dept. C.
Silicones Div.-Union Carbide Corp.

SILICONE RUBBER

Actioncraft Products
Acushnet Process Co.
Aero Gasket Corp.
Armstrong Cork Co.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Auburn Mfg. Co., The
Colonial Rubber Co.
Connecticut Hard Rubber Co., The
Continental Rubber Works
R. E. Darling Co., Inc.
Dow Corning Corp.
Ed-Berl Products, Inc.
Edwards High Vacuum Ltd.
Garlock Packing Co.
General Gasket Inc.
B. F. Goodrich Aviation Products
B. F. Goodrich Sponge Products
Goshen Rubber Co., Inc.
Insulation Mfrs. Corp.
Kirkhill Rubber Co.
Mechanical Rubber Products Co.
Minnesota Rubber Co.
Natvar Corp.
Newth Rubber Co.
Permacel
Raybestos-Manhattan, Inc.
Reeves Bros. Inc., Vulcan Rubber Div.
Rubbercraft Corp. of California
Sierra Engrg. Co.
Silicone Products Dept., General Electric Co., Dept. C.
Silicones Div.-Union Carbide Corp.
Special Products Dept., Melpar, Inc.
Stillman Rubber Co.
Thermoid Div.-H. K. Porter Co., Inc.

SILVER & ALLOYS

Allied Research & Engrg., Div.-Allied Record Mfg. Co.
American Brazing Alloys Corp.
American Silver Co., Inc.
American Smelting & Refining Co.
Attleboro Refining Co., Inc.
Bram Metallurgical Chemical Co.

Deringer Metallurgical Corp.
Eastern Smelting & Refining Corp.
Engelhard Industries, Inc.
Eutectic Welding Alloys Corp.
Gibson Electric Co.
Goldsmith Bros. Div., National Lead Co.
Handy & Harman
Leach & Gardner Co., Indsl. Div.
P. R. Mallory & Co. Inc.
Metz Refining Co.
NUMEC-Nuclear Materials & Equipment Corp.
Secon Metals Corp.
Semi-Elements, Inc.
Var-Lac-Oid Chemical Co.
Western Gold & Platinum Co.

SILVER PASTE

American Brazing Alloys Corp.
Eutectic Welding Alloys Corp.
Furane Plastics, Inc.
Handy & Harman
O. Hommel Co., The
Metz Refining Co.
Micro-Circuits Co.
Sunshine Scientific Instrument
Var-Lac-Oid Chemical Co.

SIMULATORS, FLIGHT

ACF Electronics Div., ACF Industries Inc.
ACF Industries Inc.
Aircraft Armaments, Inc.
Allied International Corp.
Atkins & Merrill, Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bermite Powder Co.
Budd Lewyt Electronics, Inc.
Burton-Rodgers, Inc.
Chance Vought Aircraft, Inc.
Curtiss-Wright Corp., Electronics Div.
Allen B. Du Mont Labs., Inc.
Eastman Kodak Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp.
Feedback Controls, Inc.
General Devices, Inc.
General Electric Co., Light Military Electronics Dept.
Gilfillan Bros. Inc.
Goodyear Aircraft Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hickok Electrical Instrument Co., The
Hughes Tool Co., Aircraft Div.
Ideal-Aerosmith, Div.-Royal Industries, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
McDonnell Aircraft Corp.
Micro Gee Products, Inc.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Motorola, Inc.
Northrop Corp.
Nortronics, Div.-Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Packard Bell Computer Corp.
Pegasus Labs., Inc.
Philco Corp.-Govt. & Industrial Group
Radiation, Inc.
***RADIO CORP. OF AMERICA**
Rucker Co., The
Southwest Research Institute
Space Corp.
Special Products Dept., Melpar, Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.

SIMULATORS, MISSILE

ACF Electronics Div., ACF Industries Inc.
ACF Industries, Inc.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Aeroscience, Inc.
Aircraft Armaments, Inc.
Andersen Labs., Inc.
Atkins & Merrill, Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Aviation Corp., York Div.
Bendix Computer Div.-Bendix Aviation Corp.
Bermite Powder Co.
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
Burton-Rodgers, Inc.
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Curtiss-Wright Corp., Electronics Div.
Eastman Kodak Co.
Emertron, Sub.-Emerson & Radio Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Feedback Controls, Inc.
Flight Support, Inc.
General Devices, inc.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Gilfillan Bros. Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hughes Tool Co., Aircraft Div.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Litton Industries, Maryland Div.
Lycoming Div., Avco Corp.
Madigan Corp.
***MARTIN CO., THE, DENVER DIV.**
McDonnell Aircraft Corp.
Micro Gee Products, Inc.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Northrop Corp.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Otis Elevator Co., Defense & Industrial Div.
Pacific Automation Products, Inc.
Packard Bell Computer Corp.
Packard-Bell Electronics Corp.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
Republic Aviation Corp., Missile Systems Div.
Southwest Research Institute
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
TRG, Inc.
Westinghouse Electric Corp.

SIMULATORS, RADAR

ACF Electronics Div., ACF Industries, Inc
ACF Industries Inc.
Advance Industries, Inc.
Aeronca Mfg. Corp.-Aerospace Div.
Aircraft Armaments, Inc.
Andersen Labs., Inc.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Aviation Corp., York Div.
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
Burton-Rodgers, Inc.
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Curtiss-Wright Corp., Electronics Div.
Daystrom, Inc., Military Electronics Div.
Allen B. DuMont Labs., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Federal Scientific Corp.
General Devices, Inc.
General Instrument Corp., Defense & Engr. Products Group
Gilfillan Bros. Inc.
Goodyear Aircraft Corp.
HRB-Singer, Inc., Sub.-Singer Mfg. Co.
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co.
Hughes Tool Co., Aircraft Div.
ITT Federal Div., International Telephone & Telegraph Corp.
Lab. for Electronics, Inc.
Litton Industries, Maryland Div.
Lockheed Electronics Co., Stavid Div.
MacLeod & Hanopol, Inc.
Madigan Corp.
W. L. Maxson Corp., The
Miller Associates
New London Instrument Co., Inc.
Newton Co., The
Northrop Corp.
Otis Elevator Co., Defense & Industrial Div.
Philco Corp.-Govt. & Industrial Group
Pitometer Log Corp.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Republic Aviation Corp., Missile Systems Div.
Singer Military Products Div.-The Singer Mfg. Co.
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
U. S. Industries, Inc.
Westgate Lab., Inc.
Westinghouse Electric Corp.

SLEEVES, METALLIC

Acme Industrial Co.
Aetna Ball & Roller Bearing Co., Div.-Parkersburg-Aetna Corp.
Alpha Metals, Inc.
American Brake Shoe Co.
American Brass Co., The
American Standard Products, Inc.
***AMERICAN STEEL FOUNDRIES, HAMMOND DIV.**
Ampco Metal, Inc.
B. H. Aircraft Co., Inc.
Best Aircraft Corp.
Bridgeport Brass Co.
California Stamping & Mfg. Co.
Capital City Mfg. Co., Inc.
Central Safety Equip. Co.
Cobra Metal Hose Div. DK Mfg. Co.
Collins Mfg. Corp.
Conrad & Moser
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Division Lead Co.
Walter K. Jaros Aircrafters
Kellett Aircraft Corp.
Lycoming Div., Avco Corp.
National Moldite Co.
Norrich Plastics Corp.
Ohlson Empire Inc.
Richard Philip Co.
J. R. Robbins Co.
Sinclair Mfg. Co.
Superior Industrial Machine Co.
***WEATHERHEAD CO., THE**

SLEEVES, NON-METALLIC

Alite Div., U. S. Stoneware Co.
Allied Plastics Supply Corp.
American Latex Products Corp.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co. Inc.
Bentley, Harris Mfg. Co.
Bonny Mfg. Corp.
Borden Chemical Co.
Capital City Mfg. Co., Inc.
Carborundum Co., The
Chemplast, Inc.
Continental Diamond Fibre Corp.
Continental Rubber Works
Crystal-X Corp.
C. R. Daniels, Inc.
Emerson Plastics Corp.
Franklin Fibre-Lamitex Corp.
Insulation Mfrs. Corp.
Walter K. Jaros Aircrafters
Lamtex Industries, Inc.
M & Q Plastic Products
J. E. Menaugh Co.
***MINNESOTA MINING & MFG. CO.**
Molding Corp. of America
National Beryllia Corp.
National Carbon Co., Div.-Union Carbide Corp.
Natvar Corp.
New England Tape Co., Div.-United-Carr Fastener Corp.
Norrich Plastics Corp.
Polymer Corp., The
Prewitt Aircraft Co.
Reeves Bros. Inc., Vulcan Rubber Div.

J. R. Robbins Co.
Fred T. Roberts & Co.
Milton Ross Metals Co., The
Rubbercraft Corp. of California
St. Marys Carbon Co.
Sanford Plastics Corp.
Sillcocks-Miller Co.
Sinclair Mfg. Co.
Synthane Corp.
Taylor Fibre Co.
Tetrafluor, Inc.
United States Rubber Co.
Varflex Corp.
Westinghouse Electric Corp., Micarta Div.
Wilmington Fibre Specialty Co.
Zippertubing Co., The

SLEEVES, TUBE

All Specs Corp.
Allied Plastics Supply Corp.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
L. J. Barwood Mfg. Co., Inc.
Bentley, Harris Mfg. Co.
Best Aircraft Corp.
Bonny Mfg. Corp.
Borden Chemical Co.
California Stamping & Mfg. Co.
Cobra Metal Hose Div. DK Mfg. Co.
Collins Mfg. Corp.
Commercial Shearing & Stamping Co.
Continental Diamond Fibre Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Crystal-X Corp.
Henry & Miller Industries, Inc.
Insulation Mfrs. Corp.
Walter K. Jaros Aircrafters
M & Q Plastic Products
***MINNESOTA MINING & MFG. CO.**
Minnesota Rubber Co.
New England Tape Co., Div.-United-Carr Fastener Corp.
Norrich Plastics Corp.
Norrich Screw Machine Products
Richard Philip Co.
Polymer Corp., The
Pressed Steel Tank Co.
Prewitt Aircraft Co.
Reeves Bros. Inc., Vulcan Rubber Div.
Milton Ross Metals Co., The
Sillcocks-Miller Co.
Synthane Corp.
Taylor Fibre Co.
Varflex Corp.
***WEATHERHEAD CO., THE**
Wilmington Fibre Specialty Co.
Zippertubing Co., The

SLEEVING

Allied Plastics Supply Corp.
Alpha Wire Corp.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
B. & C. Insulation Products, Inc.
Bentley, Harris Mfg. Co.
Birnbach Radio Co., Inc.
Bonny Mfg. Corp.
Borden Chemical Co.
William Brand, Rex Div.-American Enka Corp.
California Stamping & Mfg. Co.
Chemplast, Inc.
Cobra Metal Hose Div. DK Mfg. Co.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Division Lead Co.
Franklin Fibre-Lamitex Corp.
G-C Electronics Co.
Insulation Mfrs. Corp.
***MINNESOTA MINING & MFG. CO.**
National Electric Coil, Div.-McGraw-Edison Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Owens-Corning Fiberglass Corp.
Raybestos-Manhattan, Inc.
Sillcocks-Miller Co.
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co.
Varflex Corp.
Westline Products Div.-Western Lithograph Co.
Zippertubing Co., The

SLIDES

Amco Engrg. Co.
Ampco Metal, Inc.
Capital City Mfg. Co. Inc.
Chassis-Trak, Inc.
Eastern Rotorcraft Corp.
Grant Pulley & Hardware Corp.
Walter K. Jaros Aircrafters
Corydon M. Johnson Co., Inc.
National Co., Inc.
Remler Co.
Unified Industries, Inc.
Zippertubing Co., The

SLIDES, INDUSTRIAL

Belmar Wheel & Machine Co., Inc.
Capital City Mfg. Co., Inc.
Chassis-Trak, Inc.
Dudwallen Mfg. Co., Inc., The
Grant Pulley & Hardware Corp.
Corydon M. Johnson Co., Inc.
National Co., Inc.
Unified Industries, Inc.

SLIDING LOADS, MICROWAVE

Aircom Inc.
Bogart Mfg. Corp.
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
FXR, Inc.
Hewlett-Packard Co.
Lieco, Inc.
Meridian Metalcraft, Inc.
Microwave Associates, Inc.
Narda Microwave Corp., The
Sage Labs., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Technicraft, Div.-Electronic Specialty Co.
Waveline, Inc.

SLIP RING ASSEMBLIES

Airflyte Electronics Co.
All American Engrg. Co.
Breeze Corporations, Inc.
Collectron Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Electro Tec Corp.
Electro-Miniatures Corp.
Engelhard Industries, Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Graphite Metallizing Corp.
Lear, Inc.
Leece-Neville Co., The
Midwest Molding & Mfg. Co.
J. M. Ney Co., The
Pacific Scientific Co.
Richard Philip Co.
Piasecki Aircraft Corp.
Poly-Scientific Corp.
Milton Ross Metals Co., The
Servonic Instruments, Inc.
Skyline Electric & Mfg. Co.
Slip Ring Co. of America
Southwestern Industrial Electronics Co.
Tetrafluor, Inc.
Texas Instruments Inc.
Toledo Commutator Co.
Topper Mfg. Co., Inc.
U. S. Plastic Molding Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.

SNIPS

Ampco Metal, Inc.
Billings & Spencer Co., The
Hunter Tool Co.
Proto Tool Co.
Snap-On-Tools Corp.
Vlchek Tool Co.

SOLAR CELLS

Delco Radio Div.-General Motors Corp.
B. F. Goodrich Aviation Products
Hammett-Mercury-Rex Div.
Hoffman Electronics Corp., Semiconductor Div.
International Rectifier Corp.
Lear, Inc.
Lockheed Aircraft Corp., Missiles & Space Div.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
Semi-Elements, Inc.
Sundstrand Turbo
Texas Instruments Inc.
Transitron Electronic Corp.

SOLDER

a. Aluminum
b. Indium
c. Lead-Tin
d. Platinum
e. Printed Circuit
f. Rings & Preforms
g. Silver

Accurate Specialties Co. Inc., **a, b, c, e, f, g.**
Alloys Unlimited Inc., **b, c, d, f, g.**
Alpha Metals, Inc., **a thru f.**
Aluminum Co. of America, **a.**
American Brazing Alloys Corp., **a, f, g.**
American Silver Co., Inc., **f, g.**
American Smelting & Refining Co., **c.**
Anchor Metal Co. Inc., **a thru g.**
Art Wire & Stamping Co., **f.**
Barker Sales Co., **a, c, f.**
Belmont Smelting & Refining Works, Inc., **a, b, c, e, f, g.**
Bohn Aluminum & Brass Corp., **a.**
Bow Solder Products Co., Inc., **a, b, c, e, f.**
Chase Brass & Copper Co., Inc., **c, g.**
Chemalloy Electronics Corp., **a.**
Dalweld Co. Inc., **a, e, f, g.**
Division Lead Co., **b, c, e, f.**
M. W. Dunton Co. Inc., The, **c, e, f.**
Dyna-Therm Chemical Corp., **a.**
Engelhard Industries, Inc., **f, g.**
Eutectic Welding Alloys Corp., **a, c, e, f, g.**
Fusion Engrg., **c, f, g.**
General Electric Co., Lamp Metals & Components Dept., **a.**
General Findings & Supply Co., Industrial Div., **f.**
Gibson Electric Co., **f.**
Globe Automatic Sprinkler Div., The Fyr-Fyter Co., **c.**
Goldsmith Bros. Div., National Lead Co., **d, f, g.**
Indium Corp. of America, The, **b, f.**
Johnson Mfg. Co., Inc., **a, c, e, f.**
Kaiser Aluminum & Chemical Sales, Inc., **a.**
Kester Solder Co., **a, b, c, e, f, g.**
Morris P. Kirk & Son, Inc., **c, e, f, g.**
Leach & Garner Co., Indsl. Div., **g.**
London Chemical Co., Inc., **c, e.**
Metz Refining Co., **d.**
Micro Instrument Co., **c.**
Mitronics Inc., **e.**
Multicore Sales Corp., **c, e, f, g.**
National Electric Coil, Div.-McGraw-Edison Co., **c, g.**
Ruby Chemical Co., **c.**
Sherman Indsl. Electronics Co., Div.-Electronic Development Inc., **a.**
Texas Instruments Inc., **d, g.**

SOLDER POTS

Dee Electric Co.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
Johnson Mfg. Co., Inc.
Manhattan Lighting Equipment Co., Inc.
***MARTIN CO., THE, DENVER DIV.**
Temperature Engrg. Corp.
Waage Electric, Inc.
Western Coating Co.

SOLDERING EQUIPMENT, PRINTED CIRCUIT

American Electrical Heater Co.
Bell & Gossett Co.
Dee Electric Co.
Division Lead Co.
Ideal Industries, Inc.
Jefferson Electronic Products
Lepel High Frequency Labs. Inc.
M. M. Newman Corp.
Temperature Engrg. Corp.
Virginia Electronics Co., Inc.
Waage Electric, Inc.
P. Wall Mfg. Co.
Zephyr Mfg. Co., Inc.

SOLDERING EQUIPMENT, ULTRASONIC

Aeroprojects Inc.
Alcar Instruments, Inc.
Circo Equipment Co.
Circo Ultrasonic Corp.
Gulton Industries, Inc.
Lepel High Frequency Labs. Inc.
McKenna Labs.

SOLDERING GUNS

Bow Solder Products Co., Inc.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
Hexacon Electric Co.
Ideal Industries, Inc.
International Electronic Research Corp.
Manhattan Lighting Equipment Co., Inc.
Snap-on-Tools Corp.
P. Wall Mfg. Co.
Weller Electric Corp.
Zephyr Mfg. Co., Inc.

SOLDERING IRON STANDS

American Electrical Heater Co.
Hexacon Electric Co.
Kester Solder Co.
Manhattan Lighting Equipment Co., Inc.
P. Wall Mfg. Co.

SOLDERING IRON TIPS

American Electrical Heater Co.
Caig Labs.
General Electric Co., Apparatus Sales Div.
Hexacon Electric Co.
Manhattan Lighting Equipoment Co., Inc.
M. M. Newman Corp.
Oryx Co.
Ungar Electric Tools, Div.-Eldon Ind.
P. Wall Mfg. Co.
Weller Electric Corp.

SOLDERING IRONS

American Electrical Heater Co.
Bow Solder Products Co., Inc.
Caig Labs.
Chase Brass & Cupper Co., Inc.
Eagle Electric Mfg. Co. Inc.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
Hexacon Electric Co.
C. G. Hussey & Co., Div.-Copper Range Co.
Ideal Industries, Inc.
Johnson Mfg. Co., Inc.
Linde Co., Div.-Union Carbide Corp.
Manhattan Lighting Equipment Co., Inc.
National Specialties Co., Inc.
M. M. Newman Corp.
Oryx Co.
Selas Corp. of America
Snap-on-Tools Corp.
Ungar Electric Tools, Div.-Eldon Ind.
P. Wall Mfg. Co.
Weller Electric Corp.
Zephyr Mfg. Co. Inc.

SOLENOIDS

a. Control
b. Linear
c. Rotary
d. Sub-Miniature

A. P. W. Co., **d.**
Adel Precision Products of Calif., Div.-General Metals Corp., **b.**
Aero Supply Mfg. Inc., **a, b.**
Alco Valve Co., **a.**
Automatic Switch Co., **a, b.**
Caltron Products Co., **a.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Captive Seal Corp., **b.**
Comar Electric Co., **b, d.**
Joe Davidson & Associates, **a, b.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **c.**
Dynamic Controls Corp., **a, b, d.**
Electric Autolite Co., The, **a.**
Electroid Corp., **a, b, d.**
Electro-Mechanical Specialties Co., Inc., **a, c, d.**
Fae Instrument Corp., **a thru d.**
Five Star Co., The, **a, b, d.**
Futurecraft Corp., **a, b, d.**
General Electric Co., Apparatus Sales Div., **a.**
Gordon Enterprises, **b, c.**
B. H. Hadley, Inc., **a, d.**
Hammett-Mercury-Rex Div., **a, b, c.**
George E. Harris & Co., Inc., **a, b.**
Haskel Engrg. & Supply Co., **a.**
A. W. Haydon Co., The, **c.**
Hillburn Electronic Prods. Co., **b, d.**
Hoover Electric Co., **a, b, c.**
Walter J. Hyatt Co., The, **a, b, d.**
Hydra-Power Corp., **b.**
IMC Magnetics Corp., **a thru d.**
Jack & Heintz, Inc., **b.**
James Electronics Inc., **a.**
Janitrol Aircraft Div.-Midland-Ross Corp.
Kemp Aero Products, **a, b.**
Leetronics, Inc., **a, c, d.**
G. H. Leland, Inc., **c.**
G. W. Lisk Co., Inc., **a, b, d.**
Manhattan Lighting Equipment Co., Inc., **a, b.**
Meletron Corp., **a, b.**
Mid-West Coil & Transformer Co., **b.**
Midwestern Instruments, Inc., **a, d.**
Modelectric Products Corp., **a, b, d.**
E. V. Naybor Labs., Inc., **b, c, d.**
PSP Engrg. Co. Div.-IMC Magnetics Corp., N. Y., **a thru d.**
Pegasus Labs., Inc., **a, b.**
Phillips Control Corp., **b.**
Pickering & Co., Inc., **a, b, d.**
Joseph Pollak Corp., **b, d.**
Relay Sales Inc., **a thru d.**
J. R. Robbins Co., **a, b, d.**
Sargent Engrg. Corp., **a, b, c.**
Skyvalve, Inc., **a.**
Trepac Corp. of America
Trombetta Solenoid Corp.
U. E. Electronics Corp., **a, b, d.**
Valcor Engrg. Corp., **a, b, d.**
Vickers Inc., **b.**
West Coast Electrical Mfg. Corp., **b, d.**

SOLID ROCKET FUELS

***AEROJET-GENERAL CORP.**
Allied Chemical Corp., Nitrogen Div.
Amcel Propulsion Inc.
American Latex Products Corp.
American Potash & Chemical Corp., National Northern Div.
Bermite Powder Co.
Bjorksten Research Labs. for Industry, Inc.
Callery Chemical Co.
Food Machinery & Chemical Corp.-Epoxy Dept.
Gabriel Co., Rocket Power-Talco
B. F. Goodrich Aviation Products
B. F. Goodrich Chemical Co.
Grand Central Rocket Co.
Hercules Powder Co., Chemical Propulsion Div.
Hughes Tool Co., Aircraft Div.
Lockheed Aircraft Corp., Missiles & Space Div.
Naugatuck Chemical Div.-U. S. Rubber Co.
Olin Mathieson Chemical Corp., N. Y.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Pennsalt Chemicals Corp.
Propellex Chemical Div., Chromalloy Corp.
Southwest Research Institute
Standard Oil Co. of Indiana
Stauffer Chemical Co.
Topper Mfg. Co., Inc.
United Technology Corp.

SOLVENTS

Allied Chemical Corp., General Chemical Div.
Allied Chemical Corp., National Aniline Div.
American Oil & Supply Co.
Antara Chemicals, Div.-General Aniline & Film Corp.
Aries Laboratories, Inc.
Barco Chemical Products Co.
Circo Equipment Co.
City Chemical Corp.
Cobehn, Inc.
Delta Chemical Works, Inc.
Detrex Chemical Industries, Inc.
Dow Chemical Co., The
E. I. Du Pont De Nemours & Co., Inc.
Eastern Chemical Div., Hooker Chemical Corp.
B. F. Goodrich Industrial Products Co.
Hercules Powder Co., Chemical Propulsion Div.
Kano Labs.
Kester Solder Co.
London Chemical Co., Inc.
Monsanto Chemical Co.
National Ultrasonic Corp.
Naz-Dar Co.
Neville Chemical Co.
Penetone Co., The
Phillips Mfg. Co.
Southwest Research Institute
Topper Mfg. Co., Inc.
Trio Chemical Works, Inc.
U. S. Indsl. Chemicals Co., Div.-Natl. Distillers & Chemical Corp.
Wye Industries

SONAR

ACF Industries Inc.
Advance Industries, Inc.
Allied International Corp.
Bendix Aviation Corp.
Bendix-Pacific Div., Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
CBS Laboratories' Div.-Columbia Broadcasting System
Chance Vought Aircraft, Inc.
Clevite Ordnance, Div.-Clevite Corp.
Cosmic Instruments Inc.
Curtiss-Wright Corp., Santa Barbara Div.
Dalmo Victor Co., Div.-Textron, Inc.
Daven Co., The
***DEL MAR ENGRG. LABS.**
Edo Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp., Defense & Engrg. Products Group
Gulton Industries, Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Huyck Systems Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Lockheed Electronics Co., Stavid Div.
Motorola, Inc.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Sperry Piedmont, Co., Div.-Sperry Rand Corp.
Stromberg-Carlson, Div.-General Dynamics Corp.
Stromberg-Carlson, San Diego, General Dynamics Corp.
Texas Instruments Inc.
U. S. Sonics Corp.
Vickers Inc., Electric Products Div.
Westinghouse Electric Corp.

SOUND SYSTEMS, COMPLETE

Allied International Corp.
Beacon Steel Corp.
Blonder-Tongue Labs., Inc., Special Products Div.
Du Kane Corp.
Electromation Co., Div.-Del Mar Engrg. Labs
Executone, Inc.
Huyck Systems Co.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
***MARTIN CO., THE, DENVER DIV.**
Midwestern Instruments, Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Remler Co.
Rimak, Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Wickes Engrg. & Construction Co.

SPACERS

Aero Bolt & Screw Co., Inc.
Airhardware, Inc.
Alite Div., U. S. Stoneware Co.
All Specs Corp.
American Felt Co.
American Welding & Mfg. Co., The
Apex Tool Co., Inc., The
Auburn Mfg. Co., The
Belmar Wheel & Machine Co., Inc.
Best Aircraft Corp.
Capital City Mfg. Co., Inc.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Delron Co., Inc., The
Eljay Corp.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Gasket Inc.
John Hassall, Inc.
Honti Engrg. & Mfg. Co.
Walter K. Jaros Aircrafters
Kellett Aircraft Corp.
Ladish Co.
***MINNESOTA MINING & MFG. CO.**
Ohlson Empire Inc.
Superior Industrial Machine Co.
Tetrafluor, Inc.
Unified Industries, Inc.
Wilmington Fibre Specialty Co.

SPEAKERS

Atlas Sound Corp.
Collins Radio Co.
Du Kane Corp.
Electromation Co., Div.-Del Mar Engrg. Labs
Electro-Voice, Inc.
General Coil Products Corp.
Jensen Mfg. Co., Div.-The Muter Co.
Parkway Specialties Co.
Permoflux Products Co.
Racon Electric Co., Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Remler Co.
Rimak, Inc.
Stephens Trusonic Inc.
Stromberg-Carlson Div.-General Dynamics Corp.
Technical Materiel Corp., The
Telectro Industries Corp.
Telex, Inc.
University Loudspeakers, Inc.

SPECTROMETERS

American Electronics, Inc.
Applied Research Labs., Inc.
***ASKANIA-WERKE, U. S. BRANCH OFFICE**
Bausch & Lomb Optical Co.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Crosby-Teletronics Corp.
Davidson Optronics, Inc.
***ENGIS EQUIPMENT CO.**
Epic, Inc.
Gardner Laboratory, Inc.
Gordon Enterprises
Jarrell-Ash Co.
Lockheed Aircraft Corp., Missiles & Space Div.
Nuclear Measurements Corp.
Nuclear-Chicago Corp.
Perkin-Elmer Corp.
Process & Instruments
Production Research Corp., Sub.-Radio Condenser Co.
Radiation Instrument Development Lab., Inc.
Southwest Research Institute
TRG, Inc.
Tracelab Inc.
Veeco Vacuum Corp.

SPECTROPHOTOMETERS

American Instrument Co., Inc.
Applied Physics Corp.
Bausch & Lomb Optical Co.
Coleman Instruments, Inc.
***ENGIS EQUIPMENT CO.**
Farwest Mfg. Div., Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General Electric Co., Apparatus Sales Div.
Gordon Enterprises
Instrument Development Labs., Inc.
Jarrell-Ash Co.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Perkin-Elmer Corp.
Process & Instruments
Scientific & Process Instruments Div.-Beckman Instruments, Inc.
Southwest Research Institute
TRG, Inc.
Telechrome Mfg. Corp.

SPECTROSCOPIC EQUIPMENT

Applied Research Labs., Inc.
Bausch & Lomb Optical Co.
***ENGIS EQUIPMENT CO.**
Intercontinental Electronics Corp.
Jarrell-Ash Co.
Philips Electronic Instruments
Southwest Research Institute
TRG, Inc.

SPINNINGS, METAL

Aerocal Div., Aeronca Mfg. Corp.
Aluminum Co. of America
American Aluminum Co.
Ampco Metal, Inc.
Anchor Metal Spinning Co., The
Associated Co., Inc.
Associated Engrg. & Mfg. Corp.
Benson Mfg. Co.
Brighton Corp.
Brooks & Perkins, Inc.
Calcor Corp.
California Stamping & Mfg. Co.
Chance Vought Aircraft, Inc.
Cincinnati Milling Machine Co., The
Commercial Shearing & Stamping Co.
Henry & Miller Industries, Inc.
Hughes Tool Co., Aircraft Div.
Walter K. Jaros Aircrafters
Kanarr Corp.
Kelsey-Hayes Co.
Kling Metal Spinning & Stamping Co.
Le Fiell Mfg. Co.
Lodge & Shipley Co., The
Lycoming Div., Avco Corp.
McGregor Mfg. Corp.
Miami Engrg., Div.-Miami Shipbuilding Corp.
Northrop Corp.
Piasecki Aircraft Corp.
Rimak, Inc.
Joseph T. Ryerson & Son, Inc.
Spincraft, Inc.
Superior Spinning & Stamping Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Roland Teiner Co., Inc.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
C. W. Torngren Co., Inc.
Unified Industries, Inc.
United States Chemical Milling Corp.
Westholt Mfg. Inc.
Woolf Aircraft Products, Inc.

SPLICING EQUIPMENT

***MINNESOTA MINING & MFG. CO.**
Neumade Products Corp.
Robins Industries Corp.

SPRING CONTACT METAL STOCK

Ace Spring Mfg. Co., Inc.
American Silver Co., Inc.
Associated Spring Corp., Ohio Div.
General Findings & Supply Co., Industrial Div.
Lapham Hickey Steel Corp.
Leach & Garner Co., Indsl. Div.
J. E. Menaugh Co.

SPRINGS

a. Antenna Tension
b. Grounding Antenna
c. Hardware
d. Instrument Hairsprings
e. Knob
f. Precision

Ace Spring Mfg. Co., Inc., **a, b, c, e, f.**
Associated Spring Corp., Ohio Div., **a thru f.**
Wallace Barnes Div., Associated Spring Corp., **a thru f.**
Birnbach Radio Co., Inc., **a.**
John Chatillon & Sons, **f.**
Chemical Micro Milling Co., **f.**
Consolidated Controls Corp., **f.**
Dorau-Calza Hairspring Co., Inc., **d.**
Foursome Mfg. Co., Inc., **c, e, f.**
Gerbet Hairspring Co., **d.**
Hamilton Watch Co.-Industrial Div., **d, f.**
George E. Harris & Co., Inc., **f.**
Hunter Spring Co., Div.-American Machine & Metals, Inc., **a, d, f.**
Ingraham Co., The, **d.**
Leetronics, Inc., **f.**
J. E. Menaugh Co., **f.**
Mid-West Spring Mfg. Co., **a, b, c, e, f.**
***MINNESOTA MINING & MFG. CO.**
New England Spring Mfg. Co., Inc., **a, b, c, e, f.**
Reliable Spring & Wire Forms Co., **a, f.**
Sandvik Steel, Inc., **d, f.**
Stanley-Judd Div.-The Stanley Works, **c.**
Herman D. Steel Co., **d.**
Taylor Devices, Inc., **f.**
Tinnerman Products, Inc., **e.**
Tube-Turns Div., Chemetron Corp., **c.**
United Mfg. Co., The
United States Steel Corp.
Western Control Corp., **c, e, f.**
Wind Turbine Co.

SQUIBS

***AEROJET-GENERAL CORP.**
Aerojet-General Corp., Downey Plant
Amcel Propulsion Inc.
American Potash & Chemical Corp., National Northern Div.
Beckman & Whitley, Inc., Missile Products Div.
Bermite Powder Co.
Joe Davidson & Associates
***DEL MAR ENGRG. LABS.**
E. I. Du Pont De Nemours & Co., Inc.
Gabriel Co., Rocket Power-Talco
Hercules Powder Co., Chemical Propulsion Div.
Hi-Shear Rivet Tool Co.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Librascope Div., General Precision, Inc.
Lithium Corp. of America Inc., the Fulton-Irgon Div.
McCormick Selph Associates
Olin Mathieson Chemical Corp., N. Y.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.

STABILIZERS

Aerocal Div., Aeronca Mfg. Corp.
Bendix Aviation Corp.
Bendix Corp., The, Eclipse-Pioneer Div.
Colonial Aircraft Corp.
Djeco, Div.-Djordjevic Engrg. Co.
Doak Aircraft Co., Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Monrovia Aviation Corp.
Northrop Corp.
REF Mfg. Corp.
Southwest Research Institute
Sperry Piedmont Co., Div.-Sperry Rand Corp.
Temco Aircraft Corp.
Weber Aircraft Corp.

STACKS

California Stamping & Mfg. Co.
Djeco, Div.-Djordjevic Engrg. Co.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Heil Process Equipment Corp.
Kirk & Blum Mfg. Co., The
Nooter Corp.
Opelika Welding, Machine & Supply Inc.
Penn-Michigan Mfg. Corp.
Woolf Aircraft Products, Inc.

STAMPED PARTS, TUBE

Alloy Products Corp.
American Aluminum Co.
American Brass Co., The
Art Wire & Stamping Co.
B. H. Aircraft Co., Inc.
Babco Mfg. Inc.
Belmar Wheel & Machine Co., Inc.
Bergen Carbide Co.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Detroit Stamping Co.
Doak Aircraft Co., Inc.
Electronic Parts Mfg. Co., Inc.
Forsberg Mfg., Co., The
Foursome Mfg. Co., Inc.
Gemex Corp., The, Indsl. Div.
General Electric Co., Lamp Metals & Components Dept.
HPL Mfg. Co.
Heldor Mfg. Co., Inc.
Kerns Mfg. Corp.
King Labs., Inc.
Kling Metal Spinning & Stamping Co.
E. Konigslow Stamping & Tool Co.
Laminated Shim Co., Inc.
New England Spring Mfg. Co., Inc.
Norrich Plastics Corp.
Richard Philip Co.
Rimak, Inc.
Stamping Div.-Rockwell Standard Corp.
Superior Spinning & Stamping Co.
Unified Industries, Inc.
Waco Aircraft Co.
Whitehead Stamping Co.
Winder Aircraft Corp. of Florida
Woolf Aircraft Products, Inc.
Worcester Pressed Steel Co.
Zierick Mfg. Corp.

STAMPS

Acromark Co., The
Adept Industries Inc.
John Griffin Co.
Jas. H. Matthews & Co.
Noble & Westbrook Mfg. Co., The

Parker-Hartford Corp., The
Sillcocks-Miller Co.

STANDARDS

a. Capacitance
b. Equipment, Calibration
c. Frequency
d. Inductance
e. Laboratory Time
f. Phase
g. Resistance
h. Temperature
i. Time
j. Voltage

Acton Laboratories Inc., **f.**
Aeroscience, Inc., **b.**
Arkay Engrg., Inc., **c.**
Avien, Inc., **j.**
Barnes Development Co., **g.**
Bendix Aviation Corp., **b.**
A. Biederman, Inc., **b, e.**
Boonton Electronics Corp., **a.**
Arthur E. Booth Co., **b.**
Borg Equipment Div., Amphenol-Borg Electronics Corp., **c, e, i.**
Bulova Research & Development Labs., Inc., **b, i.**
Burton-Rodgers, Inc., **c.**
Calvert Electronics Inc., **a, d, g, j.**
Consolidated Controls Corp., **j.**
Cornell-Dubilier Electric Corp., **a.**
Daven Co., The, **g. i.**
Davenport Mfg. Co., **b, j.**
Daystrom Inc., Weston Instruments Div., **b, j.**
Decker Corp., The, **a, b, c, f thru j.**
Djeco, Div.-Djordjevic Engrg. Co., **j.**
Dmeter Mfg. Co., **g.**
Electro Scientific Industries, **a, b, g.**
Electronic Applications, Inc., **a thru d, g.**
Electronic Engrg. Co. of California, **e, i.**
Electronic Measurements Co., Inc., **j.**
Epic, Inc., **a, g.**
Farwest Mfg. Div., Inc., **f.**
General Communication Co., **b, c, j.**
General Radio Co., **a, c, d, g.**
Gray Instrument Co., **b, g.**
Gyrex Corp., The, **c, e, i.**
Hathaway Instruments, Inc., **c.**
Hewlett-Packard Co., **b, c, e, i, j.**
I-L-S Instrument Div., The Meriam Instrument Co., **c, i.**
ITT Federal Div., International Telephone & Telegraph Corp., **e.**
Industrial Test Equipment Co., **c, f.**
Infrared Industries, Inc., **b, h.**
International Electronic Research Corp., **c.**
Wayne Kerr Corp., **a.**
Kin Tel Div.-Cohu Electronics, Inc., **j.**
James Knights Co., The, **c, e.**
Lavoie Labs., Inc., **c.**
Leeds & Northrup Co., **a, d, g, h, j.**
***WALLACE O. LEONARD, INC., b.**
Liquidometer Corp., The, **a.**
MacLeod & Hanopol, Inc., **a.**
Manson Labs., Inc., **c.**
Marconi Instruments, **c.**
***MARTIN CO., THE, DENVER DIV., j.**
Mitchell Camera Corp., **b.**
Muirhead Instruments Inc., **a, c, j.**
George L. Nankervis Co., **b.**
National Co., Inc., **c.**
New England Scientific Instruments Co., **a, d, g.**
New London Instrument Co., Inc., **c.**
Nilsson Electrical Lab., Inc., **b.**
Ernest Norrman Laboratories, **c, i.**
Northeastern Engrg. Inc., **c.**
Northern Engrg. Laboratories, Inc., **c.**
Nuclear-Chicago Corp.
Philamon Labs. Inc., **c.**
Radiation, Inc., **j.**
***RADIO CORP. OF AMERICA**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **e.**
Recony Div.-Vinco Corp., **b.**
Riverbank Labs., Dept.-Engrg., **c.**
Sensitive Research Instrument Corp., **b, j.**
Shallcross Mfg. Co., **g.**
E. C. Smith Mfg. Co., Inc., **h.**
H. W. Sullivan Ltd., **a, d, g.**
Sunshine Scientific Instrument, **b, j.**
TRG, Inc., **c.**
Technical Materiel Corp., The, **c.**
Technology Instrument Corp., **f.**
Telechrome Mfg. Corp., **b, c, i.**
Theta Instrument Corp., **f.**
Trans-Sonics, Inc., **h.**
United States Radium Corp., **b.**
Universal Mfg. Co., Inc., **d.**
Varo Mfg. Co., Inc., **c, f, i, j.**
Viking Industries Inc., **j.**
Waltham Electronics Corp., **c.**

STANDS, MICROPHONE

Atlas Sound Corp.
Belmar Wheel & Machine Co., Inc.
Electromation Co., Div.-Del Mar Engrg. Labs.
Electronic Applications, Inc.
Electro-Voice, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
G-C Electronics Co.
P. B. R. Mfg. Co.
Radio Corp. of America, Defense Electronics Products
Sonotone Corp.

STANDS, TEST

Accessory Controls & Equipment Corp.
Advanced Electronics, Inc.
***AEROJET-GENERAL CORP.**
Aeroscience, Inc.
Aero-Test Equipment Co., Inc.
Aerotest Laboratories, Inc.
Air Logistics Corp.
Allegany Instrument Co., Inc.
Allison Steel Mfg. Co.
American Instrument Co., Inc.
American Research & Mfg. Corp.
Anchor Metal Spinning Co., The
Anchor Specialty Mfg. Co., Inc.
Arnolt Corp.
***ASSOCIATED TESTING LABS., INC.**
Atlas Industrial Corp.
Auto-Control Labs. Inc.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs.
Basic Tool Industries, Inc.
Beacon Steel Corp.
Beaver-Advance Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
A. Biederman, Inc.
E. W. Bliss Co.
Bogue Electric Mfg. Co.
Byrtex Corp.
Cardell Mfrs.
Chicago Bridge & Iron Co.
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cornelius Co., The, Aero Div.
Doak Aircraft Co., Inc.
Dudwallen Mfg. Co., Inc., The
Eastman Kodak Co.
Elzee Metal Products Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Emhart Mfg. Co., Maxim Div.
***ENGIS EQUIPMENT CO.**
Farwell Metal Fabricating
Flight Refueling, Inc.
Flight Support, Inc.
General Electric Co., Apparatus Sales Div.
Gremco, Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard
Haskel Engrg. & Supply Co.
Highland Engrg. Co.
Hughes Tool Co., Aircraft Div.
I-L-S Instrument Div., The Meriam Instrument Co.
Ideal-Aerosmith, Div.-Royal Industries, Inc.
Indiana Gear Works, Inc.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
Jamison Cold Storage Door Co.
Kahn & Co., Inc.
Kellett Aircraft Corp.
Kirk & Blum Mfg. Co., The
Machine Products Div., New Haven Trap Rock Co.
Metal Fabricators Corp.
Miami Engrg., Div.-Miami Shipbuilding Corp.
George L. Nankervis Co.
Northeast Metals Industries, Inc.
Northrop Corp.
Opad Electric Co.
Opelika Welding, Machine & Supply Inc.
P. B. R. Mfg. Co.
Philco Corp.-Govt. & Industrial Group
Richard Philip Co.
Philips & Davies Inc.
Propulsion Test Facilities Div.-MB Electronics
REF Mfg. Corp.
Recony Div.-Vinco Corp.
Regent Jack Mfg. Co., Inc.
Rucker Co., The
Sancor Corp.
Schaffer Air Industries, Inc.
Skydyne, Inc.
Skyline Electric & Mfg. Co.
Space Corp.
Stearns-Roger Mfg. Co., The
Sun Electric Corp., Aeronautical Div.
Temco Aircraft Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Twix Mfg. Co., Inc.
United Aircraft Products, Inc.
United Mfg. Co., Div., The W. L. Maxson Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Vinco Corp.
Waco Aircraft Co.
Weber Aircraft Corp.
Welded Construction Inc.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida

STANDS, WAVEGUIDE

Aircom Inc.
Airtron, Div.-Litton Industries
Demornay-Bonardi
Electronic Applications, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
FXR, Inc.
Hammett-Mercury-Rex Div.
Hewlett-Packard Co.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Narda Microwave Corp., The
Omega Labs., Inc.
P. B. R. Mfg. Co.
Polytechnic Research & Development Co., Inc.
Victor R. F. & Microwave Co.
Waveline, Inc.

STARTERS

Accessory Controls & Equipment Corp.
Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allied International Corp.
Bendix Utica Div., Bendix Aviation Corp.
Bogue Electric Mfg. Co.
Breeze Corporations, Inc.
Clark Controller Co., The
Consolidated Diesel Electric Corp.
Detroit Diesel Engine Div.-General Motors Corp.
Electric Autolite Co., The
Gabriel Co., Rocket Power-Talco
General Electric Co., Apparatus Sales Div.
Hamilton Standard, Div.-United Aircraft Corp.
Hammett-Mercury-Rex Div.
Lear, Inc.
Leece-Neville Co., The
Sundstrand Turbo
Talley Corp., The
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Westinghouse Electric Corp.
Wolverine Diesel Power Co.

STARTERS, GAS TURBINE ENGINE

Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Arde-Portland, Inc.
Auto-Control Labs. Inc.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Breeze Corporations, Inc.
Consolidated Diesel Electric Corp.
Gabriel Co., Rocket Power-Talco
General Electric Co., Apparatus Sales Div.
Hamilton Standard, Div.-United Aircraft Corp.
Hercules Powder Co., Chemical Propulsion Div.
Jack & Heintz, Inc.

Lear, Inc.
Solar Aircraft Co.
Southwestern Industrial Electronics Co.
Sundstrand Turbo
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Wickfield, Inc.
Wolverine Diesel Power Co.

STARTERS, PNEUMATIC

Accessory Controls & Equipment Corp.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Arnolt Corp.
Auto-Control Labs. Inc.
Bendix Utica Div., Bendix Aviation Corp.
Consolidated Diesel Electric Corp.
Gardner-Denver Co.
Hamilton Standard, Div.-United Aircraft Corp.
Kahn & Co., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear, Inc.
M-D Blowers, Inc.
Pre-Flite Industries Corp.-Sub.-Avco Mfg. Corp.
Solar Aircraft Co.
Sundstrand Turbo
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Wickfield, Inc.

STARTERS, ROCKET ENGINE

***AEROJET-GENERAL CORP.**
Arde-Portland, Inc.
Bendix Utica Div., Bendix Aviation Corp.
Bermite Powder Co.
***DEL MAR ENGRG. LABS.**
Gabriel Co., Rocket Power-Talco
Grand Central Rocket Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hercules Powder Co., Chemical Propulsion Div.
Lithium Corp. of Amerca Inc., The
Fulton-Irgon Div.
McCormick Selph Associates
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Propellex Chemical Div., Chromalloy Corp.
Rocketdyne Div.-North American Aviation, Inc.
Western Gear Corp.-Precision Products Div.

STARTING SYSTEMS & CONTROLS

***AEROJET-GENERAL CORP.**
Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allis-Chalmers
Arrow-Hart & Hegeman Electric Co., The
Auto-Control Labs. Inc.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Clark Controller Co., The
Consolidated Diesel Electric Corp.
Cornelius Co., The, Aero Div.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard, Div.-United Aircraft Corp.
Hoover Electronics Co.
Jack & Heintz, Inc.
Kahn & Co., Inc.
Leach Corp.
Lear, Inc.
Micro Gee Products, Inc.
Northrop Corp.
On Mark Couplings, Inc.
Rimak, Inc.
Southwestern Industrial Electronics Co.
Sundstrand Turbo
Vickers Inc., Div.-Sperry Rand
Vickers, Inc., Mich.
Wells Industries Corp.
Western Gear Corp.-Precision Products Div.
Wolverine Diesel Power Co.

STATIC ELIMINATORS

CGS Labs., Inc.
Hoover Electronics Co.
Isotopes Specialties Co., Div.-Nuclear Corp. of America
Lear, Inc.
Merix Chemical Co.
Micro-Circuits Co.
Statikil, Inc.
Herman H. Sticht Co., Inc.
Telkor, Inc.
United States Radium Corp.
Vibration Isolation Products

STATORS, MOTOR & GENERATOR

A. Biederman, Inc.
Bogue Electric Mfg. Co.
Chase Electronics Motor Div., Inc.
Eicor Div.-Scranton
General Electric Co., Apparatus Sales Div.
Genisco, Inc.
Hammett-Mercury-Rex Div.
George E. Harris & Co., Inc.
Hol-Gar Mfg. Corp.
IMC Magnetics Corp.
Jack & Heintz, Inc.
Leach Corp.
Leece-Neville Co., The
Leland Airborne Products, Div.-American Machine & Foundry Co.
Lincoln Electric Co., The
Marquardt Corp., The
Minneapolis-Honeywell Regulator Co. Boston Div.
Precision, Inc.
Radio Development & Research Corp.
Telley Corp., The
Westinghouse Electric Corp.

STEEL, ELECTRIC

Armco Steel Corp.
Bethlehem Steel Co.
Carpenter Steel Co., The
Crucible Steel Co. of America
Jessop Steel Co.
Jones & Laughlin Steel Corp., Stainless Strip Div.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Lapham Hickey Steel Corp.
Midvale-Heppenstall Co.
Republic Steel Corp.
Joseph T. Ryerson & Son, Inc.
Sharon Steel Corp.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
U. S. Steel Supply Div., United States Steel Corp.
United States Steel Corp.
Vanadium-Alloys Steel Co.
Wai Met Alloys Co.
Westinghouse Electric Corp.
Wyman-Gordon Co.

STEEL, METAL COATED

Armco Steel Corp.
Bethlehem Steel Co.
Chromium Corp. of America
Colorado Fuel & Iron Corp., The
General American Transportation Corp.
Jones & Laughlin Steel Corp., Stainless & Strip Div.
Earle M. Jorgensen Co.
Lukens Steel Co.
Pfaudler Div., Pfaudler Permutit Inc.
Republic Steel Corp.
Sharon Steel Corp.
Arthur Tickle Engrg. Works, Inc.
U. S. Steel Supply Div. United States Steel Corp.
United States Steel Corp.

STEEL, STAINLESS

Armco Steel Corp.
Avco Corp., Nashville Div.
Bethlehem Steel Co.
Bond Metal Surplus Co.
A. M. Byers Co.
G. O. Carlson, Inc.
Carpenter Steel Co., The
Chase Brass & Copper Co., Inc.
Colorado Fuel & Iron Corp., The
Crucible Steel Co. of America
Custom Tool & Mfg. Co.
Damascus Tube Co.
Driver-Harris Co.
Dudwallen Mfg. Co., Inc., The
Eastern Stainless Steel Corp.
General Alloys Co.
Hamilton Watch Co.-Industrial Div.
Harvey Aluminum
Hughes Tool Co., Aircraft Div.
Jessop Steel Co.
Jones & Laughlin Steel Corp., Stainless & Strip Div.
Earle M. Jorgensen Co.
Kolcast Industries-Div. Thompson Ramo Wooldridge Inc.
Charles E. Larson & Sons, Inc.
Mc Louth Steel Corp.
Midvale-Heppenstall Co.
National Tube Div.,-United State Steel Corp.
Opelika Welding, Machine & Supply Inc.
Perfecto Cast
Pioneer Aluminum Inc.
Republic Steel Corp.
Rodney Metals Inc.
Joseph T. Ryerson & Son Inc.
Sandvik Steel, Inc.
Seymour Mfg. Co., The
Sharon Steel Corp.
South River Metal Products Co., Inc.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Superior Steel Div., Copperweld Steel Co.
Timken Roller Bearing Co., The
U. S. Pipe & Foundry Co., Steel & Tubes Div.
U. S. Steel Supply Div., United States Steel Corp.
United States Steel Corp.
Universal-Cyclops Steel Corp.
Vanadium-Alloys Steel Co.
Var-Lac-Oid Chemical Co.
Wai Met Alloys Co.
Wallingford Steel Co.
Washington Steel Corp.
Wyman-Gordon Co.

STILLS & DEMINERALIZERS

Accessory Controls & Equipment Corp.
Barnstead Still & Sterlizer Co.
Chance Vought Aircraft, Inc.
Detrex Chemical Industries, Inc.
General American Transportation Corp.
Nooter Corp.
Opelika Welding, Machine & Supply Inc.
F. J. Stokes Corp.

STIMULATORS

American Electronic Labs., Inc.
Bendix Aviation Corp.
Electro-Medical Lab., Inc.
Rucker Co. The

STOOLS & BENCHES

Brooks & Perkins, Inc.
Eureka Williams Corp.
Lyon Metal Products, Inc.
Joseph T. Ryerson & Son, Inc.
Standard Pressed Steel Co.
Young & Rioux Woodworking Co., Inc.

STORAGE CONTAINERS

ACF Industries Inc.
Aerocal Div., Aeronca Mfg. Corp.
American Car & Foundry Div., ACF Industries, Inc.
American Rocket Co.
Ampco Metal, Inc.
Benson Mfg. Co.
Brooks & Perkins, Inc.
Buffalo Metal Container Corp.
Butler Mfg. Co.
California Stamping & Mfg. Co.
Cutler Metal Products Co.
C. R. Daniels, Inc.
Dempster Brothers, Inc.
Dolin Metal Products, Inc.
Dudwallen Mfg. Co., Inc. The
Farwell Metal Fabricating
Gatewood Products, Inc.
General American Transportation Corp.
Goldsman
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Hahn & Clay
Halliburton, Inc., Mfg. Div.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.

Hofman Labs., Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Kirk & Blum Mfg. Co., The
Lofstrand Co., The
Lukens Steel Co.
Lunn Laminates, Inc.
Lyon Metal Products Inc.
MEG Products, Div.-Mandrel Industries, Inc.
Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Parsons Corp., Special Products Div.
Pfaudler Div., Pfaudler Permutit Inc.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Pry Welding & Mfg., Inc.
Republic Steel Corp.
Rimak, Inc.
Skydyne, Inc.
A. O. Smith Corp., Smith-Erie Div.
Stackbin Corp.
Standard Steel Corp., Cambridge Div.
Weber Aircraft Corp.
Welded Construction Inc.

STORAGE UNITS

ACF Industries, Inc.
American Latex Products Corp.
American Rocket Co.
Brooks & Perkins, Inc.
Cutler Metal Products Co.
Dolin Metal Products, Inc.
Dudwallen Mfg. Co. Inc., The
Farwell Metal Fabricating
Gatewood Products, Inc.
General American Transportation Corp.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Image Instruments, Inc.
Lyon Metal Products, Inc.
Pfaudler Div., Pfaudler Permutit Inc.
Republic Steel Corp.
Rimak, Inc.
Joseph T. Ryerson & Son, Inc.
Standard Pressed Steel Co.
Standard Steel Corp., Cambridge Div.
Struthers Wells Corp.
Young & Rioux Woodworking Co., Inc.

STRAIN RELIEFS

American Latex Products Corp.
Birnbach Radio Co., Inc.
Heyman Mfg. Co.
Holub Industries, Inc.
MEG Products, Div.-Mandrel Industries Inc.
Malco Mfg. Co.
Milton Ross Metals Co. The
Rubbercraft Corp. of California

STRAINERS

Accessory Products Co., Div.-Textron Inc.
Aero Supply Mfg., Inc.
Agricultural Aviation Engineering Co., Inc.
Air-Maze Corp.
Bethlehem Steel Co.
Bowser Inc., Defense Div.
A. W. Cash Valve Mfg. Corp.
Chemical Micro Milling Co.
Du-Co Ceramics Co.
Eddington Metal Specialty Co.
Garwin, Inc.
General Controls Co.
Harman Equipment Co.
Kieley & Mueller, Inc.
Ladish Co.
Leslie Co.
Marsh Instrument Co., Div.-Colorado Oil & Gas Corp.
Newark Wire Cloth Co.
OPW-Jordan
Pequot Wire Cloth Co.
Protectoseal Co., The
Republic Mfg. Co.
J. R. Robbins Co.
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Schutte & Koerting Co.
Spraying Systems Co.
Zurn Industries, Inc.

STRIPS, GROUNDING

Accurate Electronics Corp.
Blaco Mfg. Co.
Metal Textile Corp. Div.-General Cable Corp.

STRIPS, MOUNTING

American Latex Products Corp.
Erie Resistor Corp.
Federal Screw Products Inc.
B. F. Goodrich Industrial Products Co.
Luzerne Rubber Co.
Sangamo Electric Co.
Unified Industries, Inc.

STROBOSCOPE, SYNCHRONIZER

Chadwick-Helmuth Co.
Edgerton, Germeshausen & Grier, Inc.
Hammett-Mercury-Rex Div.
Winkler Labs.

STROBOSCOPES

American Speedlight Corp.
Chadwick-Helmuth Co.
Davenport Mfg. Co.
Joe Davidson & Associates
Edgerton, Germeshausen & Grier, Inc.
Electronic Brazing Co.
Epic, Inc.
General Radio Co.
Hammett-Mercury-Rex Div.
I-L-S Instrument Div., The Meriam Instrument Co.
Kingston Electronics-Div.-Kingston Industries Inc.
Loral Electronics Corp.
Herman H. Sticht Co., Inc.
Sun Electric Corp., Aeronautical Div.

STRONTIUM

Bram Metallurgical Chemical Co.
Delta Chemical Works, Inc.
King Labs., Inc.
***RADIO CORP. OF AMERICA**
Tracerlab Inc.
Var-Lac-Oid Chemical Co.

SUBMINIATURIZATION SERVICES

ACF Electronics Div., ACF Industries Inc.
American Machine & Foundry Co., Government Products, N. Y.
***ARNOUX CORP.**
Beckman & Whitley, Inc., Missile Products Div.
Bendix Aviation Corp., Cincinnati Div.
Budd Lewyt Electronics, Inc.
Bulova Research & Development Labs., Inc.
Cleveland Metal Specialties Co., Electronics Div.
Delco Radio Div.-General Motors Corp.
Designers for Industry, Inc.
Du Kane Corp.
Allen B. Du Mont Labs., Inc.
Electromation Co., Div.-Del Mar Engrg. Labs
Erie Resistor Corp.
Ford Instrument Co., Div.-Sperry Rand Corp.
Guidance Controls Corp.
High Vacuum Equipment Corp., Sub-Robinson Tech. Products, Inc.
Hoover Electronics Co.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co., Inc.
Lear, Inc.
Livingston Electronic Corp.
Madigan Corp.
Maico Electronics, Inc.
Mira Corp., The
Molded Insulation Co.
Motorola, Inc.
National Co., Inc.
National Scientific Labs., Inc.
Northrop Corp.
Nugent Electronics Co., Inc.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
***RAYTHEON CO., INDUSTRIAL COMPONENTS DIV.**
Recony Div.,-Vinco Corp.
Reed Instrument Co.
Reed Research Inc.
Rimak, Inc.
Sonotone Corp.
Southwest Research Institute
Southwestern Industrial Electronics Co.
Telechrome Mfg. Corp.
Texas Instruments Inc.
Walkirt Co.

SUPERSONIC EQUIPMENT

***DEL MAR ENGRG. LABS.**
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Maico Electronics, Inc.
Philco Corp.-Govt. & Industrial Group
Vickers, Inc., Mich.

SUPPORTS, TUBE

American Latex Products Corp.
Art Wire & Stamping Co.
Electronic Parts Mfg. Co., Inc.
Lamtex Industries Inc.
National Tube Div.,-United States Steel Corp.
Northrop Corp.
Stamping Div.,-Rockwell Standard Corp.
U. S. Pipe & Foundry Co., Steel & Tubes Div.

SUPPRESSORS, NOISE

Air Logistics Corp.
Axel Electronics-Div.-Axel Bros. Inc.
A. M. Byers Co.
David Clark Co., Inc.
Continental-Wirt Electronics Corp.
Dudwallen Mfg. Co., Inc., The
Emhart Mfg. Co., Maxim Div.
Erie Resistor Corp.
Hallett Mfg. Co.
Janke & Co. Inc.
Koppers Co., Inc., Metal Products Div.
Lear, Inc.
M. V. Palmer, Inc.
Telkor, Inc.

SWITCH, GUARDS

Birnbach Radio Co., Inc.
Grimes Mfg. Co.
Hartwell Aviation Supply Co.
Lear, Inc.

SWITCH INERTIA

Beckman & Whitley, Inc., Missile Products Div.
Control Data Corp.
Joe Davidson & Associates
Eureka Williams Corp.
Genisco, Inc.
Gilfillan Bros. Inc.
Haydon Switch, Inc.
Integrated Dynamics Div., Globe Industries, Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lear, Inc.
Northrop Corp.
Patterson Moos Research, Div.-Leesona Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.

SWITCHES

a. Acceleration
b. Air Ram
c. Alarm
d. Aneroid
e. Automatic
f. Automatic Transfer
g. Circuit Breaker
h. Coaxial
i. Commutation, for Telemetering
j. Contact
k. Control
l. Crossbar
m. Decade
n. Duplex
o. Electronic
p. Float
q. Foot
r. Hermetically Sealed
s. Hydraulic
t. Ignition
u. Impact
v. Indicating
w. Jack
x. Key
y. Knife
z. Limit
a-1. Liquid Oxygen Control
b-1. Mach Limit
c-1. Mechanical Control
d-1. Mercury
e-1. Microphone
f-1. Microwave
g-1. Miniature
h-1. Oil Immersed
i-1. Plunger
j-1. Pressure
k-1. Printed Circuit
l-1. Pulse
m-1. Pushbutton
n-1. Radio
o-1. Remote Control
p-1. Reset
q-1. Rotary
r-1. Rotary Chopper
s-1. Rotary Sampling
t-1. Rotary Selector
u-1. Safety
v-1. Slide
w-1. Snap Action
x-1. Specialty
y-1. Step Type
z-1. Subminiature
a-2. Tap
b-2. Telemetering
c-2. Temperature Control
d-2. Thermal

e-2. Timing
f-2. Toggle
g-2. Transformer
h-2. Transistor
i-2. Vacuum
j-2. Wavechange Receiver
k-2. Wavechange Transmitter
l-2. Waveguide
m-2. Waveguide Microwave

*AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, a, j-1.
ACF Industries Inc., p, s, g-1, h-1, j-1, z-1, i-2.
ASCOP Div., Electro-Mechanical Research, Inc., i, s-1, b-2.
Acro Div., Robertshaw-Fulton Controls, e, j, k, v, z, g-1, j-1, m-1, p-1, u-1, w-1, z-1, f-2.
Actuation Research Corp., a, c, d, h, o, f-1, l-2, m-2.
Aero Instrument Co., b, d, s, a-1, j-1, i-2.
Aero Supply Mfg. Inc., p, r, j-1.
*AEROJET-GENERAL CORP., j-1.
Aerolux Light Corp., i-2.
Aeronautical Machinists Inc., i-1, j-1.
Aerotec Industries Inc., Aircraft Equipment Div., a thru d, p, r, s, u, v, a-1, b-1, g-1 thru j-1, i-2.
Ainslie Corp., l-2, m-2.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., a-1.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., j-1, c-2.
Airflyte Electronics Co., i, k-1, l-1, q-1 thru t-1, b-2, e-2.
Airpax Electronics Inc., Cambridge Div., g, h.
Airpax Electronics Inc. Seminole Div., g, h.
Airtron, Div.-Litton Industries, g-1, l-2, m-2.
Alden Products Co., v.
All Specs Corp., f-2.
Allard Instrument Corp., g, v.
Allen Electric & Equipment Co., w-1, x-1, a-2.
Allied Control Co., Inc., m-1, z-1, f-2, i-2.
Allied International Corp., r, z, c-1, g-1 thru j-1, m-1 thru p-1, w-1 thru z-1, b-2 thru f-2.
American Electronic Labs., Inc., f-1
American Machine & Foundry Co., Government Products Group, l.
American Machine & Foundry Co., Government Products, N. Y., e, o, s, j-1, m-1, u-1, x-1, z-1.
American Missile Products Co., Inc., i.
American Potash & Chemical Corp., National Northern Div., c-1.
American Research & Mfg. Corp., h-2.
Amglo Corp., r-1, s-1, x-1, e-2.
*ANDREW CORP., h, l-2.
Arthur Ansley Mfg. Co., k-1.
Applied Electronics Corp. of N. J., i, q-1, s-1, b-2, e-2.
Arch Gear Works Inc., z.
Armament Div.-Universal Match Corp., A-1.
*ARNOUX CORP., i, o, b-2.
Arrow-Hart & Hegeman Electric Co., The, f, j, k, l, n thru q, z.
Associated Engineers, Inc., j, k, m-1, w-1, f-2.
Automatic Electric Sales Corp., k, m, r, w, x, c-1, l-1, o-1, q-1, s-1, t-1.
Automatic Switch Co., f, k, c-1, f-1, o-1, w-1.
Automatic Timing & Controls, Inc., e, o, e-2.
Automation Products, Inc., o, a-1.
Avco Corp., Crosley Div., a, e, k, c-1, g-1, j-1, n-1, o-1, u-1, z-1, h-2, i-2.
Avien, Inc., c-2.
Barber-Colman Co., c-2, d-2.
Barksdale Valves, j-1.
Barwood Electronics Inc., q.
Beckman & Whitley, Inc., Missile Products Div. a, d, j, r, u, c-1, u-1, e-2.
Belock Instrument Corp., a, k, o, j-1, o-1, e-2.
Bendix Aviation Corp., a, d, h, i, o, p, s, t, a-1, b-1, j-1, n-1, o-1, q-1, b-2, c-2, h-2.
Bendix Aviation Corp., Cincinnati Div., a, k, o, j-1, l-1, o-1, e-2.
Bendix Aviation Corp.-Montrose Div., k, r, s, g-1, j-1, i-2.
Bendix Utica Div., Bendix Aviation Corp., e-2.
Bermite Powder Co., t.
Bernco Engrg. Corp., e, r, z, c-1, d-1, u-1.
A. Biederman, Inc., f-2.
Birnbach Radio Co., Inc., g, x, y, g-1, m-1, q-1, v-1, z-1, f-2.
Bogart Mfg. Corp., h, f-1, l-2, m-2.
*BRISTOL CO., THE, j-1.
Bulova Research & Development Labs., Inc. a, e-2.
Burroughs Corp., Electronic Tube Div., o.
CBS Electronics, Di Columbia Broadcasting System, Inc., o.
CG Electronics Corp., l-1, b-2.
CGS Labs., Inc., o.
Capitol Machine Co., The, x, m-1.
Captive Seal Corp., s, c-1, j-1.

Carleton Aviation Co., Inc., a, b, e, s, a-1, c-1, h-1, j-1, i-2.
Carling Electric, Inc., j, k, p, q, t, e-1, g-1, j-1, m-1, q-1, u-1 thru x-1, z-1, f-2.
Central Electronic Mfrs., Div.-Nuclear Corp. of America, i-2.
Centralab, Div.-Globe-Union, Inc., g-1, k-1, m-1, q-1, t-1, z-1, a-2.
Century Electronics & Instruments, Inc., j-1, h-2.
Chemical Micro Milling Co., k-1.
Chicago Miniature Lamp Works, r.
Clark Controller Co., The, a, c, e, f, k, o, p, q, v, y, z, b-1, j-1, m-1, o-1, p-1, q-1, t-1, u-1, w-1, e-2, f-2.
Clarostat Mfg. Co., Inc., k, g-1, n-1, q-1, t-1, w-1, x-1, z-1.
Cole Electric Co., r, c-1, q-1.
Collectron Corp., i, r-1, s-1, t-1, b-2.
Colvin Labs., Inc., j-1.
Comar Electric Co., i, z, b-1, g-1.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., f-1.
Components Corp., c-2, d-2.
Consolidated Airborne Systems, Inc., o, a-1.
Consolidated Controls Corp., b, c, d, r, s, v, z, b-1, g-1, j-1, z-1, c-2, d-2, i-2.
Consolidated Vacuum Corp., i-2.
Continental-Wirt Electronics Corp., v-1.
Control Data Corp., a.
Control Products Inc., c-2, d-2.
Convair Instruments, Convair Div.-General Dynamics Corp., a-1.
Control Sw. Div. Controls Co. of America, k, q, r, v, z, c-1, g-1, i-1, l-1, m-1, p-1, q-1, t-1, u-1, w-1, z-1, f-2.
Cornelius Co., The, Aero Div., r, s, j-1.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., d, e, s, j-1.
Couch Ordnance, Inc., c, q-1, t-1.
Cramer Controls Corp., e-2.
Crescent Engrg. & Research Co., a.
Croname Inc., k-1.
Crosby-Teletronics Corp., o.
James Cunningham Son & Co., Inc., l.
Curtiss-Wright Corp., Electronics Div., r, g-1, z-1, d-2, h-2.
Cushman Precision Industries, i, j, o, r, g-1, k-1, o-1, q-1, r-1, s-1, x-1, z-1, b-2, h-2.
Custom Component Switches Inc., a thru e, r, s, v, a-1, b-1, j-1, u-1, z-1, i-2.
Daven Co., The, h, i, j, m, n, o, r, z, g-1, k-1, q-1, s-1, t-1, v-1, w-1, y-1 thru b-2, h-2.
Joe Davidson & Associates, a, g, h, k, r, u, v, z, f-1, g-1, i-1, j-1, m-1, w-1, x-1, y-1, d-2, l-2, m-2.
Daystrom Inc., Pacific Div., a.
De Havilland Aircraft of Canada, Ltd., Special Products Div., r-1.
Delco Radio Div.-General Motors Corp., o, z, h-2.
Deltron Inc., o, h-2.
Demornay-Bonardi, f-1, l-2, m-2.
Dialight Corp., v, p-1, w-1.
Diamond Antenna & Microwave Corp., h, f-1, l-2, m-2.
Henry G. Dietz Co., Inc., The, j-1, e-2, i-2.
Digitran, Co., The, k, m, r, g-1, k-1, m-1, q-1, x-1.
Djeco, Div.-Djordjevic Engrg. Co., o, h-2.
Don-Lan Electronics Inc., h, i, f-1, m-1, m-2.
Dougles Microwave Co., Inc., h, f-1, l-2, m-2.
Dow-Key Co., h, o.
Durakodl, Inc., d-1.
Dynamic Controls Corp., b, d, p, j-1, y-1, d-2, e-2.
Eagle Electric Mfg. Co. Inc., n, y, d-1, q-1, w-1, f-2.
Eagle Signal Co., e, k, r, z, c-1, l-1, e-2.
Eastern Industries Inc., j-1.
Eastern Specialty Co., The, q-1, a-2.
Ebert Electronics Corp., r, d-1, i-1, o-1; w-1, e-2, g-2.
Hugh H. Eby Co., m-1.
Edcliff Instruments, a.
Edgerton, Germeshausen & Grier, Inc., h.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., r, d-2, e-2.
Edwards High Vacuum Ltd., i-2.
Eitel-McCullough, Inc., i-2.
Eldema Corp., g-1, m-1, p-1, w-1, x-1, z-1, h-2.
Electro Switch Corp., k, c-1, g-1, o-1, q-1, t-1, w-1, x-1, z-1, a-2.
Electro Tec Corp., i, o, g-1, q-1, r-1, s-1, b-2.
Electro-Miniatures Corp., i, r, g-1, q-1, r-1, s-1, x-1, z-1, b-2.
Electronic Control Corp., o.
Electronic Engrg. Co. of California, o.
Electronic Specialty Co., h.
Electron-Radar Products, r, d-1, d-2.
Elektro-Serv Co., i, s-1, b-2.
Elgin Micronics, West Coast Div.-Elgin National Watch Co., a.
Ellison Draft Gage Co., Inc., c, v, c-1, i-2.
Emertron, Sub.-Emerson Radio & Phonograph Corp., f-1, k-1, b-2, j-2 thru m-2.
*EQUIPMENT DIV., RAYTHEON CO., g-2, h-2.
Era Engrg. Inc., a, s, u.
Essex Mfg., Co., Inc., b, d, p, r, s, a-1, j-1, q-1, t-1, v-1, f-2.
Eureka Williams Corp., a, u, d-2, e-2.
Exact Engrg. & Mfg. Inc., e-2.
FXR, Inc., f-1, l-2, m-2.
Fairfield Engrg. Corp., f, g, k, o.
Farmer Electric Products Co., Inc., z, s-1.
Farwest Mfg. Div., Inc., o, f-2.
Federal Screw Products Inc., v-1, f-2.
Fenwal Inc., c, c-2, d-2.
Food Machinery & Chemical Corp., Ordnance Div., h-2.
Ford Instrument Co., Div.-Sperry Rand Corp., k, o, c-1, h-2.
Frebank Co., b, d, a-1, j-1, i-2.
Furnas Electric Co., j, k, p, q, z, j-1, m-1, o-1, q-1, a-2.
G-C Electronics Co., q-1, v-1, f-2.
G-V Controls Inc., c-2, d-2, e-2.
Gamewell Co., The, q-1, s-1, t-1.
General Aniline & Film Corp., Ansco Div., m-2.
General Communication Co., h, f-1.
General Controls Co., e, j, k, q, r, z, c-1, j-1, w-1, c-2, e-2, i-2.
General Devices, Inc., a thru z, a-1 thru z-1, a-2 thru m-2.
General Electric Co., Apparatus Sales Div., e, f, g, j, k, p, r, y, z, h-1, j-1, m-1, o-1, p-1, q-1, u-1, w-1, x-1, b-2 thru g-2, i-2.
General Radio Co., m.
Genisco, Inc., a, i, u, s-1.
Genisco, Inc., Instrument Div., a, i, s-1, b-2.
Gibson Electric Co., j.
Gilfillan Bros, Inc., a, h, u-1, x-1, d-2, l-2, m-2.
Glassco Instrument Co., a-1, j-1, i-2.
John Gombos Co., Inc., f-1, l-2, m-2.
Good Electronic Corp., m, s-1, t-1.
B. F. Goodrich Aviation Products, j-1.
Gorham Electronics-Div.-Gorham Mfg. Co., l-2, m-2.
Gorn Electric Co., Inc., Aircraft Controls Div., b, c, d, k, p, r, s, b-1, j-1, o-1, z-1, d-2.
Gorn Electric Co., Inc. Gorn Electronics Div., b, c, d, p, r, b-1, j-1, o-1, y-1, d-2.
Graphik Circuits, Div.-Cinch Mfg. Co., k-1.
Graphite Metallizing Corp., i, r-1.
Grayhill, Inc., g-1, m-1, t-1, z-1.
Great Lakes Mfg. Corp., d, r, s, j-1.
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., a.
Grigsby Co., Inc., The, j, m, o, q, c-1, e-1, g-1, i-1, k-1, m-1 thru q-1, t-1, v-1, w-1, x-1, z-1, j-2, k-2.
Guided Missile Div., The Firestone Tire & Rubber Co., j-1.
B. H. Hadley, Inc., k, p, s, a-1, c-1, j-1, x-1.
Hagan Chemicals & Controls Inc., j-1.
Hagen Mfg. Co., e, k, z, c-1, p-1, e-2.
Hamilton Watch Co., Military Products Div., a, i, v, p-1.
Hamlin, Inc., c, i, r, d-1, x-1, z-1.
Hammett-Mercury-Rex Div., g, o, d-1, f-1, o-1, q-1, v-1 thru y-1, a-2, e-2, j-2 thru m-2.
George E. Harris & Co., Inc., g, r, v, z, b-1, g-1, i-1, j-1, m-1, n-1, q-1, w-1, z-1, d-2, f-2.
Hart Mfg. Co., The, o, r, k-1, q-1, t-1, v-1, w-1, x-1, c-2, f-2.
Hartwell Aviation Supply Co., f-1.
Haskel Engrg. & Supply Co., b, s, a-1, j-1, f-2, i-2.
A. W. Haydon Co., The, e, f, i, o, o-1, s-1, b-2, e-2, h-2.
Haydon Switch, Inc., a, d, r, u, z, a-1, g-1 thru j-1, m-1, p-1, w-1, x-1, z-1, f-2.
Heinemann Electric Co., z.
Hermetic Seal Corp. & Thermal Controls, Inc., r, d-1, w-1, d-2.
Hewlett-Packard Co., l-2, m-2.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., i-2.
Highland Engrg. Co., E-2.
E. Vernon Hill & Co., c-2.
John W. Hobbs Corp., Div.-Stewart-Warner Corp., J-1.
Hughes Semiconductor Div.-Hughes Aircraft Co., h-2.
Walter J. Hyatt Co., The, s, j-1.
Hydra-Power Corp., s, j-1.
Hydraulic Research & Mfg. Co., s, j-1.
ITT Components Div., International Telephone & Telegraph Corp., g-1.
Imtra Corp., y-1.
Industrial Devices Inc., t-1.
Industrial Instruments Inc., m, q-1.
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp., h, r, f-1, g-1, l-2.
Industrial Timer Corp., d-2, e-2.
Ingraham Co., The, e-2.
Instrument Development Labs., Inc., i, s-1, b-2.
Instrument Div., The W. L. Maxson Corp., a.
Integral Corp., s.

Integrated Dynamics Div., Globe Industries, Inc., a, u, b-1.
Interstate Engrg. Corp., j-1.
JEM Electronics Corp., o-1.
JFD Electronics Corp., d-1.
James Electronics Inc., h.

Janco Corp., g, r, s, z, g-l, j-l, q-l, t-l, z-l, a-2, c-2, d-2, e-2.
Javex Electronics, h, q-l.
Jennings Radio Mfg. Corp., g, h.
Jordan Electronics, Div.-Victoreen Instrument Co., o, e-2, h-2.
Joy Mfg. Co., m-l, w-l, f-2.
Kahn & Co., Inc., k.
Kay Electric Co., f-2.
*KEARFOTT DIV., GENERAL PRECISION, INC., q-l.
*KEARFOOT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS, f-l.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., e, f, j, k, l, o, v, w, x, c-l, e-l, i-l, k-l, m-l, o-l, q-l, y-l.
Kemp Aero Products, s, j-l.
Kidde Aero-Space Div., Walter Kidde & Co., Inc., u, j-l.
Kings Electronics Co., Inc., h.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., a, r, b-l, c-l, j-l, k-l.
Kolton Electric Mfg. Co., y, u-l.
Kulka Electric Corp., o, f-2.
Lamtex Industries Inc., i.
Langley Corp., r, c-2, d-2.
Lear, Inc., a, b, c, e thru m, o thru r, u, v, z, c-l, d-l, g-l, j-l, k-l, m-l, o-l, p-l, q-l, s-l, t-l, u-l, x-l, z-l, c-2, d-2, h-2, i-2.
Leece-Neville Co., The, j, m-l.
Leeds & Northrup Co., m, x, y, m-l, q-l, t-l, a-2, f-2.
Leetronics, Inc., s-l, x-l, m-2.
G. H. Leland, Inc., r, o-l, p-l, q-l, y-l.
*WALLACE O. LEONARD, INC., a, d, s, u, b-l, j-l, z-l.
Leviton Mfg. Co., Inc., k, n, x, y, d-l, g-l, m-l, n-l, q-l, v-l, w-l, a-2, f-2.
*LEWIS ENGRG. CO., THE, q-l, t-l.
Licon Switch & Control Div., Illinois Tool Works, r, z, c-l, m-l, t-l, w-l, x-l, z-l.
Lieco, Inc., f-l, l-2, m-2.
Line Material Industries-McGraw-Edison Co., e, f, g, c-l, o-l.
Liquidometer Corp., The, o, p, c-2.
Litton Industries, Inc., l-2.
Livingston Electronic Corp., q.
Lundy Mfg. Corp., e, f, k, q-l.
*MAGNAVOX CO., THE, a, s-l, b-2.
P. R. Mallory & Co. Inc., e, j, m, o, r, w, z, g-l, i-l, k-l, m-l thru p-l, t-l thru w-l, y-l, z-l, a-2, e-2, f-2, h-2.
Markite Corp., i, s-l, b-2.
Mason Electric Corp., r, u, c-l, g-l, l-l, o-l, q-l, t-l, w-l, x-l, y-l, a-2, b-2, f-2, g-2.
Mason-Neilan, j-l, y-l.
McGill Mfg., Co. Inc., Bearing Div., o, z.
Mechanical Products, Inc., g.
Meletron Corp., d, s, v, z, a-l, b-l, c-l, h-l, i-l, k-l, o-l, q-l thru t-l, w-l, d-2, l-2.
Micro Switch, Div.-Minneapolis-Honeywell Reg. Co., q, r, z, d-l, g-l, i-l, l-l, m-l, p-l, q-l, t-l, w-l, z-l, f-2.
Microdot Inc., h.
Microwave Associates, Inc., h, n, f-l, q-l, j-2 thru m-2.
Miller-Robinson Co., s, g-l, j-l.
Milli-Switch Corp., z, g-l, i-l, m-l, q-l, u-l, w-l, z-l, f-2.
Minneapolis-Honeywell Regulator Co., Aeronautical Div., a-l.
Minneapolis-Honeywell Regulator Co., Boston Div., a.
Mitchell Camera Corp., j-l, l-l.
Donald P. Mossman, Inc., x, m-l.
Motorola, Inc., o, f-l, h-2, l-2, m-2.
Muirhead Instruments Inc., m, x, q-l, t-l.
Mycalex Corp. of America, o, k-l, q-l, b-2.
National Co., Inc., i, n-l, o-l, h-2, i-2.
Navigation Computer Corp., o, h-2.
Networks Electronic Corp., o, r, h-2.
Newark Controls Co., d, p, j-l, i-2.
Newton Co., The, o.
Norrich Plastics Corp., g-l, l-l thru p-l, w-l, x-l, y-l.
Northrop Corp., o, o-l, y-l, e-2.
Norwalk Thermostat Co., k, w-l, c-2, d-2, e-2.
Olin Mathieson Chemical Corp., N. Y., o, d-2.
Omega Labs., Inc., f-l, l-2, m-2.
Ordnance Research & Development Co., Div.-Bermite Powder Co., t.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y., q-l.
Pacific Mercury Electronics, i, u, v, s-l, b-2.
Pacific Scientific Co., a, d, e, i, k, n, r, u, c-l, d-l, g-l, k-l, l-l, o-l thru t-l, x-l, z-l, b-2 thru e-2.
Packard Bell Computer Corp., o, k-l, l-l, e-2, h-2.
M. V. Palmer, Inc., y-l.
Parkway Specialties Co., k.
Pass & Seymour, Inc., Defense Div., x-l.
Patterson Moos Research, Div.-Leesona Corp., a, u, e-2.
Penn-Keystone Corp., h-2.
Permoflux Products Co., q, e-l.
Philco Corp.-Govt. & Industrial Group, k, l, o, k-l, n-l, o-l, b-2, h-2, m-2.
Piqua Engrg. Inc., j-l, x-l.
Joseph Pollak Corp., j, k, o, r, t, x, g-l, m-l, o-l, q-l, t-l, w-l, f-2.
Poly-Scientific Corp., i, g-l, q-l, s-l, t-l, v-l, z-l, b-2.
Powers Regulator Co., The, o-l, c-2.
Q-Circuits, Div.-Etching Co. of Calif., k-l.
Radar Relay, Inc., v, d-l.
Radiation, Inc., i, b-2.
Rantec Corp., f-l, l-2, m-2.
Raymond Engrg. Lab., Inc., a.
Reed Instrument Co., g-l, z-l, f-2.
Reed Research Inc., g-l, z-l, f-2.
Remler Co., e-l.
Republic Aviation Corp., Missile Systems Div., d-l.
Republic Mfg. Co., s.
Resitron Labs., Inc., g, i, j, i-2.
Revere Corp. of America, Sub., Neptune Meter Co., p, r, a-l, j-l.
M. H. Rhodes, Inc., e-2.
Robot Industries Inc., e, z, o-l, e-2.
Rochester Mfg. Co. Inc. of Calif., j-l.
Ronson Hydraulic Units Corp., s.
Rosemount Engrg. Co., b-l.
Milton Ross Metals Co., The, g-l, z-l.
Rotron Mfg. Co., u-l.
Royal Electric Corp., m-l, q-l.
Sage Labs., Inc., f-l.
Sangamo Electric Co., g, d-2, e-2.
Sargent Electric Corp., o, m-l, f-2.
Scintilla Div., Bendix Aviation Corp., t.
Scott Aviation Corp., d.
Secode Corp., c, e, k, l-l, o-l, p-l, y-l.
*SEMICONDUCTOR DIV., RAYTHEON CO., h-2.
Servomechanisms, Inc., b-l, j-l.
Servonic Instruments, Inc., d, j-l.
Shallcross Mfg. Co., g, j, m, g-l, k-l, m-l, o-l, q-l, t-l.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., s.
Sigma Instruments, Inc., i, o-l, s-l, t-l, b-2.
Singer Military Products Div.-The Singer Mfg. Co., q-l, t-l, x-l.
Southwest Research Institute, h-2.
Southwestern Industrial Electronics Co., a-l, j-l.
Southwestern Industries, Inc.
Space Components, Inc., g-l, z-l, f-2.
Specialties, Inc., j-l.
Spectra Electronics Corp., h-2.
Spectrol Electronics Corp., k-l, q-l, b-2.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., f-l, l-2, m-2.
Stackpole Carbon Co., n-l, v-l, w-l.
Statham Development Corp., c-2, h-2.
Stevens Mfg. Co. Inc., c-2, d-2.
Stewart-Warner Electronics Div., h-2.
Strand Engrg. Co., f-l.
Stromberg-Carlson Div.-General Dynamics Corp., w, x, y-l.
Switchcraft, Inc., j, w, x, e-l, g-l, m-l, q-l, f-2.
TRG, Inc., f-l, m-2.
Talley Corp., The, b-2.
Tapco Group, Thompson Ramo Wooldridge Inc., h, f-l, l-2, m-2.
Technical Materiel Corp., The, w.
Technology Instrument Corp., d, j-l.
Tektronix, Inc., o.
Telechrome Mfg. Corp., e, i, t-l, b-2, h-2.
Teleflex Inc., c-l.
Telex, Inc., o, g-l, m-l, z-l.
Telkor, Inc., x-l, e-2.
Temperature Engrg. Corp., c-2, i-2.
Texas Instruments Inc., g, i, j, k, o, r, z, c-l, g-l, m-l, q-l, w-l, z-l, c-2, d-2.
Thermo Electric Co., Inc., c-2.
Thompson Ramo Wooldridge Inc., h, f-l, l-2, m-2.
Tingstol Co., k-l.
Tork Time Controls, Inc., e-2.
Tower Mfg. Corp., o, y, m-l, w-l, x-l.
Transco Products, Inc., h, f-l, l-2, m-2.
Transistor Electronics Corp., v, g-l, m-l.
Transitron Electronic Corp., h-2.
Trans-Sonics, Inc., j-l, c-2.
Trepac Corp. of America, c, e, k, o, k-l, o-l, c-2, e-2, h-2.
Tucson Instrument Corp., k-l.
George Ulanet Co., r, d-2, e-2.
Unimax Switch Div., The W. L. Maxson Corp., k, z, b-l, c-l, g-l, i-l, k-l, m-l, p-l, u-l, w-l, z-l, f-2.
Unison Products, Inc., g-l, q-l, s-l, z-l, b-2.
United Control Corp., p, a-l, t-l, c-2, d-2.
United Electric Controls Co., c thru g, k, r, s, v, z, k-l, p-l, u-l, w-l, c-2, d-2, i-2.
U. S. Plastic Molding Corp.
U. S. Science Corp., Div.-Topp Industries, Inc., a, o, b-l, j-l, c-2, d-2, g-2.
United States Instrument Corp., e, i, w, x, e-l, m-l, q-l, t-l, y-l.
United Supply Co.
Universal Circuit Controls, o, w, x, z, b-l, m-l, q-l, w-l, x-l, f-2.
Universal Transistor Products Corp., o, l-l, z-l, g-2, h-2.
Vacuum Tube Products, Div.-Hughes Aircraft Co., i-2.
Vap-Air Aeronautical Products Div., Vapor Heating Corp., d-2.
Varo Mfg. Co., Inc., o, c-l, o-l, c-2, h-2.
Veeco Vacuum Corp., i-2.
Vemaline Products Co., q, m-l, x-l.
Vickers Inc., s.
Vickers, Inc., Mich., s.
Virginia Electronics Co., Inc., x-l.
Voi-Shan Electronics, o.
Walkirt Co., o.
Wang Labs., Inc., k-l, b-2.
Warren Components, Div.-El-Tronics, Inc., j.
Waugh Engrg. Co., o.
Waveline, Inc., f-l, l-2, m-2.
Wells Industries Corp., o-l, c-2, e-2.
Weltronic Co., o.
Western Control Corp., c-l.
Western Electronic Products Co., a.
Westinghouse Electric Corp., g, k, o, r, y, z, h-l, d-2, h-2.
Westport Development & Mfg. Co., Inc., b, d, r, g-l, j-l, x-l, d-2, i-2.
Whittaker Gyro, Div.-Telecomputing Corp., a.
Wiancko Engrg. Co., j-l.
Zenith Electric Co., f, o-l, e-2.

SWITCHING EQUIPMENT, ANTENNA

Actuation Research Corp.
Allied International Corp.
*ANDREW CORP.
Bendix Aviation Corp.
CG Electronics Corp.
CGS Labs., Inc.
Collins Radio Co.
Joe Davidson & Associates
Diamond Antenna & Microwave Corp.
Don-Lan Electronics Inc.
Electro Tec Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Devices, Inc.
George E. Harris & Co., Inc.
Microwave Associates, Inc.
Motorola, Inc.
Philco Corp.-Govt. & Industrial Group
Portland Copper & Tank Works Inc.
Rantec Corp.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Transco Products, Inc.
United Electric Controls Co.
Wind Turbine Co.
Winder Aircraft Corp. of Florida

SWITCHING EQUIPMENT, CAMERA

Aeroflex Labs. Div., Aeroflex Corp.
Benson-Lehner Corp.
Dage Television Div., Thompson Ramo Wooldridge, Inc.
Eastman Kodak Co.
Electronic Engrg. Co of California
General Devices, Inc.
Optomechanisms Inc.
Philco Corp.-Govt. & Industrial Group
Standard Electronics Div.-Reeves Instrument Corp.
Telechrome Mfg. Corp.

SYNCHROS

American Electronics, Inc.
Bendix Aviation Corp.
Bendix Aviation Corp.-Montrose Div.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Clifton Precision Products Co., Inc.
Control Data Corp.
Courter Products, Div.-Model Engrg. & Mfg., Inc.
Joe Davidson & Associates
Daystrom Inc., Transicoil Div.
Ford Instrument Co., Div.-Sperry Rand Corp.
George E. Harris & Co., Inc.
IMC Magnetics Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Interstate Electronics Corp.
*KEARFOTT DIV., GENERAL PRECISION, INC.
Ketay Dept., Norden Div., United Aircraft Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
Librascope Div., General Precision, Inc.

Minneapolis-Honeywell Regulator Co., Boston Div.
Muirhead Instruments Inc.
John Oster Mfg. Co., Avionic Div.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y.
Philco Corp.-Govt. & Industrial Group
Servo-Tek Products Co.
Summers Gyroscope Co.
Transicoil Div.-Daystrom Inc.

SYNCHROSCOPES

Daystrom Inc., Weston Instruments Div.
General Electric Co., Apparatus Sales Div.
Hazeltine Electronics Div.-Hazeltine Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lavoie Labs., Inc.
James Millen Mfg. Co. Inc.
Muirhead Instruments Inc.
Polarad Electronics Corp.

SYSTEMS, REMOTE CONTROL

Advance Instrument Corp.
Aeroflex Labs. Div., Aeroflex Corp.
Antlab Inc.
Armament Div.-Universal Match Corp.
Barber-Colman Co.
Belock Instrument Corp.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Bendix Aviation Corp., Montrose Div.
Bendix Corp., The, Eclipse-Pioneer Div.
Broadview Research Corp.
Chance Vought Aircraft, Inc.
Clark Controller Co., The
Collins Radio Co.
Consolidated Airborne Systems, Inc.
Daystrom, Inc., Control Systems Div.
Daystrom Inc., Transicoil Div.
Djeco, Div.-Djordjevic Engrg. Co.
Dynatronics, Inc.
Eastern Industries Inc.
Electro Instruments, Inc.
Electromation Co., Div.-Del Mar Engrg. Labs
Electronic Engrg. Co. of California
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fairfield Engrg. Corp.
Fenwal, Inc.
Flight Refueling, Inc.
Ford Instrument Co., Div.-Sperry Rand Corp.
GPL Div.-General Precision, Inc.
General Devices, Inc.
General Electric Co., Apparatus Sales Div.
General Instrument Corp., Defense & Engrg. Products Group
General Mills, Inc.
Gordon Enterprises
Guidance Controls Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hammarlund Mfg. Co., The
A. W. Haydon Co., The
Howe Scale Co., The
Hughes Tool Co., Aircraft Div.
Industrial Control Co.
Industrial Electronic Engineers, Inc.
International Electronic Research Corp.
Kahn & Co., Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kieley & Mueller, Inc.
Lear, Inc.
***WALLACE O. LEONARD, INC.**
Librascope Div., General Precision, Inc.
Lynch Carrier Systems Inc.
Madigan Corp.
Micro Gee Products, Inc.
Mitchell Camera Corp.
Motorola, Inc.
National Co., Inc.
National Electronics
Northrop Corp.
Optomechanisms Inc.
M. V. Palmer, Inc.
Pegasus Labs., Inc.
Philco Corp.-Govt. & Industrial Group
Pneu-Hydro Valve Corp.
Propulsion Test Facilities Div.-MB Electronics
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Rimak, Inc.
Robertshaw-Fulton Controls Co., A & I Div.
Servo-Tek Products Co.
Skyline Electric & Mfg. Co.
Southwestern Industrial Electronics Co.
Spectrol Electronics Corp.
Statham Development Corp.
Sun Electric Corp., Aeronautical Div.
Tapco Group, Thompson Ramo Wooldridge Inc.
Technical Materiel Corp., The
Telechrome Mfg. Corp.
Telectro Industries Corp.
Temco Aircraft Corp.
Thompson Ramo Wooldridge Inc.
Trepac Corp. of America
Tucson Instrument Corp.
United Electric Controls Co.
Varo Mfg. Co., Inc.
Virginia Electronics Co., Inc.
Wang Labs., Inc.
Wells Industries Corp.
Westinghouse Electric Corp.
Westronics Inc.

TABS

Adept Industries Inc.
Alloys Unlimited Inc.
Art Wire & Stamping Co.
Breeze Corporations, Inc.
California Plasteck Inc.
Duramark, Inc.
Eljay Corp.
Emeloid Co., Inc., The
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Monrovia Aviation Corp.
Sillcocks-Miller Co.

TABS, DIAL ACCESS

Adept Industries Inc.
Breeze Corporations, Inc.
California Plasteck Inc.

TACHOMETERS

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
Actuator Products Div., Geartronics Corp.
American Electronics, Inc.
American Electronics Incorporated
American Machine & Foundry Co., Government Products Group
Amthor Testing Instrument Co., Inc.
Bendix Aviation Corp.
Bendix Aviation Corp.-Montrose Div.
Bendix Corp., The, Eclipse-Pioneer Div.
A. Biederman, Inc.
Daystrom Inc., Weston Instruments Div.
Diehl Mfg. Co.
R. C. Dudek & Co.
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Apparatus Sales Div.
Ideal Industries, Inc.
Jack & Heintz, Inc.
Jones Motrola Corp.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Ketay Dept., Norden Div., United Aircraft Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Martin-Decker Corp.
Metron Instrument Co.
Motordyne Inc.
National Electronics
Norden Div., United Aircraft Corp.
John Oster Mfg. Co., Avionic Div.
Potter Aeronautical Corp.
Power Supplies Inc.
Servo-Tek Products Co.
Standard Electric Time Co., The
Herman H. Sticht Co., Inc.
Sun Electric Corp., Aeronautical Div.
Task Corp.
Wacline, Inc.
Wang Labs., Inc.
Westberg Mfg. Co.

TACHOMETERS, ELECTRONIC

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
Airpax Electronics Inc., Cambridge Div.
Airpax Electronics Inc., Seminole Div.
Allen Electric & Equipment Co.
Beckman Instruments, Inc., Berkeley Div.
Bendix Aviation Corp.
Courter Products' Div.-Model Engrg. & Mfg., Inc.
Electro Products Labs., Inc.
Erie Resistor Corp.
Kahn & Co., Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Magtrol, Inc.
Norden Div., United Aircraft Corp.
John Oster Mfg. Co., Avionic Div.
Potter Aeronautical Corp.
Servomechanisms, Inc.
Servo-Tek Products Co.
Standard Electric Time Co., The
Sunshine Scientific Instrument
Varo Mfg. Co., Inc.
WacLine, Inc.
Westberg Mfg. Co.

TAILPIPES, JET ENGINE

Aerocal Div., Aeronca Mfg. Corp.
Arnolt Corp.
Associated Co., Inc.
California Stamping & Mfg. Co.
Cromer Mfg. & Engrg., Inc.
Kaiser Fleetwings, Inc.
***LAVELLE AIRCRAFT CORP.**
Lycoming Div., Avco Corp.
Marquardt Corp., The
Northeast Metals Industries, Inc.
Penn-Michigan Mfg. Corp.
Solar Aircraft Co.
Stamping Div.-Rockwell Standard Corp.
Thermionic Aeronautical Div.

TANKS

a. Auxiliary
b. Auxiliary Drop
c. Fuel
d. Liquid Nitrogen
e. Liquid Oxygen
f. Liquified Gas Storage
g. Low Temperature
h. Oil
i. Self-Sealing
j. Transportation & Storage

ACF Industries Inc., **a, d, e, f, j.**
Aerocal Div., Aeronca Mfg Corp., **a, b, c.**
***AEROJET-GENERAL CORP., b, d, e, f.**
Agricultural Aviation Engineering Co. Inc.
Air Products, Inc., **d thru g, j.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., d thru g.**
Allied International Corp., **h.**
Alsop Engrg. Corp., **c, f ,h, j.**
Aluminum Co. of America, **a thru h, j.**
American Car & Foundry Div., ACF Industries Inc., **e, f, g, j.**
American Latex Products Corp., **g.**
American Machine & Foundry Co., Government Products Group, **j.**
Ampco Metal, Inc., **h, j.**
Anchor Metal Spinning Co., The, **a, b.**
Arde-Portland, Inc., **j.**
Arnolt Corp., **b.**
Associated Co., Inc., **a, b, c, j.**
Avondale Marine Ways, Inc., **j.**
B. H. Aircraft Co., Inc., **h.**
Beech Aircraft Corp., **a, b, g.**
Bell Aircraft Corp., Niagara Frontier Div., **a, c, j.**
Bendix Aviation Corp., **e, g.**
Bendix Utica Div., Bendix Aviation Corp., **a, thru h.**
Bennett-Feragen
Benson Mfg. Co., **a, b, c, f.**
Bethlehem Steel Co., **c thru h.**
S. Blickman, Inc., **b, d, e, f.**
Bowser, Inc., **a thru j.**
Brighton Corp., **c thru f.**
Brooks & Perkins, Inc., **a thru h, j.**
Brunswick Balke Collender Co., The, Defense Products Div., **a, c.**
Butler Mfg. Co., **a, c, g, h, j.**
Calcor Corp., **a thru j.**
California Stamping & Mfg. Co., **a thru h, j.**
Chicago Bridge & Iron Co., **c thru g, j.**
Cobra Metal Hose Div. DK Mfg. Co., **d thru**
Consolidated Diesel Electric Corp., **c.**
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **c thru f.**
Cromer Mfg. & Engrg., Inc., **d, e, g, h, j.**
Cutler Metal Products Co., **a, b, c, h, j.**
***DEL MAR ENGRG. LABS., d, f.**
Dempster Brothers, Inc., **j.**
Drayer Hanson Div.-Crane Co., **a, b.**
Dudwallen Mfg. Co., Inc., The
Eubanks Industries, Inc., **a, j.**
***EXCELCO DEVELOPMENTS INC., c, j.**
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp., **b, c, h.**
Foster Wheeler Corp., **f, h.**
Frick Co., **g.**
Fruehauf Trailer Co., Military Equipment Div., **j.**
General American Transportation Corp., **c thru h, j.**
B. F. Goodrich Aviation Products, **c, d, h, i.**
Goodyear Tire & Rubber Co., The, Aviation Products Div., **a, c, h, i, j.**
Graver Tank & Mfg. Co., Div.-Union Tank Car Co., **c thru h, j.**
Guided Missiles Div., The Firestone Tire & Rubber Co., **a, c, d, e.**
Hahn & Clay, **c thru i.**
Halliburton, Inc., Mfg. Div., **j.**
Hanson-Van Winkle-Manning Co.
Heil Process Equipment Corp. **j.**
Henry & Miller Industries, Inc.
Herlo Corp., **c, d, g.**
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP., a, b, c.**
Horsey, Robson & Co., Inc., **h.**
ITE Circuit Breaker Co., Special Products Div., **j**
Intercontinental Mfg. Co., Inc., **j.**
International Fermont Machinery Co., Inc., **h**
Kaiser Fleetwings, Inc., **c.**
Kellett Aircraft Corp., **a, c.**

Kirk & Blum Mfg. Co., The, a, h, j.
Ladish Co., d, e.
Lamtex Industries Inc., c, j.
*LAVELLE AIRCRAFT CORP., a, h.
Linde Co., Div.-Union Carbide Corp., d thru g, j.
Liquid Carbonic Div.-General Dynamics Corp., d, e, f.
Lofstrand Co., The, a, b, h, j.
Lukens Steel Co., c thru f, j.
Lunn Laminates, Inc., a, b, c.
Lycoming Div., Avco Corp., d, e.
MEG Products, Div.-Mandrel Industries, Inc., a, b, c, j.
Mak Industries, Inc., a.
Marquardt Corp., The, c, g.
*MARTIN CO., THE, DENVER DIV., c, d, e.
McGregor Mfg. Corp., a, c, f, g, h.
Menasco Mfg. Co., d thru g.
Monrovia Aviation Corp., a, b, c, j.
Nooter Corp., a thru h, j.
Norris-Thermador Corp., e, f.
Northeast Metals Industries, Inc., a, b, c, h.
Opelika Welding, Machine & Supply Inc., c thru g, j.
Pastushin Industries, Inc., a, b, c, j.
Pfaudler Div., Pfaudler Permutit Inc., j.
Philips & Davies Inc., g.
Portland Copper & Tank Works Inc., d, e, i.
Pressed Steel Tank Co., a, c thru f, j.
Protectoseal Co., The, c, h.
REF Mfg. Corp.
Edw. Renneburg & Sons Co., a thru d, g.
Reynolds Metals Co., Sheffield Missile Plant, c, e, j.
Rimak, Inc., a, b, c, g, h, i.
Ronan & Kunzl, Inc., d thru g.
Roto Finish-Ransohoff, j.
Royal Jet, Div.-Royal Industries, Inc., a, b, c.
Santa Barbara Research Center, d, f.
Skyline Products, Inc., a, h, j.
A. O. Smith Corp., Smith-Erie Div., c, f.
Southwest Research Institute, c, h, i, j.
Spaceatomics Div., The Budd Co., d, e, g.
Stamping Div.,-Rockwell Standard Corp., j.
Standard Steel Corp., d thru g, j.
Standard Steel Corp., Cambridge Div., c thru g, j.
Standard Steel Works, Inc., j.
Stearns-Roger Mfg. Co., The, c thru g, j.
Structural Fibers, Inc., a thru d, g, h, j.
Struthers Wells Corp., c thru g.
Superior Air Products Co., d, e, j.
Tapco Group, Thompson Ramo Wooldridge Inc., d, e, g.
Temco Aircraft Corp., b, c.
Thermon Mfg. Co., c, g, h, j.
Thompson Ramo Wooldridge Inc., d, e, g.
Trailmobile Inc., c, j.
Twin Coach Co., Aircraft-Missiles, a, b, c, g.
Uni-Flex Mfg. & Engrg. Inc., d thru g.
United Aircraft Products, Inc., h.
United States Chemical Milling Corp., b, c.
United States Rubber Co., a, c, h, i, j.
United States Steel Corp.
Vilter Mfg. Co., The, f, j.
Waco Aircraft Co., a, b, c, h, j.
Washington Aluminum Co., Inc., e.
Weber Aircraft Corp., a thru f, h.
Wells Industries Corp., c, h, j.
Westholt Mfg. Inc., a, b, c, e, h, j.
Whitlock Mfg. Co., The, d thru g.
Winder Aircraft Corp. of Florida, a, b.
Wolverine Diesel Power Co., a, b.
Woolf Aircraft Products, Inc., a, c, h.
Young Development Div., Hercules Powder Co., f.

NTALUM

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Alpha Metals, Inc.
American Silver Co., Inc.
Associated Engrg. & Mfg. Corp.
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Custom Tool & Mfg. Co.
Delta Chemical Works, Inc.
Fansteel Metallurgical Corp.
Firth Sterling Inc.
George E. Harris & Co., Inc.
Harvey Aluminum
Haynes Stellite Co., Div.-Union Carbide Corp.
Hughes Tool Co., Aircraft Div.
Johnston & Funk Metallurgical Corp.
Kennametal Inc.
NUMEC-Nuclear Materials & Equipment Corp.
National Research Corp., Metals Div.
F. H. Paul & Stein Brothers, Inc.
Pfaudler Div., Pfaudler Permutit Inc.
Rembar Co., Inc., The
Rodney Metals Inc.
Stauffer Chemical Co.
Thermionic Aeronautical Div.
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Universal-Cyclops Steel Corp.
Var-Lac-Oid Chemical Co.
Wah Chang Corp.
Wai Met Alloys Co.
Westinghouse Electric Corp.

TAPE, INSTRUMENTATION

ACF Industries Inc.
Audio Devices, Inc.
*CONSOLIDATED ELECTRODYNAMICS CORP.
General Electric Co., Instrument Dept.
General Plastics Corp.
Liquidometer Corp., The
Midwestern Instruments, Inc.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
*MINNESOTA MINING & MFG. CO.
Orr Industries Co., Div.-Ampex Corp.
Radiaphone Co. Inc.
*RADIO CORP. OF AMERICA
Reeves Soundcraft Corp.
Telectro Industries Corp.

TAPES

a. Asbestos
b. Coated & Impregnated
c. Electrical Insulation
d. Fabric
e. Friction
f. Heat Resistant
g. Plastic
h. Pressure Sensitive
i. Recording
j. Rubber, Natural & Synthetic
k. Test

Accurate Mfg. Co., c, e, g, j.
Acme Wire Co., b, c.
Acromark Co., The
Actioncraft Products, c, g.
Allied International Corp.,h.
Allied Plastics Supply Corp., a thru h, j.
American Cord & Webbing Co., Inc., c, d, f.
American Felt Co., d.
American Latex Products Corp., g, j, k.
American Super-Temperature Wires, Inc., c, f, g, h.
Anchor Packing Co., The, a thru h, j.
Arbeka Webbing Co., d, g.
Arno Adhesive Tapes, Inc., h.
Arnold Engrg. Co., The, i.
Associated Suppliers Co., d.
Auburn Mfg. Co., The, a, f, g, j.
L. J. Barwood Mfg. Co. Inc., a, g.
Behr-Manning Co., c, f, g, h.
Bemis Bro. Bag Co., b, h.
Bentley, Harris Mfg. Co., b, c.
Birma Mfg. Co., Inc., f.
Bishop Mfg. Corp., c, g, h, j.
Blossom Mfg. Co. Inc., b, g, j.
Bonny Mfg. Corp., g.
Borden Chemical Co., c, g.
Borden Chemical Co., The Resinite Dept., g.
Budd Co., The, b, c, d, f, g, h, k.
California Plasteck Inc., h.
Carborundum Co., The, f.
Chemplast, Inc., c, f, g, h.
Commercial Services Cor., Inc., g, h.
Connecticut Hard Rubber Co., The, b, c, d, f, g, h.
Continental Diamond Fibre Corp., f, g, h.
Continental Rubber Works, e, g.
Cordo Chemical Corp., b, d, k.
Crystal-X Corp., g.
C. R. Daniels, Inc., d.
Darcoid Co., Inc., The, a, j.
Dilectrix Corp., g.
Dixon Corp., c, g.
John L. Dore Co., g.
E. I. Du Pont de Nemours & Co. Inc., b, c, d, f, g.
Duracote Corp., b, d, g, h.
Dyna-Therm Chemical Corp., f.
Franklin Fibre-Lamitex Corp., c, g, h.
Garlock Packing Co., c, j.
Garlock Packing Co., The-Electronic Products, c, g.
Gatewood Products, Inc., a, b, d, thru h, j.
General Kinetics Inc., k.
General Plastics Corp., b, c, f, h.
Gentape Corp., Div.-General Plastics Corp., b.
B. F. Goodrich Industrial Products Co., c, e, g.
Greene, Tweed & Co., a, b, j.
Guided Missile Div., The Firestone Tire & Rubber Co., g, j.
Halogen Insulator & Seal Corp., g.
Hess, Goldsmith & Co., Inc.
Hitemp Wires Inc., c.
Walter J. Hyatt Co., The, h.
Insulation Mfrs. Corp., a thru h, j.
Joclin Mfg. Co., The, a thru h.
Johns-Manville Sales Corp., a thru h.
Kano Labs.
Kendall Co., The, Polyken Sales Div., c, f, g, h.
Kirkhill Rubber Co., j.
M & Q Plastic Products, g.
Master Tape Printers, h.
McMillan Companies, The, c.
Mechanical Rubber Products Co., j.
Meyercord Co., The, AMC Div., f.
Mica Insulator Div.-Minnesota Mining & Mfg. Co., c.
*MINNESOTA MINING & MFG. CO, a thru k.
Minnesota Rubber Co., c, j.
Narrow Fabric Co., The, b.
National Electric Coil, Div.-McGraw-Edison Co., a thru d.
Natvar Corp., b, c, g.
Naz-Dar Co., h.
New England Tape Co., Div.-United-Carr Fastener Corp., g.
New Jersey Wood Finishing Co., c, f, g.
Norrich Plastics Corp., g.
North Shore Nameplate, Div.-Anodyne, Inc., d, f, h.
Okonite Co., The, Sub.-Kennecott Cooper Corp., c, e, g, j.
Orr Industries Co., Div.-Ampex Corp., i.
Owens-Corning Fiberglas Corp., c, d, f.
Paper Mfrs. Co., i.
Pee Cee Tape & Label Co., Inc., h.
Permacel, b, c, d, f, g, h.
Polymer Corp., The, c, g.
Precision Specialties, Inc., i.
Products Research Co., b.
*RADIO CORP. OF AMERICA, i.
Raybestos-Manhattan, Inc., a thru d, f, g, j.
Reeves Brothers, Inc., d, g.
Reeves Bros. Inc., Vulcan Rubber Div., b, j.
Reeves Soundcraft Corp., i.
Reynolds Metals Co., Plastics Div., g.
Fred T. Roberts & Co., g, j.
Robins Industries Corp., h.
Roovers-Lotsch Corp., g, h.
Russell Mfg. Co., a, f.
Schlegel Mfg. Co., d.
D. A. Schultz Co., c.
W. S. Shamban & Co., g.
Sillcocks-Miller Co., g, h.
Soroban Engrg., Inc., i.
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co., c.
Stanpat Co., h.
Surprenant Mfg. Co., c, f, g.
Swedlow Inc., f, g.
Tally Register Corp., k.
Technical Tape Corp., b thru h.
Telectro Industries Corp., i.
Tetrafluor, Inc., g.
Thermoid Div.-H. K. Porter Co., Inc., a thru f, h, j.
E. F. Timme & Son Inc., d.
Topflight Corp., h.
Uniform Hood Lace Co., b.
Union Asbestos & Rubber Co., a, b, c, e, f.
United States Rubber Co., a thru e, j.
Vernon Chemical & Mfg. Corp., b, c, d, f, g, h, k.
Waste King Corp., Technical Products Div., f, i.
Westinghouse Electric Corp., Micarta Div., a thru d, f, g.
Westline Products Div.-Western Lithograph Co., h.
Zippertubing Co., The, a thru d, f, g, j.

TARGET DEVICES

ACF Industries Inc.
*AEROJET-GENERAL CORP.
All American Engrg. Co.
American Optical Co., Instrument Div.
American Potash & Chemical Corp., National Northern Div.
Andersen Labs., Inc.
Anderson, Greenwood & Co.
Beech Aircraft Corp.
Bendix Aviation Corp.
Burton-Rodgers, Inc.
Calcor Corp.
Clevite Ordnance, Div.-Clevite Corp.
Curtiss-Wright Corp., Santa Barbara Div.
DBM Research Corp.
Dale Products, Inc.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
*DEL MAR ENGRG. LABS.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Lear, Inc.
Miami Engrg., Div.-Miami Shipbuilding Corp.
Micro Gee Products, Inc.
Motorola, Inc.
Northrop Corp.
Optomechanisms Inc.
Philco Corp.-Govt. & Industrial Group.
Reeves Bros. Inc., Vulcan Rubber Div.
Republic Aviation Corp., Missile Systems Div.
Skiatron Elecfronics & Television Corp.

Specia Products Dept., Melpar, Inc.
Standard Armament Inc.
Swift Textile Metalizing & Laminating Corp.
Temco Aircraft Corp.
U. S. Industries, Inc.

TEFLON

Abesto Corp.
Aero Bolt & Screw Co., Inc.
Aeroquip Corp., Jackson Div.
Allied Plastics Supply Corp.
Anaconda Metal Hose Div., The American Brass Co.
Armstrong Cork Co.
Auburn Mfg. Co., The
L. J. Barwood Mfg. Co. Inc.
Beemer Engrg. Co.
Bonny Mfg. Corp.
Bram Metallurgical Chemical Co.
Chemplast, Inc.
Chicago Gasket Co.
Chicago Rawhide Mfg. Co.
Comco Plastics Inc.
Connecticut Hard Rubber Co., The
Crystal-X Corp.
Dixon Corp.
Drilube Co.
Driver-Harris Co.
E. I. Du Pont de Nemours & Co. Inc.
Electric Hose & Rubber Co.
Eljay Corp.
Emerson Plastics Corp.
Fabricon Corp.
Fluorocarbon Co., The
Franklin Fibre-Lamitex Corp.
Garlock Packing Co.
Garlock Packing Co., The-Electronic Products
General Gasket Inc.
General Plastics Corp.
Greene, Tweed & Co.
Halogen Insulator & Seal Corp.
Haskel Engrg. & Supply Co.
Insulation Mfrs. Corp.
Walter K. Jaros Aircrafters
Thomas J. Long, Inc.
J. E. Menaugh Co.
Mica Fabricating Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Permacel
Raybestos-Manhattan, Inc.
Reeves Bros. Inc., Vulcan Rubber Div.
Resistoflex Corp.
Rogers Corp.
Russell Mfg. Co.
St. Regis Paper Co., Panelyte Div.
Ray A. Scharer & Co.
Sealectro Corp.
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co.
A. T. Stevens Co.
Tetrafluor, Inc.
Topper Mfg. Co., Inc.
Tri-Point Plastics Inc.
Union Asbestos & Rubber Co.
United Supply Co.
Weatherhead Co., The
Western Div., Aeroquip Corp.
Zippertubing Co., The

TELEMETERING EQUIPMENT

a. Antennas
b. Decommutators
c. FM
d. Ground Equipment
e. Monitoring Equipment
f. PCM (Pulse Code Modulation)
g. PDM (Pulse Duration Modulation)
h. Receivers
i. Recorders
j. Systems
k. Transducers
l. Transmitters

ACF Electronics Div., ACF Industries Inc., **h, k.**
ACF Industries Inc.
ASCOP Div., Electro-Mechanical Research, Inc., **b thru g, i thru l.**
Actuation Research Corp., **b.**
Advance Industries, Inc., **c thru h, j, l.**
Aeronca Mfg. Corp.-Aerospace Div., **d, h, j, l.**
Ainslie Corp., **a, d.**
Aircom Inc., **a.**
Aircraft Armaments, Inc., **a, d, h, l.**
Airpax Electronics Inc., Cambridge Div., **e, j.**
Airpax Electronics Inc. Seminole Div., **e, j.**
All Products Co., **a.**
Alpar Mfg. Corp., **a.**
Alpine Electronic Components, Inc., **l.**
Alto Scientific Co., Inc., **h.**
American Electronics Inc., Teller-Cooper Div. & Data Systems Div., **e, i.**
American Machine & Foundry Co., Greenwich Engrg. Div., **a.**
American Missile Products Co., Inc., **b thru h, j, l.**
Ampex Data Products Co., **e, i.**
***ANDREW CORP., a.**
Antlab Inc., **d, i.**
Applied Electronics Corp. of N. J., **a thru l.**
Applied Research Inc., **h.**
***ARNOUX CORP., a thru l.**
Autometric Corp., **d.**
Avco Corp.-Research & Advanced Development Div., **c, d.**
Avien, Inc., **f.**
Ball Brothers Research Corp., **e.**
Barker Sales Co., **j.**
Beckman-Systems Div., **d, i, j.**
Bendix Aviation Corp., **a thru f, h thru l.**
Bendix Aviation Corp., Cincinnati Div., **b thru l.**
Bendix Aviation Corp., Montrose Div., **k.**
Bendix-Pacific Div., Bendix Aviation Corp., **b thru f, h thru l.**
Blonder-Tongue Labs. Inc., Special Products Div., **l.**
Bourns, Inc., **k.**
***BRISTOL CO., THE, h, i, j, l.**
Broadview Research Corp.
Brooks Rotameter Co., **l.**
Budd Lewyt Electronics, Inc., **c thru l.**
Bulova Research & Development Labs., Inc., **d, e.**
CBS Laboratories, Div.-Columbia Broadcasting System, **h, i, l.**
CG Electronics Corp.
Calcor Corp., **a, d.**
California Computer Products, Inc., **b, f, g.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **d, h.**
Chance Vought Aircraft, Inc., **a, d, e, k, l.**
Cleveland Metal Specialties Co., Electronics Div., **l.**
Clevite Ordnance, Div.-Clevite Corp., **k.**
G. L. Collins Corp., **k.**
Collins Radio Co., **a, h, l.**
Colorado Research Corp., **d, e.**
Colvin Labs., Inc., **k.**
***CONSOLIDATED ELECTRODYNAMICS CORP., f, g, i, j, k.**
Crescent Engrg. & Research Co., **d, e, k.**
Crosby-Teletronics Corp., **c.**
Curtiss-Wright Corp., Electronics Div., **d.**
Curtiss-Wright Corp., Electronics Div., IMI Branch, **j.**
Curtiss-Wright Corp., Santa Barbara Div., **d, f, k.**
Dalmo Victor Co., Div.-Textron, Inc., **a, c, d, e, h, j.**
Data-Control Systems, Inc., **c, d, e, g, j, k.**
Datex Corp.
Daystrom Inc., Pacific Div., **k.**
Dejur-Amsco Corp., Electronic Sales Div., **k.**
Designers for Industry, Inc., **d, h.**
Diamond Antenna & Microwave Corp., **a.**
Digital Sensors Inc., **k.**
Dorne & Margolin, Inc., **a.**
Dorsett Electronic Labs., Inc., **b, c, d, f, g, j, l.**
Du Kane Corp., **l.**
Allen B. Du Mont Labs., Inc., **d, h, i, k, l.**
Dynatronics, Inc., **a, d, e, f, h, i, j, l.**
Eastman Kodak Co., **c, h, i, k.**
Edcliff Instruments, **k.**
Electro Instruments, Inc., **d.**
Electro Products Labs., Inc., **k.**
Electromation Co., Div.-Del Mar Engrg. Labs., **b thru j, l.**
Electronic Engrg. Co. of California, **j.**
Electro-Pulse, Inc., **f, g.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **c thru j, l.**
Empire Products Sales Corp., **e, i.**
Endevco Corp., **k.**
***EQUIPMENT DIV., RAYTHEON CO., d, f, g, h, j, l.**
Erie Resistor Corp., **d, k.**
Fenske, Fedrick & Miller Inc., **e, i, j.**
Ford Instrument Co., Div.-Sperry Rand Corp., **d, j.**
GPL Div.-General Precision, Inc., **e, j.**
Gates Radio Co., **c, l.**
General Bronze Electronics Corp., **a, b, h, j, l.**
General Communication Co., **h, l.**
General Devices, Inc., **b thru g, j, k, l.**
General Electric Co., Apparatus Sales Div.
General Electric Co., Ordnance Dept., **a.**
General Instrument Corp., Defense & Engrg. Products Group, **c thru h, j, k, l.**
Genisco, Inc., Instrument Div., **k.**
Gilfillan Bros. Inc., **a, b, c, f, g, j, l.**
Gonset Div.-Young Spring & Wire Corp., **h, l.**
Gorham Electronics-Div.-Gorham Mfg. Co., **k.**
Guidance Controls Corp., **d, e, j, l.**
Guided Missile Div., The Firestone Tire & Rubber Co., **a, c, e, j, k, l.**
Gulton Industries, Inc., **a, e, i, k.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co., **a.**
Hagan Chemicals & Controls Inc., **e, i.**
Hallamore Electronics Co., Div.-Siegler Corp., **a, c thru h, j.**
Hallicrafters Co., The, **h, j.**
Hammarlund Mfg. Co., The, **c thru f, h, j, l.**
Hammett-Mercury-Rex Div., **a thru l.**
Hathaway Instruments, Inc., **i.**
A. W. Haydon Co., The
Hazeltine Electronics Div.-Hazeltine Corp., **a, c e, h, j, l.**
Hoover Electronics Co., **c, d, f, j.**
Houston Fearless Corp., **f, g.**
Huyck Systems Co., **d.**
ITI Electronics, Inc., **h, l.**
ITT Federal Div., International Telephone & Telegraph Corp., **c thru h, j, l.**
Instruments for Industry, Inc., **d, h, j.**
Integrated Dynamics Div., Globe Industries, Inc **k.**
Interstate Electronics Corp., **a, d, e, i, j, l.**
Kay Electric Co., **e, i.**
Lab. For Electronics, Inc., **d.**
Land-Air Inc., Sub.-California Eastern Aviation Inc., **c, d, e, h, i, j, l.**
Leach Corp., **h, i.**
Lear, Inc., **b thru l.**
Lel, Inc., **d, h, l.**
Lenkurt Electric Co., Inc., **h, j, l.**
***WALLACE O. LEONARD, INC., d, k.**
***LEWIS ENGRG. CO., THE, k.**
Litton Industries, Inc.
Litton Industries, Maryland Div., **a thru f, h, j,**
Lockheed Aircraft Corp., Missiles & Space Div **a thru l.**
Lockheed Electronics Co., Stavid Div., **h, k, l.**
Lycoming Div., Avco Corp., **j.**
MEG Products, Div.-Mandrel Industries, Inc., **thru h, j, l.**
Madigan Corp., **d, e, j.**
Magnasync Corp., **i.**
Marconi Instruments, **c.**
***MARTIN CO., THE, DENVER DIV., d, e, f, j,**
Martin-Decker Corp., **i, k.**
Mason Electric Corp., **f, g, h, l.**
Midwestern Instruments, Inc., **c, g, i, j.**
Mincom Div., Minnesota Mining & Mfg. Co **d, i.**
Minneapolis-Honeywell, Heiland Div., **i.**
Minneapolis-Honeywell Regulator Co., Industri Systems Div. **i, j.**
Minneapolis-Honeywell Regulator Co., Industri Div., **g thru l.**
***MINNESOTA MINING & MFG. CO., i.**
Moore Associates, Inc., **b, d, e, g, j, l.**
Motorola, Inc., **a, c, f, h, j, l.**
Narmco Mfg. Co., **a.**
National Co., Inc., **b thru h, j, l.**
Newton Co., The, **b.**
Northeast Electronics Corp., **j.**
Northeastern Engrg. Inc., **l.**
Northrop Corp.
Nutmeg Screw Machine Products Co., **l.**
Offner Electronics Inc., **i.**
Pace Engrg. Co., **k.**
Pacific Mercury Electronics, **a, c thru f, j, l.**
Packard Bell Computer Corp., **j.**
M. V. Palmer, Inc., **c, h.**
Panoramic Radio Products, Inc., **d, e.**
Ralph M. Parsons Co., The, Electronics Div., **d. e, g, j, l.**
Philco Corp.-Govt. & Industrial Group, **a thru**
Portland Copper & Tank Works Inc., **d.**
Potter Aeronautical Corp., **k.**
Potter Instrument Co., Inc., **d, f, i, j.**
Probescope Co. Inc., **c, e.**
Production Research Corp., Sub-Radio Condenser Co., **i, j.**
Projects Unlimited, Inc., **h, l.**
RS Electronics Corp., **h, j, l.**
Radalab Inc., **a, c, d, e.**
Radiaphone Co. Inc., **a, c thru j, l.**
Radiation, Inc., **a thru d, f thru l.**
Radio City Products Co. Inc., **h.**
Radio Condenser Co., **j.**
***RADIO CORP. OF AMERICA, a, c thru l.**
***RADIO CORP. OF AMERICA, DEFENS ELECTRONICS PRODUCTS, d, j, l.**
Radio Receptor Co., Inc., Sub-General Instrument Corp., **c thru h, j, k, l.**
Rahm Instruments Div.-American Machine Metals, **k.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **b thru j.**
Rantec Corp., **a, d.**
Raven Industries Inc., **j, k, l.**
Reeves Instrument Corp., **d.**
Resdel Engrg. Corp., **h, l.**
Rosemont Engrg. Co., **k.**
Sangamo Electric Co., **i, l.**
Scanivalve Co., **k.**
Seeburg Corp., The, **a thru e, g thru j, l.**
Servomechanisms, Inc., **k.**
Sierra Electronic Corp., Div.-Philco Corp., **c, e, l.**
Southwest Research Institute
Southwestern Industrial Electronics Co., **f, h,**
Specialty Electronics Development Corp., **j.**
Spectra Electronics Corp., **a, h, l.**
Spectralab Instruments, **c, l.**
Spectrum Instruments, Inc., **d.**
Standard Controls, Inc., **k.**

Statham Instruments, Inc., **k.**
Stewart-Warner Electronics Div., **f, g.**
Stromberg-Carlson Div.-General Dynamics Corp., **d, h, j, k, l.**
Sun Electric Corp., Aeronautical Div.
TRG, Inc., **a.**
***TABER INSTRUMENT CORP., k.**
Talley Corp., The
Tamar Electronics, Inc., **a, c, h, l.**
Tapco Group, Thompson Ramo Wooldridge Inc., **c, h, j, l.**
Technical Appliance Corp., **a.**
Telechrome Mfg. Corp., **c thru h, j, l.**
Telectro Industries Corp., **a, c, e, f, h, i, j, l.**
Telex, Inc., **k.**
Texas Instruments Inc., **c, f, g, j, l.**
Thompson Ramo Wooldridge Inc., **c, h, j, l.**
Transco Products, Inc., **a.**
Trans-Sonics, Inc., **k.**
Ultradyne, Inc., **k.**
U. S. Science Corp., Div.-Topp Industries, Inc., **k.**
United States Time Corp., **k.**
Universal Toroid Coil Winding, Inc., **k.**
Waltham Electronics Corp., **e.**
Wang Labs., Inc., **f, i, j.**
Western Gear Corp.-Precision Products Div., **a.**
Westport Development & Mfg. Co., Inc., **k.**
Wiancko Engrg. Co., **k.**

TEMPERATURE CONTROL SYSTEMS

Airborne Accessories Corp.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Alloy Bellows Inc.
American Instrument Co., Inc.
American Missile Products Co., Inc.
American Research Corp.
Andersen Labs., Inc.
Armament Div.-Universal Match Corp.
***ARNOUX CORP.**
***ASSOCIATED TESTING LABS., INC.**
Astra Tech
Atlas Engrg. Corp.
Auto-Control Labs. Inc.
Avien, Inc.
Barber-Colman Co.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
Bernco Engrg. Corp.
***BRISTOL CO., THE**
Budd Lewyt Electronics, Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Clark Controller Co., The
Compudyne Corp.
Consolidated Controls Corp.
Datex Corp.
Daystrom, Inc., Control Systems Div.
Daystrom Inc., Pacific Div.
Daystrom Inc., Weston Instruments Div.
Dynamic Controls Corp.
Eastern Industries Inc.
Eclipse Fuel Engrg. Co.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electronic Control Corp.
Electronic Processes Corp. of California
Ellis & Watts Products, Inc.
Fairfield Engrg. Corp.
Fenwal Inc.
Flight Refueling, Inc.
Flight Support, Inc.
Gardner Laboratory, Inc.
General Controls Co.
General Electric Co., Apparatus Sales Div.
Gulton Industries, Inc.
B. H. Hadley, Inc.
Hagan Chemicals & Controls Inc.
Hallikainen Instruments
Hamilton Standard, Div.-United Aircraft Corp.
Harco Labs., Inc.
Harris Refrigeration Co.
Hathaway Instruments, Inc.
Hays Corp., The
Hughes Tool Co., Aircraft Div.
ITI Electronics, Inc.
Illinois Testing Laboratories, Inc.
Janitrol Aircraft Div.-Midland-Ross Corp.
Kahn & Co., Inc.
***KEARFOTT DIV., GENERAL PRECISION, INC.**
Kieley & Mueller, Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
Leeds & Northrup Co.
Leslie Co.
Liquidometer Corp., The
Madigan Corp.
Magnetic Controls Co.
Magnetic Instrument Co. Inc.
Magnetic Research Corp.
***MARTIN CO., THE, DENVER DIV.**
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Boston Div.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Missimers Inc.
National Co., Inc.
National Electronics
Networks Electronic Corp.
Northrop Corp.
OPW-Jordan
Ordnance Engrg. Associates, Inc.
Otis Elevator Co., Defense & Industrial Div.
Pioneer Industries Div., Almar-York Co. Inc.
Powers Regulator Co., The
Projects Unlimited, Inc.
Pyrometer Instrument Co., Inc.
Radio Condenser Co.
Recony Div.,-Vinco Corp.
Research, Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Rimak, Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Santa Barbara Research Center
Servomechanisms, Inc.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
South Wind Div., Stewart Warner Corp.
Southwest Research Institute
Spectra Electronics Corp.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Statham Development Corp.
Stearns-Roger Mfg. Co., The
Stratos, Div.-Fairchild Engine & Airplane Corp.
Sun Electric Corp., Aeronautical Div.
Tapco Group, Thompson Ramo Wooldridge Inc.
Temperature Engrg. Corp.
Texas Instruments Inc.
Thermo Electric Co., Inc.
Thermon Mfg. Co.
Thompson Ramo Wooldridge Inc.
Trans-Sonics, Inc.
Trepac Corp. of America
United Aircraft Products, Inc.
United Control Corp.
United Electric Controls Co.
United Sensor & Control Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Vap-Air Aeronautical Products Div., Vapor Heating Corp.
Varo Mfg. Co., Inc.
Victory Engrg. Corp.
Weksler Instruments Corp.
Wells Industries Corp.
Westinghouse Electric Corp.
Wilcolator Co., The
Yellow Springs Instrument Co., The
York Div., Borg-Warner Corp.

TEMPERATURE MEASURING EQUIPMENT

Advance Instrument Corp.
Aero Research Instrument Co. Inc.
American Instrument Co., Inc.
Andersen Labs., Inc.
***ARNOUX CORP.**
Assembly Products, Inc.
Atlas Engrg. Corp.
Avien, Inc.
Beckman & Whitley, Inc., Instrument Div.
Bendix Aviation Corp.
Blonder-Tongue Labs. Inc., Special Products Div.
***BRISTOL CO., THE**
Burr-Brown Research Corp.
Carborundum Co., The
Clark Controller Co., The
Conax Corp.
Consolidated Controls Corp.
Datex Corp.
Daven Co., The
Joe Davidson & Associates
Daystrom Inc., Weston Instruments Div.
Dejur-Amsco Corp., Electronic Sales Div.
Eastman Kodak Co.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
Electric Autolite Co., The
Electro Instruments, Inc.
Electronic Processes Corp. of California
Engelhard Industries, Inc.
Epic, Inc.
Fenwal Inc.
Fisher Scientific Co.
Friez Instrument Div., Bendix Aviation Corp.
General Electric Co., Apparatus Sales Div.
General Electric Co., Instrument Dept.
General Instrument Corp., Defense & Engrg. Products Group
Gray Instrument Co.
Gulton Industries, Inc.
Hallikainen Instruments
Harris Refrigeration Co.
Hays Corp, The
E. Vernon Hill & Co.
Illinois Testing Laboratories, Inc.
Instrument Div., The Budd Co.
Kahn & Co., Inc.
Wayne Kerr Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Langley Corp.
Lear, Inc.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Liquidometer Corp., The
Lycoming Div., Avco Corp.
Magnetic Instrument Co, Inc.
Magnetic Research Corp.
Marsh Instrument Co., Div.-Colorado Oil & Gas Corp.
Minco Products, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
National Electronics
Networks Electronic Corp.
Ordnance Engrg. Associates, Inc.
Pace Engrg. Co.
Palmer Thermometers, Inc.
Pyrometer Instrument Co., Inc.
Radio Condenser Co.
Research, Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Rochester Mfg. Co. Inc.
Rosemount Engrg. Co.
Santa Barbara Research Center
Serdex, Inc.
Servomechanisms, Inc.
Sheffield Corp., The, Sub.-Bendix Aviation Corp.
Simmonds Aerocessories, Inc.
E. C. Smith Mfg. Co., Inc.
Southwest Research Institute
Spectra Electronics Corp.
B. K. Sweeney Mfg. Co.
***TABER INSTRUMENT CORP.**
Tapco Group, Thompson Ramo Wooldridge Inc.
Technique Associates Div., Duncan Electric Co., Inc.
Telechrome Mfg. Corp.
Temperature Engrg. Corp.
Tempil Corp.
Thermo Electric Co., Inc.
Thermon Mfg. Co.
Thompson Ramo Wooldridge Inc.
Trans-Sonics, Inc.
Trepac Corp. of America
United Electric Controls Co.
United Sensor & Control Corp.
Victory Engrg. Corp.
Weksler Instruments Corp.
Wells Industries Corp.
Westport Development & Mfg. Co., Inc.
Yellow Springs Instrument Co., The

TEMPERATURE RESISTANCE BULBS

Aero Research Instrument Co. Inc.
***ARNOUX CORP.**
Astra Tech
Barber-Colman Co.
***BRISTOL CO., THE**
Consolidated Controls Corp.
Daystrom Inc., Weston Instruments Div.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Electronic Processes Corp. of California
Engelhard Industries, Inc.
Fenwal Inc.
Hallikainen Instruments
Hays Corp., The
Illinois Testing Laboratories, Inc.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Minco Products, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Pyrometer Instrument Co., Inc.
Rosemount Engrg. Co.
Thermo Electric Co., Inc.
Trans-Sonics, Inc.
United Control Corp.
Yellow Springs Instrument Co., The

TENSIONS, COIL WINDING

General Kinetics Inc.
Thermionic Products Co.

TERMINAL BLOCKS

ADC Inc.
Accurate Electronics Corp.
Aerolite Electronics Corp.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.

American Aerophysics Corp.
American Insulator Corp.
Armel Electronics, Inc.
Associated Engineers, Inc.
Automatic Electric Sales Corp.
Brook Molding Corp.
Buchanan Electrical Products Corp.
Burndy Corp., Omaton Div.
Cal Connector Co.
Cambridge Thermionic Corp.
Comco Plastics Inc.
Continental Connector Corp.
Dejur-Amsco Corp., Electronic Sales Div.
Electrical Insulation Co., Inc.
Emmco Plastics Fabricators
Epoxy Products, Inc., Div.-Joseph Waldman & Sons
Excellex Electronics Inc.
Federal Screw Products Inc.
Fisher & Crome
Garde Mfg. Co.
General Products Corp.
Globe Electrical Mfg. Co.
Goe Engrg. Co.
Walter K. Jaros Aircrafters
Howard B. Jones Div.-Cinch Mfg. Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kings Electronics Co., Inc.
Kolton Electric Mfg. Co.
Kulka Electric Corp.
***LEWIS ENGRG. CO., THE**
Thomas J. Long, Inc.
Lytle Corp.
James Millen Mfg. Co. Inc.
Molded Insulation Co.
Molding Corp. of America
Norrich Screw Machine Products
Norwalk Thermostat Co.
Olympic Plastics Co., Inc.
Plastic Age Sales, Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
States Co., The
Telkor, Inc.
Thermo Electric Co., Inc.
Thor Ceramics, Inc.
United States Instrument Corp.

TERMINAL BOARDS

Accurate Electronics Corp.
Aerolite Electronics Corp.
Alac, Inc.
Alden Products Co.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Aerophysics Corp.
American Insulator Corp.
Anchor Specialty Mfg. Co. Inc.
Apahouser Corp. of N. E.
Armel Electronics, Inc.
Associated Engineers, Inc.
Brook Molding Corp.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Buchanan Electrical Products Corp.
CG Electronics Corp.
Cal Connector Co.
California Plasteck Inc.
Cambridge Thermionic Corp.
Cleveland Metal Specialties Co., Electronics Div.
Comco Plastics Inc.
Continental Connector Corp.
Daven Co., The
Double E Products Co.
Electrical Insulation Co., Inc.
Electronic Circuits
Emerson Plastics Corp.
Emmco Plastics Fabricators
Engineered Plastics, Inc.
Excellex Electronics Inc.
Federal Screw Products Inc.
Fisher & Crome
Garde Mfg. Co.
General Products Corp.
Globe Electrical Mfg. Co.
Goe Engrg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hampden Mfg. Co., Inc.
Hobson Brothers, Inc.
Walter K. Jaros Aircrafters
Howard B. Jones Div.-Cinch Mfg. Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kolton Electric Mfg. Co.
Kulka Electric Corp.
Thomas J. Long, Inc.
Lytle Corp.
Martin Machine Works, Inc.
James Millen Mfg. Co. Inc.
Molded Insulation Co.
Molding Corp. of America
Norrich Screw Machine Products
Nylok Corp., The
Olympic Plastics Co., Inc.
Precision Metal Products Co. Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Spruce Pine Mica Co.
States Co., The
Synthane Corp.
Taylor Fibre Co.
Tele Coil Co.
Telkor, Inc.
Thomas & Betts Co., Inc., The
Thor Ceramics, Inc.
Tingstol Co.
Tri-Point Plastics Inc.
Twix Mfg. Co., Inc.
Unified Industries, Inc.
United States Instrument Corp.
Vector Electronic Co., Inc.
Warren Components, Div.-El-Tronics, Inc.

TERMINAL LUG SWAGGERS

AMP Inc.
Alden Products Co.
Amatom Electronic Hardware Co. Inc.
Buchanan Electrical Products Corp
Burndy Corp., Omaton Div.
Cambridge Thermionic Corp.
Double E Products Co.
Globe Electrical Mfg. Co.
Goe Engrg. Co.
Walter K. Jaros Aircrafters
Kulka Electric Corp.
Precision Metal Products Co. Inc.

TERMINAL STRIPS

Accurate Electronics Corp.
Aerolite Electronics Corp.
Allied Plastics Supply Corp.
Amatom Electronic Hardware Co. Inc.
American Aerophysics Corp.
American Insulator Corp.
Apahouser Corp. of N. E.
Armel Electronics, Inc.
Associated Engineers, Inc.
Birnbach Radio Co., Inc.
Blonder-Tongue Labs., Inc.
Milton H. Brooks & Son Engraving & Mfg. Co., Inc.
Buchanan Electrical Products Corp.
Cal Connector Co.
Dejur-Amsco Corp., Electronic Sales Div.
Duralith Corp.
Electric Terminal Corp.
Electrical Insulation Co., Inc.
Emerson Plastics Corp.
Emmco Plastics Fabricators
Erie Resistor Corp.
Excellex Electronics Inc.
Fisher & Crome
G-C Electronics Co.
Garde Mfg. Co.
General Products Corp.
Globe Electrical Mfg. Co.
Goe Engrg. Co.
Hampden Mfg. Co., Inc.
Hobson Brothers, Inc.
Walter K. Jaros Aircrafters
Howard B. Jones Div.-Cinch Mfg. Corp.
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp.
Kings Electronics Co., Inc.
Kolton Electric Mfg. Co.
Kulka Electric Corp.
Thomas J. Long, Inc.
James Millen Mfg. Co. Inc.
Molded Insulation Co.
Norrich Screw Machine Products
Nylok Corp., The
Olympic Plastics Co., Inc.
Precision Metal Products Co. Inc.
Sangamo Electric Co.
Standard Pressed Steel Co.
Stanley-Judd Div.-The Stanley Works
States Co., The
Tele Coil Co.
Telkor, Inc.
Thomas & Betts Co., Inc., The
Thor Ceramics, Inc.
Twix Mfg. Co., Inc.
United States Instrument Corp.
Vector Electronic Co., Inc.
Waterbury Companies, Inc.

TERMINALS

a. Hermetically Sealed
b. Miniature & Subminiature
c. Snap
d. Solderless
e. Standoff
f. Wire & Cable

AMP Inc., **d.**
Abbott Screw & Mfg. Co., **b, c, d.**
Accurate Electronics Corp., **b.**
Alac, Inc., **b, d, e.**
Alden Products Co., **b.**
Alite Div., U. S. Stoneware Co., **a, b, e.**
Alpine Electronic Components, Inc.
Amaton Electronic Hardware Co. Inc., **b, d, e, f**
Armel Electronics, Inc., **e.**
Art Wire & Stamping Co., **a, b.**
Associated Engineers, Inc., **f.**
B G Corp., The, **a.**
L. J. Barwood Mfg. Co. Inc., **d.**
Bead Chain Mfg. Co., The, **b.**
Bendix Aviation Corp., **f.**
Bergen Wire Rope Co., **f.**
Bermite Powder Co., **a, b.**
Birnbach Radio Co., Inc., **b, e, f.**
Blaco Mfg. Co., **d.**
Buchanan Electrical Products Corp., **d, f.**
Burndy Corp., Omaton Div., **d, f.**
Cal Connector Co., **f.**
Cambridge Thermionic Corp., **b.**
Ceramaseal, Inc., **a, e.**
Chemical Micro Milling Co., **b.**
L. L. Constantin & Co., **a.**
Continental Connector Corp., **b, d, e.**
Dage Electric Co., Inc., **a.**
Dante Electric Mfg. Co., **d, f.**
Dejur-Amsco Corp., Electronic Sales Div., **a thr f.**
Deutsch Co., The, Electronic Components Div **a, b, d.**
Dialight Corp., **a, d.**
Du-Co Ceramics Co., **e.**
Electric Terminal Corp., **d, f.**
Emmco Plastics Fabricators, **b.**
Erie Resistor Corp., **e.**
Excellex Electronics Inc., **b, d.**
Federal Screw Products Inc., **d, f.**
Freeman Co., The, **f.**
Fusite Corp., **a, b, e.**
G-C Electronics Co., **d.**
Garde Mfg. Co., **a, b, d, e.**
Garlock Packing Co., The-Electronic Products **b, e.**
General Ceramics Div., Indiana General Corp **a, b.**
Globe Electrical Mfg. Co., **b.**
Goe Engrg. Co., **b.**
Hallett Mfg. Co., **f.**
Harrelson Mfg. Co., **f.**
George E. Harris & Co., Inc., **b.**
Hartwell Aviation Supply Co., **f.**
Heldor Mfg. Co., Inc., **a.**
Hermetic Seal Corp., **a, b.**
Hermetic Seal Corp. & Thermal Controls, Inc., **a thru e.**
Hobson Brothers, Inc., **d.**
Hollingsworth Co., Solderless Terminal Div., **d**
Hunter Tool Co., **d.**
Walter K. Jaros Aircrafters
Javex Electronics, **d, f.**
Joclin Mfg. Co., The, **a, e.**
Kellogg Switchboard & Supply Co., Communica tions Div.-IT&T Corp., **f.**
Kennedy Aircraft Supply Co., **f.**
Keystone Electronics Corp., **b, e.**
Kolton Electric Mfg. Co.
Kulka Electric Corp., **b, d.**
Lab-Tronics, Inc., **d, f.**
Lerco Electronics, Inc., **b, d, e.**
Litton Industries, Inc.
Malco Mfg. Co., **b, c, d, f.**
McCormick Selph Associates, **a, b.**
J. E. Menaugh Co., **f.**
James Millen Mfg. Co. Inc., **b.**
***MINNESOTA MINING & MFG. CO., a, b.**
Mitronics Inc., **a, b.**
Molding Corp. of America, **a, b, d, e.**
Networks Electronic Corp., **a.**
Norrich Screw Machine Products
Nutmeg Screw Machine Products Co., **b.**
Ordnance Research & Development Co., Div. Bermite Powder Co., **a, b.**
Precision Metal Products Co. Inc., **b, e.**
Research Development Mfg. Inc., **b.**
Revere Corp. of America, Sub., Neptune Mete Co., **f.**
Milton Ross Metals Co., The, **a, b, d, e.**
Sealectro Corp.
Sealtron Corp., **a.**
Seeger-Williams, Inc.
C. Sjoberg & Son., **b, d, f.**
Sphere Co. Inc., The, **a, b, d, e.**
Stanley-Judd Div.-The Stanley Works, **f.**
Stevens Co. Inc., **b.**
Strat-O-Seal Mfg. Co., **a.**
Taurus Corp., **b, e.**
Thermo Electric Co., Inc., **f.**
Thomas & Betts Co., Inc., The, **b, d, f.**
Thor Ceramics, Inc., **a, b, e.**
Torwico Electronics, Inc., **a.**
Unified Industries, Inc., **b thru e.**
United Shoe Machinery Corp., **b, e.**
Vaco Products Co., **c, d.**
Vector Electronic Co., Inc., **b, d, e.**
Waltham Screw Co., **b.**
Warren Components, Div. El-Tronics, Inc., **a.**

Whitaker Cable Corp., **f.**
Whitso, Inc., **b, e.**
Wincheste. Electronics, Inc., **a thru f.**
Zierick Mfg. Corp., **c, d, f.**

TERMINATIONS

Alite Div., U. S. Stoneware Co.
Bogart Mfg. Corp.
Burndy Corp., Omaton Div.
Ceramaseal, Inc.
Diamond Antenna & Microwave Corp.
Don-Lan Electronics Inc.
Electric Terminal Corp.
Electrical & Physical Instrument Corp.
Empire Products Sales Corp.
FXR, Inc.
General Ceramics Div., Indiana General Corp.
International Electric Industries, Inc.
Kings Electronics Co., Inc.
Lab-Tronics, Inc.
Lieco, Inc.
Malco Mfg. Co.
Manger Electric Co., Inc.
Meridian Metalcraft, Inc.
Microlab
Molding Corp. of America
Narda Microwave Corp., The
Omega Labs., **Inc.**
Polytechnic Research & Development Co., Inc.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp.
Stoddarf Aircraft Radio Co., Inc.
Taurus Corp.
Victor R. F. & Microwave Co.
Wacline, Inc.

TEST CHAMBERS, ENVIRONMENTAL

Ace Engrg. & Machine Co., Inc.
***AEROJET-GENERAL CORP.**
Aero-Test Equipment Co., Inc.
Aerotest Laboratories, Inc.
Allied International Corp.
American Electronics, Inc.
American Instrument Co., Inc.
American Latex Products Corp.
American Machine & Foundry Co.
American Research Corp.
Anchor Specialty Mfg. Co. Inc.
Associated Testing Labs., Inc.
Atlas Engrg. Corp.
Auto-Control Labs. Inc.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Budd Co., The
Bulova Research & Development Labs., Inc.
Chicago Bridge & Iron Co.
Consolidated Vacuum Corp.
Cryogenerators, Inc.
R. E. Darling Co., Inc.
Delta Design Inc.
Gardner Laboratory, Inc.
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Vacuum Corp.
Hahn & Clay
Hamilton Standard
Harris Refrigeration Co.
Industrial Filter & Pump Mfg. Co.
International Steel Co.
***ITEMCO, INC.**
Jamison Cold Storage Door Co.
Labline, Inc.
R. C. Mahon Co., The
Marquardt Corp., The
Mechanics Research Div., American Machine & Foundry Co.
Missimers Inc.
John Mohr & Sons
Murphy & Miller Inc.
Northeast Metals Industries, Inc.
Pioneer Industries Div., Almar-York Co. Inc.
Propulsion Test Facilities Div.-MB Electronics
Recony Div.-Vinco Corp.
Fred T. Roberts & Co.
Rucker Co., The
Scientific Engrg. Labs., Inc.
Shielding, Inc.
Space Corp.
Standard Cabinet Co., Inc.
State Testing Laboratory Inc.
Statham Development Corp.
Statham Instruments, Inc.
F. J. Stokes Corp.
Temperature Engrg. Corp.
Tenney Engrg., Inc.
Thermon Mfg. Co.
United States Testing Co., Inc.
Universal Dynamics Corp.
Vacuum Specialties Co., Inc.
Webber Engrg. Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Whittaker Controls, Div.-Telecomputing Corp.
Wyle-Burgoyne, Inc.
Wyle-Parameters, Inc.

TEST CHAMBERS, FLIGHT SIMULATION

***AEROJET-GENERAL CORP.**
Aeroscience, Inc.
Aero-Test Equipment Co., Inc.
Allied International Corp.
American Research Corp.
Atlas Engrg. Corp.
Auto-Control Labs. Inc.
Bendix Aviation Corp.
Chicago Bridge & Iron Co.
Dean Products, Inc.
Hahn & Clay
Hamilton Standard
Harris Refrigeration Co.
Huyck Systems Co.
Ideal-Aerosmith, Div.-Royal Industries, Inc.
International Steel Co.
Marquardt Corp., The
Micro Gee Products, Inc.
Missimers Inc.
John Mohr & Sons
Squiers Gage Co.
Standard Cabinet Co., Inc.
State Testing Laboratory Inc.
Temperature Engrg. Corp.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.
Wyle-Parameters, Inc.

TEST EQUIPMENT

a. Accelerator
b. Altitude Simulating
c. Aural
d. Aviation
e. Centrifuge
f. Combustion
g. Corona Ionization
h. Dielectric
i. Electrical
j. Electronic
k. Environmental
l. Flight
m. Humidity
n. Hypersonic
o. Ignition
p. Impact
q. Inertial Guidance
r. Microwave
s. Oxygen System
t. Pneumatic
u. Temperature
v. Vibration

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS, q.**
ACF Electronics Div., ACF Industries Inc., **b, j.**
ACF Industries Inc., **i, j.**
Accessory Controls & Equipment Corp., **d, t.**
Accessory Products Co., Div.-Textron Inc., **t.**
Adage, Inc., **j, q.**
Advanced Electronics, Inc., **j, v.**
Aeroflex Labs. Div., Aeroflex Corp., **a, d, i thru l, p, q, v.**
Aeronca Mfg. Corp.-Aerospace Div., **d, j.**
Aeroscience, Inc., **b.**
Aero-Test Equipment Co., Inc., **a, b, d, e, i thru p, t, u.**
Aero test Laboratories, Inc., **d, i thru l, n, t, u.**
Air Logistics Corp., **j.**
Air Products, Inc., **s.**
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., **s.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **j, r.**
Aircom Inc., **r.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., j.**
Airpax Electronics Inc., Cambridge Div., **j.**
Airpax Electronics Inc. Seminole Div., **j.**
Airtron, Div.-Litton Industries, **r.**
Alfred Electronics, **j, r.**
All American Engrg. Co., **d.**
Allen Electric & Equipment Co., **d, f, i, j, o.**
Allied International Corp., **d, k, l, t.**
Amerac Inc., **j, r.**
American Electronics, Inc., **k.**
American Instrument Co., Inc., **b, k, m, u.**
American Machine & Foundry Co., **e, k, p.**
American Machine & Foundry Co., Government Products Group, **e, u.**
American Research Corp., **b, d, g, k, l, m, t, u.**
American Research & Mfg. Corp., **s, t, v.**
Anaheim Electronics Div.-Electronic Engrg. Co. of Calif., **j.**
Anchor Specialty Mfg. Co. Inc., **a, b, d, e, i thru m, o, q, s thru v.**
Applied Dynamics Corp., **r.**
Applied Radiation Corp., **a.**
Arch Gear Works Inc.
Arkay Engrg., Inc., **j.**
Armament Div.-Universal Match Corp., **j, l, o.**
Arnolt Corp.
Aro Equipment Corp., The, **s.**
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., **k, s.**
Associated Research, Inc., **g, h, i.**
***ASSOCIATED TESTING LABS., INC., a, b, e, f, i, j, k, m, o, p, t, u, v.**
Atlas Engrg. Corp., **k, u.**
Auto-Control Labs. Inc., **b, f, k, m, p, t, u.**
Autonetics, Div.-North American Aviation, Inc., **j, q.**
Avien, Inc., **d.**
Avo Ltd., **i, j.**
Avtron Mfg., Inc., **i, j, k.**
B & H Instrument Co., Inc., **u.**
B & K Instruments, Inc., **j.**
Babcock Radio Engrg., Inc., **j.**
Baird-Atomic, Inc., **j.**
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., **p.**
Barnes Development Co., **i, j.**
Barry Controls, Inc., **p.**
Beckman Instruments, Inc., Berkeley Div., **j, r.**
Belock Instrument Corp., **b, k, q.**
Bendix Aviation Corp., **b, d, j, l, q thru t.**
Bendix Aviation Corp., Cincinnati Div., **j, q.**
Bendix Aviation Corp., Pioneer-Central Div., **d, s.**
Bendix Aviation Corp., York Div., **r.**
Bendix Corp., The, Eclipse-Pioneer Div., **d, h, j, l, q.**
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., b, d, i thru l, t, u.**
Bermite Powder Co., **o, p.**
Bernco Engrg. Corp., **d, i, j.**
James G. Biddle Co., **g, h, i.**
A. Biederman, Inc., **i, k, m, s, u, v.**
Blonder-Tongue Labs., Inc., **c, v.**
Bogue Electric Mfg. Co., **i.**
Arthur E. Booth Co., **i.**
Bowser, Inc., **k.**
Bowser Inc., Defense Div., **d.**
Briggs Associates, Inc., **g, j.**
Bruno-New York Industries Corp., **j, r.**
Budd Co., The, **k, v.**
Budd Lewyt Electronics, Inc., **j, k, m, r, t, u.**
Bulova Research & Development Labs., Inc., **k.**
Burr-Brown Research Corp., **j, u.**
Calidyne Co., Inc., The, Sub.-Ling-Altec Electronics, Inc., **v.**
Calvert Electronics Inc., **h, i, j, o.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **k, l, r.**
Cardell Mfrs., **i.**
Central Research Labs., Inc., **h.**
Chadwick-Helmuth Co., **k, v.**
Chalco Engrg. Corp., **i, j.**
Chance Vought Aircraft, Inc., **i thru l, q.**
Chase Electronics Motor Div., Inc., **j.**
Chemalloy Electronics Corp., **r.**
Chicago Bridge & Iron Co., **b, k.**
Cincinnati Sub Zero Products, **b, k, m, u, v.**
Clegg Labs., Div.-Clegg, Inc., **j, r.**
Cleveland Instrument Co., **j.**
Collins Radio Co., **d, r.**
Columbia Research & Development Corp., **t.**
Compudyne Corp., **a, b, d, j, l, n, u, v.**
Conoflow Corp., **b, t.**
Consolidated Diesel Electric Corp., **i, t.**
***CONSOLIDATED ELECTRODYNAMICS CORP., i thru l, v.**
Consolidated Vacuum Corp., **b, k.**
Control Electronics Co., Inc., **j, r.**
Convair Instruments, Convair Div.-General Dynamics Corp., **m.**
Cornelius Co., The, Aero Div., **t.**
Cornell Deep Drawing Co., Div.-Lanes Industries Corp., **t.**
Cosa Corp., **v.**
Courter Products, Div.-Model Engrg. & Mfg., Inc., **j.**
Cubic Corp., **j, r.**
Curtiss-Wright Corp., Electronics Div., **j.**
Curtiss-Wright Corp., Princeton Div., **n.**
Curtiss-Wright Corp., Santa Barbara Div., **i, j.**
Custom Component Switches Inc., **t.**
Dalmo Victor Co., Div.-Textron, Inc., **r.**
R. E. Darling Co., Inc., **b, d, h thru k, m, s, u, v.**
Daven Co., The, **i, j.**
Davenport Mfg. Co., **i, j.**
Davidson Optronics, Inc., **q.**
Daystrom Inc., Weston Instruments Div., **i, j.**
Dayton Aircraft Products, Inc., **g.**
Dean Products, Inc., **b, k.**
Decker Corp., The, **h, m.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **d.**
Dejur-Amsco Corp., Electronic Sales Div., **d, i.**

Delsen Corp., **h.**
Delta Design Inc., **b, k, u.**
Demornay-Bonardi, **r.**
Designers for Industry, Inc., **i, j, v.**
Desomatic Products, Inc.-Anders-Driline, **m.**
Development Engrg. Co., Inc., **b, k, m, u.**
Diamond Antenna & Microwave Corp., **r.**
W. C. Dillon & Co., Inc., **d.**
Dit-Mco, Inc., **i.**
Djeco, Div.-Djordjevic Engrg. Co., **i, j.**
Douglas Microwave Co., Inc., **r.**
Driaire, Inc., **m.**
Du Kane Corp., **i, j.**
Allen B. Du Mont Labs., Inc., **d, f, j, l, o, q.**
Dunn Engrg. Associates Inc., **j, q.**
Dynatronics, Inc., **j.**
Dytronics Co., **j.**
Eastern Specialty Co., The, **i.**
Eastman Kodak Co., **i, j.**
Electro Impulse Lab., Inc., **i, j.**
Electro Instruments, Inc., **h, j.**
Electro Precision Corp., **j.**
Electro Scientific Industries, **i, j.**
Electronic Applications, Inc., **h, r.**
Electronic Engrg. Co. of California, **j.**
Electronic Measurements Corp., **j.**
Electron-Radar Products, **r.**
Electro-Pulse, Inc., **b, j.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **j.**
Ellison Draft Gage Co., Inc., **f, s.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **b, c, d, k, l, p, q, r.**
Empire Products Sales Corp., **j, r.**
Endevco Corp., **k, v.**
Epic, Inc., **h, i, u, v.**
Erdco Engrg. Corp., **i, j, t.**
Erie Instrumation, Div.-Erie Resistor Corp., **j.**
Fairchild Astrionics Div., Fairchild Engine & Airplane Corp., **i, j, r.**
Farwest Mfg. Div., Inc., **i, j.**
J. W. Fecker Div., American Optical Co., **a, q.**
Fenwal Inc., **u.**
Ferrotran Electronics Co., Inc., **j.**
Fischer & Porter Co., **u.**
Fla. Aircraft Radio & Marine, **j.**
Flight Support, Inc., **d, i, j, l, q, s, t.**
Fluid Power Inc., **s.**
Ford Instrument Co., Div.-Sperry Rand Corp., **q.**
Foto-Video Labs., Inc., **i, j.**
Gardner Laboratory, Inc., **e, f, k, m, p, u.**
Garwin, Inc., **d, i, j.**
Gates Electronic Co., **j.**
General Communication Co., **j, r.**
General Electric Co., Apparatus Sales Div., **i.**
General Electric Co., Missile & Space Vehicle Dept., **i, j.**
General Electric Co., Missile & Space Vehicle Dept., Pa., **j, r.**
General Instrument Corp., Defense & Engrg. Products Group
General Kinetics Inc., **j.**
General Laboratory Associates, Inc., **o.**
General Mills, Inc.
General Radio Co., **j, v.**
General Regulator Corp., **t.**
General Scientific Equipment Co., **m.**
Genisco, Inc., **a, e, k, q, v.**
Claud S. Gordon Co., **u.**
Gordon Enterprises, **j, l.**
Gray Instrument Co., **i.**
Gray Mfg. Co., The, **j.**
Grove Valve & Regulator Co., **t.**
Guardite Co., Div.-American-Marietta Co., **b, k, m, u.**
Guided Missile Div., The Firestone Tire & Rubber Co., **l, t.**
Gulton Industries, Inc., **k, v.**
Gyrex Corp., The, **a, e, k, u.**
B. H. Hadley, Inc., **k, m, s thru v.**
Hallamore Electronics Co., Div.-Siegler Corp., **d, i thru l.**
Hallicrafters Co., The, **r.**
Hallikainen Instruments, **u.**
Hamilton Standard, Div.-United Aircraft Corp., **k.**
Hamilton Watch Co., Military Products Div., **e, i.**
Hammett-Mercury-Rex Div., **d, h, i, j, l, o, r, u.**
George E. Harris & Co., Inc., **d.**
Harris Refrigeration Co., **k, m,** u.
Haskel Engrg. & Supply Co., **s.**
A. W. Haydon Co., The, **i.**
Hays Corp., The, **f.**
Hazeltine Electronics Div.-Hazeltine Corp., **j, r.**
Herlo Corp., **s, t.**
Hewlett-Packard Co., **j, r.**
Hickok Electrical Instrument Co., The, **i, j.**
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., **b, k.**
Highland Engrg. Co., **t.**
E. Vernon Hill & Co., **k, m, u, v.**
Carl Hirschmann Co., Inc., **p, v.**
Hofman Labs., Inc., **s.**
C. G. Hokanson Co., Inc., **k.**
Hughes Tool Co., Aircraft Div., **i, j, t.**
Humidial Co., **m.**
Huyck Systems Co., **b, l.**
I-L-S Instrument Div., The Meriam Instrument Co., **i, j.**
ITE Circuit Breaker Co., Special Products Div., **r.**
ITI Electronics, Inc., **j.**
ITT Federal Div., International Telephone & Telegraph Corp., **j, r.**
Ideal Industries, Inc., **i.**
Ideal-Aerosmith, Div.-Royal Industries, Inc., **a, b, t.**
Illinois Testing Laboratories, Inc., **u.**
Impact-O-Graph Corp., The, **p.**
Industrial Acoustics Co., Inc., **d.**
Industrial Control Co., **l.**
Industrial Engrg. Corp., **j, t, u.**
Industrial Equipment Div., Baldwin-Lima-Hamilton Corp., **e.**
Industrial Instruments Inc., **h, i, j.**
Industrial Test Equipment Co., **j.**
Integrated Dynamics Div., Globe Industries, Inc., **e, q.**
Intercontinental Dynamics Corp., **b, d, i, j, t.**
International Electronic Research Corp., **j.**
International Equipment Co., **a, e.**
International Fermont Machinery Co., Inc., **i.**
***ITEMCO, INC., b, k, m, u.**
Jack & Heintz, Inc., **i.**
Jan Hardware Mfg. Co., Inc., **p.**
Janke & Co., Inc., **d, t.**
Kahn & Co., Inc., **d, i, j, m, t, u, v.**
Kay Electric Co., **c, j, r, v.**
***KEARFOTT DIV., GENERAL PRECISION, INC., d, i, j, q, r.**
***KEARFOTT DIV., GENERAL PRECISION, INC., MICROWAVE PRODUCTS, r.**
Keithley Instruments, Inc., **j.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **i.**
Wayne Kerr Corp., **r, v.**
Kieley & Mueller, Inc., **t.**
Kin Tel Div.-Cohu Electronics, Inc., **j.**
Kingston Electronics-Div.-Kingston Industries Inc., **j.**
Knopp Inc., **i.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **b, c, d, i, j, l.**
L. A. B. Corp., **p.**
Labline, Inc., **e, k, m.**
Lab. for Electronics, Inc., **d, j, r.**
Lampkin Labs., Inc., M. R. Div., **j.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **v.**
Langley, Corp., **t, u.**
Lavoie Labs., Inc., **j.**
Leach Corp., **k.**
Lear, Inc., **d, j, l, o, q, t.**
Lee Electric & Mfg. Co., **i.**
Leeds & Northrup Co., **f, m, t, u.**
Leemath Inc., **q.**
***WALLACE O. LEONARD, INC., b, l, t.**
Levinthal Electronic Products, Inc., **j, r.**
***LEWIS ENGRG. CO., THE, u.**
Lieco, Inc., **r.**
Ling Electronics Div.-Ling-Altec Electronics, Inc., **v.**
Liquidometer Corp., The, **j.**
Lockheed Aircraft Corp., Missiles & Space Div., **i, j.**
Lockheed Electronics Co., Stavid Div., **r.**
MB Electronics, **v.**
M-D Blowers, Inc., **t.**
Magnaflux Corp., Sub.-General Mills, Inc., **j.**
Magnetic Instrument Co. Inc., **j.**
Magtrol, Inc., **j.**
Manson Labs., Inc., **h, r.**
Marconi Instruments, **j.**
Marquardt Corp., The, **b, l, n.**
***MARTIN CO., THE, DENVER DIV., b, f, h thru k, m, q, r, t, u, v.**
Martin-Decker Corp., **t.**
Massa Div.-Cohu Electronics, Inc., **v.**
W. L. Maxson Corp., The, **d.**
McGregor Mfg. Corp., **e.**
Micro Gee Products, Inc., **a, b, d, j, l.**
Northeast Electronics Corp., **j.**
Northeastern Engrg. Inc., **j, q.**
Northrop Corp., **a, d, e, i thru l, n, p, q, v.**
Nortronics, Div.-Northrop Corp., **j, l, q.**
Paul Nurches Co., **j.**
Omega Labs., Inc., **r.**
Opad Electric Co., **h.**
Optomechanisms Inc., **q, v.**
Orbitran Co., Inc., **j.**
Ordnance Research & Development Co., Div.-Bermite Powder Co., **o, p.**
Otis Elevator Co., Defense & Industrial Div., **i, j, q, t.**
Oxygen Equipment & Service Co., **s.**
Pace Engrg. Co., **d, l.**
Pacific Mercury Electronics, **j, l, p.**
Packard-Bell Electronics Corp., **d, i, j, r.**
Paco Electronics Co., Inc., **i, j, l.**
Palmer Thermometers, Inc., **u.**
Panoramic Radio Products, Inc., **j, k, p, r, v.**
Pegasus Labs., Inc., **p, v.**
Performance Measurements Co., **d, j, l.**
Peschel Electronics, Inc., **g thru j.**
Philco Corp.-Govt. & Industrial Group, **j, r.**
Photron Instrument Co., **j.**
Piasecki Aircraft Corp., **e, i, j, p, v.**
Pimex, Inc., **m.**
Pioneer Industries Div., Almar-York Co. Inc., **j.**
Piqua Engrg. Inc., **h, i.**
Pitometer Log Corp., **j, r.**
Polarad Electronics Corp., **j, r.**
Polytechnic Research & Development Co., Inc., **r.**
Projects Unlimited, Inc., **i, j, u.**
Propulsion Test Facilities Div.-MB Electronics, **b, u, v.**
Pyrometer Instrument Co., Inc., **u.**
Quan-Tech Labs., Inc., **j.**
REF Mfg. Corp., **d, i, j, t.**
Radalab Inc., **i thru l.**
Radar Design Corp., **r.**
Radiaphone Co. Inc., **d, l.**
Radiation, Inc., **j, k.**
Radio City Products Co. Inc., **r.**
***RADIO CORP. OF AMERICA, j.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, d, i, k, l, r, v.**
***RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY, j.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **j, r.**
Ram Meter Inc., **i, j.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **i, j, r.**
Rantec Corp., **r.**
Raymond Engrg. Lab., Inc., **a.**
Recony Div.-Vinco Corp., **k, m, t, u.**
Reed Instrument Co., **j, v.**
Reed Research Inc., **j, v.**
Reeves Instrument Corp., **q.**
Republic Aviation Corp., Missile Systems Div., **i, j, r.**
Rese Engrg., Inc., **j.**
Research Controls, **t.**
Research, Inc., **g, k, u.**
Research Indsl. Lab. of Electronics, **j.**
Micrometrical Mfg. Co., **v.**
Microwave Associates, Inc., **r.**
Midwestern Instruments, Inc., **i thru l.**
James Millen Mfg. Co. Inc., **j.**
Millipore Filter Corp., **k.**
Minco Products, Inc., **u.**
Minneapolis-Honeywell Regulator Co., Aeronautical Div., **d, l, q.**
Minneapolis-Honeywell Regulator Co., Boston Div., **a, q.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **i, j, s, t, u.**
Mira Corp., The, **j, s, u, v.**
Missimers Inc., **b, f, k, m, u.**
Mitchell Camera Corp., **t.**
Motorola, Inc., **i, j, r.**
Muirhead Instruments Inc., **g, i, j, v.**
Multi-Amp Electronic Corp., **i.**
Murphy & Miller Inc., **b, k, m, u.**
George L. Nankervis Co., **d, i, j, l, t, u.**
Narda Microwave Corp., The, **r.**
National Co., Inc., **i, j, r.**
National Electronics, **i, u.**
National Instrument Laboratories, Inc., **s, t.**
National Scientific Labs., Inc., **j.**
Navigation Computer Corp., **j.**
New England Scientific Instruments Co., **i, m.**
New London Instrument Co., Inc., **j.**
Nilsson Electrical Lab., Inc., **i, j.**
Non-Linear Systems, Inc., **j.**

Resistoflex Corp., **k, t, u, v.**
Fred T. Roberts & Co., **k, s, t.**
Rosemount Engrg. Co., **u.**
Rucker Co., The, **a, e, k, t.**
Ryan Industries, Inc., Dept. M., **s.**
St. John X-Ray Laboratory
Sargent Engrg. Corp., **k, p, s thru v.**
Scanivalve Co., **t.**
Schaevitz Engrg., **a, e, k, p.**
Schaffer Air Industries, Inc., **d, i, s, t.**
Scientific Electric Inc., **j.**
Scientific Engrg. Co., **t.**
Scientific Engrg. Labs., Inc., **b, k.**
Scientific-Atlanta, Inc., **r.**
Scintilla Div., Bendix Aviation Corp., **o.**
Seco Mfg. Co., **j.**
Sensitive Research Instrument Corp., **i.**
Servicair Co., **o.**
Servo Consultants Ltd., **i, j.**
Servomechanisms, Inc., **b, t.**
Servo-Tek Products Co., **j.**
Shallcross Mfg. Co., **h.**
Sharples Corp., The, **e.**
Sierra Engrg. Co., **s.**
Simpson Electric Co., **u.**
Skyproducts, **t.**
Skyvalve, Inc., **t.**
Slaughter Co., Inc., **h, i, j.**
Small Motors Inc., **i.**
E. C. Smith Mfg. Co., Inc., **u.**
Solar Aircraft Co., **j.**
Sonex, Inc., **j.**
South Wind Div., Stewart Warner Corp., **f, k, t.**
Southwest Research Institute, **a, p, t, v.**
Southwestern Industrial Electronics Co., **j, v.**
Southwestern Valve Corp., **t.**
Specialties, Inc., **d.**
Specialty Electronics Development Corp., **j, r.**
Spectralab Instruments, **j, r.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **r.**
Standard Cabinet Co., Inc., **b, k, m, t, u.**
State Testing Laboratory Inc., **k, u.**
Statham Development Corp., **k, u.**
Statham Instruments, Inc., **a, k, v.**
***STELLARDYNE LABS., INC., a, b, e, i, j, k, m, p, s thru v.**
Stephens Trusonic Inc., **k, v.**
Stewart-Warner Electronics Div., **i, j, r.**
Stromberg-Carlson Div.-General Dynamics Corp., **j, l, p, r.**
Sun Electric Corp., Aeronautical Div., **d, f, i, j, o, s, t, v.**
Sunshine Scientific Instrument, **g, i, j.**
B. K. Sweeney Mfg. Co., **h, j, u.**
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc., **r.**
Systron Corp., **j.**
TRG, Inc., **r.**
Taffet Electronics, Inc., **b, d, i, j, l, r.**
Tally Register Corp., **i, j.**
Technical Electronics Co. Div.-Consolidated Electronic Industries, **h.**
Technology Instrument Corp., **i, j.**
Technoproducts, Inc., **f, p.**
Tektronix, Inc., **j.**
Telechrome Mfg. Corp., **j, r.**
Telectro Industries Corp., **i, j.**
Tel-Instrument Electronics Corp., **v.**
Telonic Industries, Inc., **j, r.**
Temperature Engrg. Corp., **b, k, m, u.**
Tenney Engrg., Inc., **b, k, m, u.**
Texas Instruments Inc., **j.**
Thermal Research & Eng. Corp., **f, t, u.**
Thermo Electric Co., Inc., **u.**
Thermon Mfg. Co., **i, u.**
Theta Instrument Corp., **d, l, q.**
Thomas Electronics, Inc., **i, j.**
Tinius Olsen Testing Machine Co., **p.**
Topatron, Inc., **b, j, r.**
Trans-Sonics, Inc., **u.**
Trimount Instrument Co., **h.**
Trio Laboratories, Inc., **i, j.**
Triplett Electrical Instrument Co., **i, j.**
Tucson Instrument Corp., **d.**
Twix Mfg. Co., Inc., **b, k, p, v.**
Ultra-Violet Products, Inc., **s.**
Unholtz-Dickie Corp., **k, v.**
Unit Process Assemblies, Inc., **j.**
United Electric Controls Co., **u.**
United Mfg. Co., Div., The W. L. Maxson Corp., **d, i, t.**
U. S. Industries, Inc., **j, l, v.**
U. S. Science Corp., Div.-Topp Industries, Inc., **d, i, j.**
United States Testing Co., Inc., **h thru k, m, p, u, v.**
Universal Dynamics Corp., **m.**
Valor Instruments, Inc., **j.**
Varo Mfg. Co., Inc., **i, j.**
Victor R. F. & Microwave Co., **r.**
Victory Engrg. Corp., **u.**
Video Instruments Co., Inc., **v.**
Wallson Associates, Inc., **i, j.**
Waltham Electronics Corp., **j.**
Wang Labs., Inc.
Warren Components, Div.-El-Tronics, Inc., **m.**
Waveline, Inc., **r.**
Webber Engrg. Corp., **b, k, m, u.**
Webber Mfg. Co., Inc., **b, k, m, u.**
Wells Industries Corp., **d, m, t.**
Weltronic Co., **j.**
Westberg Mfg. Co., **o.**
Westinghouse Electric Corp., **d, i, j, k, n, u, v.**
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., **j.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **i, j.**
Whittaker Controls, Div.-Telecomputing Corp., **s thru v.**
Wiancko Engrg. Co., **j, t.**
Winder Aircraft Corp. of Florida, **i, j.**
Wolverine Diesel Power Co., **k.**
Wyle Mfg. Corp., **b, k, m, p, u, v.**
Wyle-Burgoyne, Inc., **b, k, u.**
Wyle-Parameters, Inc., **b, k, m, u.**
Zep Aero, **s.**

TEST LEADS

Accurate Electronics Corp.
Aerolite Electronics Corp.
Amatom Electronic Hardware Co., Inc.
American Smelting & Refining Co.
Anchor Specialty Mfg. Co., Inc.
J. T. Baker Chemical Co.
Bendix Aviation Corp., Cincinnati Div.
Bernco Engrg. Corp.
Birnbach Radio Co., Inc.
Bruno-New York Industries Corp.
Bud Radio, Inc.
Calvert Electronics Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Allen B. Du Mont Labs., Inc.
Eastern Specialty Co., The
Empire Electronics Co., Inc.
G-C Electronics Co.
International Electric Industries, Inc.
Javex Electronics
Keystone Electronics Corp.
Lab-Tronics, Inc.
***MARTIN CO., THE, DENVER DIV.**
Paul Nurches Co.
Paco Electronics Co., Inc.
Pomona Electronics Co., Inc.
Precise Development Corp.
Projects Unlimited, Inc.
Radio City Products Co. Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Schaffer Air Industries, Inc.
Skytronics, Inc.
Specialty Electronics Development Corp.
Sunshine Scientific Instrument

TEST STANDS, STATIC

Accessory Products Co., Div.-Textron Inc.
***AEROJET-GENERAL CORP.**
Aeroscience, Inc.
Aero-Test Equipment Co., Inc.
Aerotest Laboratories, Inc.
Air Logistics Corp.
Anchor Specialty Mfg. Co. Inc.
Arde-Portland, Inc.
Arnolt Corp.
Auto-Control Labs, Inc.
Basic Tool Industries, Inc.
Beacon Steel Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Cromer Mfg. & Engrg., Inc.
Devco Engrg. Inc.
Dynametrics Corp.
Eclipse-Pioneer Div., Bendix Aviation Corp.
Farwell Metal Fabricating
Ford Instrument Co., Div.-Sperry Rand Corp.
General Electric Co., Missile & Space Vehicle Dept., Pa.
Gray Mfg. Co., The
Guided Missile Div., The Firestone Tire & Rubber Co.
Hamilton Standard
Haskel Engrg. & Supply Co.
Herlo Corp.
Hughes Tool Co., Aircraft Div.
Industrial Acoustics Co., Inc.
International Fermont Machinery Co., Inc.
Jonco Aircraft Corp., Sub.-Fairchild Engine & Airplane Corp.
Kahn & Co., Inc.
Kellett Aircraft Corp.
Ledeen Inc.
Machine Products Div., New Haven Trap Rock Co.
Marquardt Corp., The
***MARTIN CO., THE, DENVER DIV.**
Mullenbach Div.-Electric Machinery Mfg. Co.
George L. Nankervis Co.
Northeast Metals Industries, Inc.
Northrop Corp.
Ozone Metal Products Corp.
P. B. R. Mfg. Co.
Richard Philip Co.
Philips & Davies Inc.
Piasecki Aircraft Corp.
Projects Unlimited, Inc.
Recony Div.-Vinco Corp.
Rucker Co., The
Sancor Corp.
Sargent Engrg. Corp.
Space Corp.
Squiers Gage Co.
Stearns-Roger Mfg. Co., The
Sun Electric Corp., Aeronautical Div.
Temco Aircraft Corp.
Thiokol Chemical Corp., Hunter-Bristol Div.
Tucson Instrument Corp.
Twin Coach Co., Aircraft-Missiles
Vickers, Inc., Mich.
Wells Industries Corp.
Westinghouse Electric Corp.
Winder Aircraft Corp. of Florida
Wolverine Diesel Power Co.

TEST UNITS, ACCELERATION, MILITARY

All American Engrg. Co.
American Machine & Foundry Co., Government Products, N. Y.
Anchor Specialty Mfg. Co. Inc.
Associated Testing Labs., Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
***ENGIS EQUIPMENT CO.**
Genisco, Inc.
Northrop Corp.
Otis Elevator Co., Defense & Industrial Div.
Raymond Engrg. Lab., Inc.
Rimak, Inc.
Rucker Co., The
United States Testing Co., Inc.
Wiancko Engrg. Co.

TESTERS

a. Amplitude Linearity
b. Automatic Tube
c. Battery
d. Cable
e. Capacitor
f. Cathode Ray Tube
g. Circuit
h. Coat Thickness
i. Coil
j. Color Infrared
k. Continuity
l. Crystal Testing
m. Diode
n. Distortion
o. Induction
p. Insulation
q. Insulation Breakdown
r. Meter
s. Microwave
t. Theodolite

Aero-Test Equipment Co., Inc., **g.**
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc., **g, l, m, s.**
Aircom Inc., **s.**
Airpax Electronics Inc., Cambridge Div., **r.**
Airpax Electronics Inc., Seminole Div., **r.**
Airtron, Div.-Litton Industries, **s.**
Allen Electric & Equipment Co., **c, r.**
Amerac Inc., **s.**
American Electronics, Inc., Nuclear Div., **e, l, m.**

American Instrument Co., Inc., **h.**
***ASKANIA-WERKE, U. S. BRANCH OFFICE, t.**
Associated Research, Inc., **d, e, k, p, q, r.**
***ASSOCIATED TESTING LABS., INC., g, k.**
Avo Ltd.
Baird-Atomic, Inc., **m.**
Barnes Development Co., **l, m.**
Bendix Aviation Corp., **d, k.**
Bendix Aviation Corp., Cincinnati Div., **g.**
Bennett-Feragen
Bernco Engrg. Corp., **g, k.**
James G. Biddle Co., **d, h, i, k, p, q.**
Bogue Electric Mfg. Co., **c.**
Arthur E. Booth Co., **r.**
Branson Instruments, Inc., **h.**
Briggs Associates, Inc., **d, k.**
Bruno-New York Industries Corp., **s.**
Bulova Research & Development Labs., Inc., **l.**
Calvert Electronics Inc., **c thru g, p, q, r.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **a.**
Chemalloy Electronics Corp., **s.**
Cincinnati Sub Zero Products, **p.**
Clegg Labs., Div.-Clegg, Inc., **b.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., d, q.**
Consolidated Airborne Systems, Inc., **a, e, p.**
Control Electronics Co., Inc., **s.**
Cornell-Dubilier Electric Corp., **e.**
Crosby-Teletronics Corp., **m.**
Curtiss-Wright Corp., Princeton Div., **p, q.**
Dale Products, Inc., **d, g, k, p, q.**
Daven Co., The, **m, n.**
Davenport Mfg. Co., **p, q, r.**
Davidson Optronics, Inc., **t.**
Daystrom Inc., Weston Instruments Div., **b, g, h, k, p, q, r.**
Delsen Corp., **p.**
Demornay-Bonardi, **s.**
Designers for Industry, Inc., **d, h, i, m.**
Development Engrg. Co., Inc., **m.**
Dit-Mco, Inc., **d, g, k, p.**
Djeco, Div.-Djordjevic Engrg. Co., **h.**
Dorne & Margolin, Inc., **l.**
Du Kane Corp., **g, k.**
Allen B. Du Mont Labs., Inc., **f.**
Eastern Specialty Co., The, **r.**
Eclipse-Pioneer Div., Bendix Aviation Corp., **q.**
Electrical & Physical Instrument Corp., **d.**
Electro Instruments, Inc., **b thru e, g, i, k, m, p.**
Electro Scientific Industries, **e.**
Electronic Applications, Inc., **s.**
Electronic Brazing Co., **p, q.**
Electronic Measurements Corp., **e.**
Electro-Seal Corp., **q.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **s, t.**
Empire Products Sales Corp., **n, s.**
***ENGIS EQUIPMENT CO., t.**
Epic, Inc., **d, p.**
Erdco Engrg. Corp., **d, e.**
Fleetwood Labs., Inc.
Flight Support, Inc., **g, k.**
Flite-Tronics, Inc., **m.**
Food Machinery & Chemical Corp., Ordnance Div., **d, g.**
Gardner Laboratory, Inc., **h.**
General Communication Co., **s.**
General Electric Co., Apparatus Sales Div., **h, q.**
General Electric Co., Missile & Space Vehicle Dept., Pa.
General Radio Co., **e, p.**
General Scientific Equipment Co., **b.**
Gordon Enterprises, **t.**
Gray Instrument Co., **g, k.**
Gulton Industries, Inc., **e.**
W. & L. E. Gurley, **t.**
Hammett-Mercury-Rex Div., **c, f, l, r, s.**
Hewlett-Packard Co., **s.**
Hickok Electrical Instrument Co., The, **a, b, c, f, g, m.**
Holtzer-Cabot Div., National Pneumatic Co., Inc., **p.**
Hunter Tool Co., **g.**
Ideal Industries, Inc., **g, p.**
Industrial Instruments Inc., **e, p, q.**
Industrial Test Equipment Co., **e, i, p.**
Instruments for Industry, Inc., **g.**
Jan Hardware Mfg. Co., Inc., **e, l, m.**
Janco Corp., **p.**
Kahn & Co., Inc., **e, k.**
Kay Electric Co., **d, n, s.**
Wayne Kerr Corp., **e, n.**
Keystone Electronics Corp., **k.**
Lab. for Electronics, Inc., **s.**
Lavoie Labs, Inc., **g.**
Lear, Inc., **c, g, k, m.**
Leeds & Northrup Co., **d.**
Leemath Inc., **d.**
Manson Labs., Inc., **q, s.**
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co., **r.**
***MARTIN CO., THE, DENVER DIV., c, d, g, k, m, n, p thru s.**
Martindale Electric Co., **p.**
Micro Gee Products, Inc., **a.**
Microwave Associates, Inc., **s.**
James Millen Mfg. Co. Inc., **i.**
Minneapolis-Honeywell Regulator Co., Missile Equipment Div., **b, d, g.**
Modern Design Div.-H. C. Schloer, Inc., **g, k.**
Motorola, Inc., **g, m, s.**
Multi-Amp Electronic Corp., **p, r.**
National Co., Inc., **g, k, s.**
Nilsson Electrical Lab., Inc., **r.**
Northrop Corp., **g, k.**
Opad Electric Co., **c, d, k, p, q.**
Optimized Devices, Inc., **g, k, m.**
Optomechanisms Inc., **t.**
Owen Labs., Inc., **m.**
Pacific Automation Products, Inc., **d.**
Packard Bell Computer Corp., **g.**
Packard-Bell Electronics Corp., **s.**
Paco Electronics Co., Inc., **c thru g, l, m, n, r.**
Panoramic Radio Products, Inc., **n.**
Performance Measurements Co., **g, k.**
Peschel Electronics, Inc., **d, e, g, k, p, q.**
Philco Corp.-Govt. & Industrial Group, **g, s.**
Pioneer Industries Div., Almar-York Co. Inc., **f.**
Piqua Engrg. Inc., **d.**
Polarad Electronics Corp., **s.**
Polytechnic Research & Development Co., Inc., **s.**
Precision Apparatus Co., Inc., **a, b, c, e, f, l, n, r.**
Projects Unlimited, Inc., **d, g, k, q.**
Radar Design Corp., **s.**
Radiation, Inc., **n.**
Rantec Corp., **s.**
Rese Engrg., Inc., **g.**
Research Indsl. Lab. of Electronics, **b, f, h, k, m.**
Rimak, Inc., **a, e, f, g, i, l thru o, r, s.**
Santa Barbara Research Center, **j.**
Schaffer Air Industries, Inc., **c, d, g.**
Scientific-Atlanta, Inc., **s.**
Scopes Co., Inc., The, **l, m.**
Seco Mfg. Co., **b.**
Servo-Tek Products Co., **r.**
Shallcross Mfg. Co., **p.**
Simpson Electric Co., **c, e, g.**
Slaughter Co., Inc., **d, g, k, p, q.**
Solar Aircraft Co., **g.**
Sonotone Corp., **c.**
Southwest Research Institute, **t.**
Southwestern Industrial Electronics Co., **e.**
Special Products Dept., Melpar, Inc., **d.**
Specialty Electronics Development Corp., **d, k.**
Spectralab Instruments, **q, s.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **b, s.**
States Co., The, **q, r.**
Herman H. Sticht Co., Inc., **d, g, k, p.**
Strand Engrg. Co., **g, k.**
Stromberg-Carlson Div.-General Dynamics Corp., **d, g, s.**
H. W. Sullivan Ltd., **e, o.**
Sun Electric Corp., Aeronautical Div., **c, d, f, g, i, p, q, r.**
Sunshine Scientific Instrument, **d, h, i, r.**
B. K. Sweeney Mfg. Co., **e, p.**
TRG, Inc., **s.**
Technical Electronics Co. Div.-Consolidated Electronic Industries, **d, e, g, o, q.**
Technology Instrument Corp., **e, k.**
Texas Instruments Inc., **e, g, m.**
Theta Instrument Corp., **a.**
Thomas Electronics, Inc., **f.**
Transistor Electronics Corp., **m.**
Triplett Electrical Instrument Co., **b, f, g.**
Ultra-Violet Products, Inc., **g.**
Unit Process Assemblies, Inc., **h.**
U. S. Science Corp., Div.-Topp Industries, Inc., **a, e, k.**
United States Testing Co., Inc., **e.**
Valor Instruments, Inc., **m.**
Wallson Associates, Inc., **m.**
Western Union Telegraph Co., The, **n.**
Westinghouse Electric Corp., **m.**
Wickes Engrg. & Construction Co., **d, q.**

THERMAL CONDITIONING EQUIPMENT

American Instrument Co., Inc.
American Machine & Foundry Co., Government Products, N. Y.
***ASSOCIATED TESTING LABS., INC.**
Barber-Colman Co.
Blue M Electric Co.
Budd Lewyt Electronics, Inc.
Hallicrafters Co., The
Hermetic Seal Corp. & Thermal Controls, Inc.
International Electronic Research Corp.
***ITEMCO, INC.**
Janitrol Aircraft Div.-Midland-Ross Corp.
Manning & Lewis Eng. Co.
Franklin P. Miller & Son, Inc.
Missimers Inc.
Modine Mfg. Co.
Northrop Corp.
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Recony Div.-Vinco Corp.
Research, Inc.
Solar Aircraft Co.
Southwest Research Institute
Statham Development Corp.
Temperature Engrg. Corp.
Thermal Dynamic Products Div.-Waltham Precision Instrument Co.
United Control Corp.
Wenzlau Engrg. Co.

THERMAL CONDUCTIVITY CELLS

Engelhard Industries, Inc.
International Electronic Research Corp.
Joseph Kaye & Co.
Leeds & Northrup Co.
Mira Corp., The
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Recony Div.,-Vinco Corp.
Southwest Research Institute

THERMOCOUPLES

***AC SPARK PLUG, THE ELECTRONICS DIV.-GENERAL MOTORS**
Advanced Electronics, Inc.
Aero Research Instrument Co. Inc.
American Instrument Co., Inc.
American Thermo Electric Co.
***ARNOUX CORP.**
Astra Tech
B G Corp., The
Barker Sales Co.
Bernco Engrg. Corp.
J. Bishop & Co., Platinum Works
Bram Metallurgical Chemical Co.
***BRISTOL CO., THE**
Calvert Electronics Inc.
Carborundum Co., The
Central Electronics Mfrs., Div.-Nuclear Corp. of America
Conax Corp.
Consolidated Controls Corp.
Continental Sensing, Inc.
Daven Co., The
Daystrom Inc., Weston Instruments Div.
Dejur-Amsco Corp., Electronic Sales Div.
Du-Co Ceramics Co.
Engelhard Industries, Inc.
Fenwal Inc.
General Controls Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Instrument Dept.
Claud S. Gordon Co.
Gray Instrument Co.
Harco Labs., Inc.
Illinois Testing Laboratories, Inc.
Instrulab, Inc.
Kerns Mfg. Corp.
Leeds & Northrup Co.
***LEWIS ENGRG. CO., THE**
Lycoming Div., Avco Corp.
Magnetic Instrument Co. Inc.
***MARTIN CO., THE, DENVER DIV.**
Minneapolis-Honeywell Regulator Co., Industrial Div.
Ordnance Engrg. Associates, Inc.
Pemco Inc.
Philco Corp.-Govt. & Industrial Group
Pyrometer Instrument Co., Inc.
***RADIO CORP. OF AMERICA**
Research, Inc.
Revere Corp. of America, Sub., Neptune Meter Co.
Sensitive Research Instrument Corp.
Simpson Electric Co.
E. C. Smith Mfg. Co., Inc.
Southwest Research Institute

Teleflex Inc.
Temperature Engrg. Corp.
Thermo Electric Co., Inc.
Trinity Equipment Corp.
United Sensor & Control Corp.

THERMOELECTRIC

a. Devices
b. Materials

Advanced Electronics, Inc., **a.**
Aero Research Instrument Co. Inc., **a.**
American Thermo Electric Co., **a.**
***ARNOUX CORP., a.**
Bendix Aviation Corp., **a.**
J. Bishop & Co., Platinum Works, **b.**
Blonder-Tongue Labs. Inc., Special Products Div., **a, b.**
Budd Lewyt Electronics, Inc., **a.**
CBS Laboratories, Div.-Columbia Broadcasting System, **a.**
Carborundum Co., The, **b.**
Curtiss-Wright Corp., Princeton Div., **a.**
Daven Co., The, **a.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **a.**
Delco Radio Div.-General Motors Corp., **a, b.**
Fenwal Inc., **a.**
Filtron Co., Inc., **a.**
General Controls Co.
General Electric Co., Missile & Space Vehicle Dept., Pa., **a.**
General Instrument Corp., Defense & Engrg. Products Group, **a.**
Harco Labs., Inc., **a, b.**
Joseph Kaye & Co., **a, b.**
Lear, Inc.,.**a, b.**
***LEWIS ENGRG. CO., THE, a, b.**
Lockheed Aircraft Corp., Missiles & Space Div., **a.**
***MARTIN CO., THE, DENVER DIV., a.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co., **b.**
***MINNESOTA MINING & MFG. CO., a. b.**
***MINNESOTA MINING & MFG. CO.-CHEMICAL DIV., b.**
Monsanto Chemical Co., **a, b.**
NUMEC-Nuclear Materials & Equipment Corp., **b.**
National Beryllia Corp., **b.**
Northrop Corp., **a.**
Norton Co., New Products Dept., **b.**
Olin Mathieson Chemical Corp., N. Y., **a.**
Ordnance Engrg. Associates, Inc.
Patterson Moos Research, Div.-Leesona Corp., **a, b.**
Pesco Products Div.-Borg-Warner Corp., **a.**
***RADIO CORP. OF AMERICA, a.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a, b.**
Servomechanisms, Inc., **a, b.**
E. C. Smith Mfg. Co., Inc., **a, b.**
Solar Mfg. Corp., **a.**
Southwest Research Institute
Thermal Dynamics Products Div.-Waltham Precision Instrument Co., **a, b.**
Thermo Electric Co., Inc., **a, b.**
Thermon Mfg. Co., **b.**
Transitron Electronic Corp., **a, b.**
H. W. Tuttle & Co., **a.**
United Mineral & Chemical Corp., **a, b.**
Westinghouse Electric Corp., **a.**

THERMOMETERS, RESISTANCE

Aero Research Instrument Co., Inc.
***ARNOUX CORP.**
Astra Tech
***BRISTOL CO., THE**
Daystrom Inc., Weston Instruments Div.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co.
Fenwal Electronics, Inc.
Fisher Scientific Co.
Fisher Scientific Co., Maryland
General Controls Co.
General Electric Co., Apparatus Sales Div.
Gray Instrument Co.
Hallikainen Instruments
Illinois Testing Laboratories, Inc.
***LEWIS ENGRG. CO., THE**
Lycoming Div., Avco Corp.
Minco Products, Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Mira Corp., The
Pyrometer Instrument Co., Inc.
Rochester Mfg. Co. Inc.
Rochester Mfg. Co. Inc. of Calif.
Rosemount Engrg. Co.
Simpson Electric Co.
E. C. Smith Mfg. Co., Inc.
Thermo Electric Co., Inc.
Trans-Sonics, Inc.
Yellow Springs Instrument Co., The

THERMOPILES

Aero Research Instrument Co. Inc.
James G. Biddle Co.
***ENGIS EQUIPMENT CO.**
Harco Labs., Inc.
Lycoming Div., Avco Corp.
***MARTIN CO., THE, DENVER DIV.**
***MINNESOTA MINING & MFG. CO.**
Ordnance Engrg. Associates, Inc.
Pyrometer Instrument Co., Inc.
Thermo Electric Co., Inc.

THERMOSTATS

***AIRESEARCH MFG. OF ARIZONA**
Alloy Bellows Inc.
Barber-Colman Co.
Components Corp.
Dynamic Controls Corp.
Thomas A. Edison Ind. Instrument Div.-McGraw Edison Co.
Engelhard Industries, Inc.
Fenwal Inc.
Filtron Co., Inc.
G-V Controls Inc.
General Controls Co.
General Electric Co., Apparatus Sales Div.
Hart Mfg. Co., The
Hathaway Instruments, Inc.
Hermetic Seal Corp. & Thermal Controls, Inc.
Kingston Electronics-Div.-Kingston Industries Inc.
Norwalk Thermostat Co.
Powers Regulator Co., The
Pyrometer Instrument Co., Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Stevens Mfg. Co. Inc.
Texas Instruments Inc.
George Ulanet Co.
United Control Corp.
Valverde Labs.
Vap-Air Aeronautical Products Div., Vapor Heating Corp.

THICKNESS EQUIPMENT

Aeroflex Labs. Div., Aeroflex Corp.
Airborne Instruments Lab., Div.-Cutler-Hammer, Inc.
American Instrument Co., Inc.
Bendix Aviation Corp.
Branson Instruments, Inc.
Daystrom Inc., Weston Instruments Div.
J. W. Dice Co.
Djeco, Div.-Djordjevic Engrg. Co.
Gardner Laboratory, Inc.
General Electric Co., Apparatus Sales Div.
Lea Mfg. Co., The
Magnaflux Corp., Sub.-General Mills, Inc.
Southwest Research Institute
Unit Process Assemblies, Inc.

THORIUM

American Potash & Chemical Corp.
American Potash & Chemical Corp., National Northern Div.
Associated Engrg. & Mfg. Corp.
Cerium Metals & Alloys Div.-Ronson Metals Corp.
City Chemical Corp.
Delta Chemical Works, Inc.
W. R. Grace & Co., Davison Chem Div., Nuclear Reactor Mat. Plant
Metal Hydrides Inc.
NUMEC-Nuclear Materials & Equipment Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Westinghouse Electric Corp.

THRUST CHAMBERS

ACF Industries Inc.
***AEROJET-GENERAL CORP.**
Aeroscience, Inc.
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
Allison Div., General Motors Corp.
B. H. Aircraft Co., Inc.
Basic Tool Industries, Inc.
Bermite Powder Co.
Brunswick Balke Collender Co., The, Defense Products Div.
Cosmic Instruments Inc.
Gabriel Co., Rocket Power-Talco
General Electric Co., Rocket Engine Section
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Janke & Co. Inc.
Kaiser Fleetwings, Inc.
Lithium Corp. of America Inc., The Fulton-Irgon Div.
Marquardt Corp., The
McGregor Mfg. Corp.
George L. Nankervis Co.
Norris-Thermador Corp.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Portland Copper & Tank Works Inc.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Rimak, Inc.
Space Corp.
Spaceatomics Div., The Budd Co.
Vac-Hyd Processing Corp.
Westholt Mfg. Inc.

THRUST MEASURING INSTRUMENTS

Aero Research Instrument Co. Inc.
Aeroscience, Inc.
American Instrument Co., Inc.
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs.
Beacon Steel Corp.
Bermite Powder Co.
A. Biederman, Inc.
Bytrex Corp.
Consolidated Controls Corp.
Falcon Machine & Tool Co.
Gilmore Industries, Inc.
Hagan Chemicals & Controls Inc.
Highland Engrg. Co.
Instrument Div., The Budd Co.
Integrated Dynamics Div., Globe Industries, Inc.
Janke & Co. Inc.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Lear, Inc.
Mitchell Camera Corp.
Ordnance Engrg. Associates, Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Schaevitz Engrg.
Servomechanisms, Inc.
Space Corp.
Wiancko Engrg. Co.

TIMERS

a. Automatic Cycle
b. Automatic Reset
c. Automatic Sequence
d. Clock Radio
e. Counting
f. Cycle
g. Electronic
h. Hour Counting
i. Impulse
j. Inertia
k. Interval
l. Motor Operated
m. Multicontact
n. Percentage
o. Sequence
p. Special
q. Thermal
r. Welding, Electronic

***ABRAMS INSTRUMENT CORP., a, b.**
Accessory Controls & Equipment Corp., **l.**
Aero Instruments Co., **h, k.**
Agastat Timing Instruments-Elastic Stop Nut Corp. of America, **a, b, c, f, i, m.**
Allegany Instrument Co., Inc., **g.**
American Electronics Inc., Taller-Cooper Div. & Data Systems Div., **l, m.**
American Missile Products Co., Inc., **g.**
Amglo Corp., **a, b, c, e, k, l, m, o, p.**
Automatic Timing & Controls, Inc., **a, b, c, e, f, g, i thru p, r.**
Autotron, Inc., **g.**
Baird-Atomic, Inc., **b.**
E. Bauches S. A., Freeport Engrg. Co., **c, f, g, h, p.**
Beattie-Coleman, Inc., **m, p.**
Beckman Instruments, Inc., Berkeley Div., **a, b, e, f, g, k.**
Beckman-Systems Div., **g.**
Beckman & Whitley, Inc., Missile Products Div.

Belock Instrument Corp., **a, c, g, i, o, p.**
Bendix Aviation Corp., **j.**
Bendix Aviation Corp., Cincinnati Div., **g, p.**
Bendix-Pacific Div., Bendix Aviation Corp., **c, f, k, l, o.**
Bendix Utica Div., Bendix Aviation Corp., **a, b, g, o.**
Bergen Labs., Inc., **p.**
Bermite Powder Co., **k.**
Bernco Engrg. Corp., **a, b, c, f, l, m, p.**
Branson Corp., **a, b, c, e, f, g, i, k, m, o, p, q.**
***BRISTOL CO., THE, a, b.**
Bristol Motors Div.-Vocaline Co. of America, Inc., **a, c, h, k thru p.**
Bulova Research & Development Labs. Inc., **a, b, c, g, i, k, l, o, p.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Carleton Aviation Co., Inc., **a, o.**
Chalco Engrg. Corp., **c, g, m, o.**
Clark Controller Co., The, **g.**
Clevite Ordnance, Div.-Clevite Corp., **g, m.**
Cramer Controls Corp., **a, b, c, f, h, i, k thru p.**
Daystrom Inc., Pacific Div., **a, b, c, g, l.**
Daystrom Inc., Weston Instruments Div., **h.**
Delco Radio Div.-General Motors Corp., **g, o, p.**
Deltron Inc., **g.**
Designers for Industry, Inc., **a, c, f, k, l, m, o, p.**
Destron Co., **a, b, c, g, i, m, o, p.**
Henry G. Dietz Co., Inc., **c, g, o, p.**
Digital Sensors Inc., **c, k, o.**
Dimco-Gray Co., **k, l.**
M. Ducommun Co.
R. C. Dudek & Co.**k, l, p.**
Dynamic Controls Corp., **p.**
Dynatronics, Inc., **g.**
Eagle Signal Co., **a, b, c, e, f, g, i, k thru p.**
Eastman Kodak Co., **k, p.**
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., **a, b, q.**
Eisler Engrg. Co., Inc., **r.**
Electro Instruments, Inc., **a, b, c, e, thru i, k, n, o, p.**
Electro-Mechanical Specialties Co., Inc., **a, b, c, g, k, m, p.**
Electronic Control Corp., **g.**
Electronic Engrg. Co. of California, **g, p.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **a, b, c, f, g, i thru l, o, p.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **a, b, c, g, i, q.**
Erie Resistor Corp., **b, e, g, i, o.**
Eureka Williams Corp., **q.**
Ewald Instruments, **r.**
Exact Engrg. & Mfg. Inc., **a, b, c, f, h, o.**
Farmer Electric Products Co., Inc., **a, b, g.**
Fenske, Fedrick & Miller Inc., **a, b, p.**
Flight Research, Inc., **g.**
Food Machinery & Chemical Corp., Ordnance Div., **g.**
Ford Instrument Co., Div.-Sperry Rand Corp., **f, g.**
G-V Controls Inc., **b, g, q.**
General Controls Co., **a, b, c, e, thru i, k, l, m, o, p, q.**
General Devices, Inc., **a, b, c, e, g, i, l, m.**
General Electric Co., Apparatus Sales Div., **a, f, k, l.**
General Electric Co., Missile & Space Vehicle Dept., Pa.
Gilfillan Bros. Inc., **k, p.**
Gordon Enterprises, **a, b, c, e, f, k, l, m, o, p.**
Greenleaf Mfg. Div., The, Mandrel Ind. Inc., **k.**
Guided Missile Div., The Firestone Tire & Rubber Co., **g, p, q.**
B. H. Hadley, Inc., **a, b, c, p.**
Hagan Chemicals & Controls Inc., **a, g, o.**
Hagen Mfg. Co., **a, b, c, e, f, i, k thru o.**
Hallicrafters Co., The, **p.**
Hamilton Watch Co., Industrial Div.
Hamilton Watch Co., Military Products Div., **a, b, c, h thru m.**
Hammett-Mercury-Rex Div., **d, l, r.**
A. W. Haydon Co., The, **a, b, c, e, thru i, k, l, m, o, p.**
Heinemann Electric Co., **t.**
Hewlett-Packard Co., **g.**
I-L-S Instrument Div., The Meriam Instrument Co., **a, b, e, f, g, i, k.**
Iconix Inc., **a, b, c, e, f, g, i, k.**
Industrial Electronic Engineers, Inc., **h, p.**
Industrial Timer Corp., **a, b, c, f, h, k thru q.**
Ingraham Co., The, **d, e, f, h, k, l, p.**
Integrated Dynamics Div., Globe Industries, Inc., **a, b, c, e, j, k, l, q.**
Interstate Electronics Corp., **g, o.**
Janco Corp., **i.**
Jordan Electronics, Div.-Victoreen Instrument Co., **a, b, c, f, g, k, m, o, p.**
Kellogg Switchboard & Supply Co., Communications Div.-IT&T Corp., **a, b, c, e, g, i, k, m, o, p.**
H. Koch & Sons, **g, l, o, p.**
Labline, Inc.
Lear, Inc., **b, c, f, g, i thru m, o.**
Leland Airborne Products, Div.-American Machine & Foundry Co., **h.**
Livingston Electronic Corp., **q, r.**
Lockheed Aircraft Corp., Missiles & Space Div., **c, o, p.**
Lundy Mfg. Corp., **a, b, c, o, p.**
Lux Clock Mfg. Co., Inc., **k, l, m, o, p.**
Lytle Corp., **i, l, p.**
MEG Products, Div.-Mandrel Industries, Inc., **g, o.**
P. R. Mallory & Co. Inc., **a, b, c, f, g, i, k, l, m, o.**
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co., **h.**
***MARTIN CO., THE, DENVER DIV., c, i, k.**
Mead Specialties Co., Inc., **a, c, l, o.**
National Cylinder Gas, Div.-Chemetron Corp., **r.**
Naz-Dar Co., **k.**
Northeastern Engrg. Inc., **g, k.**
Northrop Corp., **g, p.**
Norwalk Thermostat Co., **q.**
Nuclear Development Corp. of America, **h, k.**
Nuclear-Chicago Corp., **b, f, k.**
Ordnance Research & Development Co., Div.-Bermite Powder Co., **k.**
Pacific Mercury Electronics, **c, i, p.**
Packard Bell Computer Corp., **a, b, c, e, g.**
Parabam, Inc., **c, h, l, m, o, p.**
Ralph M. Parsons Co., The, Electronics Div., **g, p.**
Patterson Moos Research, Div.-Leesona Corp., **a, b, g, i, j, k, o, p.**
Performance Measurements Co., **g.**
Radiation Instrument Development Lab., Inc., **a, g.**
***RADIO CORP. OF AMERICA, g.**
Raymond Engrg. Lab., Inc., **j. p.**
Research Indsl. Lab. of Electronics, **a, b, c, g, o.**
Sage-Craft, Inc., **a, b, g, l, o.**
Sangamo Electric Co., **k, l.**
Sciaky Brothers, Inc., **a, b, c, e, f, g, r.**
SERVOMECHANISMS, INC., j.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., **c.**
Southwest Research Institute, **e, h, i, p.**
Southwestern Industrial Electronics Co., **a, b, c, k, l, m, o, p.**
Spectrol Electronics Corp.
Standard Electric Time Co., The, **g, k, l, p.**
Herman H. Sticht Co., Inc., **g, h, k.**
Stromberg-Carlson Div.-General Dynamics Corp., **g, k.**
Sun Electric Corp., Aeronautical Div., **p.**
Sunshine Scientific Instrument, **g, k, p.**
Systron Corp., **a, b, e, f, g, i, k.**
TRG, Inc., **e.**
Telechrome Mfg. Corp., **a, c, g, i, k, l, m, o, p.**
Telkor, Inc., **f, g, k, l, o.**
Tempo Instrument Inc., **a, b, c, e, f, g, i, k, o, p.**
Texas Instruments Inc., **g, k, o.**
Tork Time Controls, Inc., **k.**
Tracerlab Inc., **b, e, p.**
Trepac Corp. of America, **g, o, p.**
George Ulanet Co., **q.**
United Control Corp.
U. S. Science Corp., Div.-Topp Industries, Inc., **a, b, c, g, k, o.**
Varo Mfg. Co., Inc., **a, b, c, e, f, g, i, k, l, n, o, p.**
Vickers Inc., Electric Products Div., **r.**
Vickers, Inc., Mich., **p.**
Vocaline Co. of America Inc., **a, b, c, f, h, k thru p.**
Voi-Shan Electronics, **c, g, k, o.**
Walkirt Co., **g, o.**
Wang Labs., Inc., **m, o.**
Waugh Engrg. Co., **g.**
Wells Industries Corp., **a, b, e, p.**
Weltronic Co., **c, e, g, o, r.**
Wickes Engrg. & Construction Co., **g, h, k, p.**
G. C. Wilson & Co., **a, b, c, g, k, o, p, r.**

TIN & ALLOYS

Accurate Specialties Co. Inc.
Alloys Unlimited Inc.
Alpha Metals, Inc.
American Brake Shoe Co.
American Silver Co., Inc.
American Smelting & Refining Co.
Belmont Smelting & Refining Works, Inc.
Delta Chemical Works, Inc.
Division Lead Co.
Eutectic Welding Alloys Corp.
Morris P. Kirk & Son, Inc.
Metal & Thermit Corp.
Semi-Elements, Inc.
United Mineral & Chemical Corp.
United States Steel Corp.
Var-Lac-Oid Chemical Co.

TINNING, HOT DIPPED

Penn-Michigan Mfg. Corp.

TITANIUM

Airdrome Parts Co.
American Silver Co., Inc.
Bios Labs., Inc.
Bram Metallurgical Chemical Co.
Bridgeport Brass Co.
Budd Co., The
Calcor Corp.
Chicago Bridge & Iron Co.
Chicago Development Corp.
Crucible Steel Co. of America
Custom Tool & Mfg. Co.
E. I. Du Pont De Nemours & Co. Inc.
Engelhard Industries, Inc.
Fansteel Metallurgical Corp.
Hamilton Watch Co.-Industrial Div.
Harvey Aluminum
Johnston & Funk Metallurgical Corp.
P. R. Mallory & Co. Inc.
Mallory-Sharon Metals Corp.
Metal Hydrides Inc.
NUMEC-Nuclear Materials & Equipment Corp.
Pfaudler Div., Pfaudler Permutit Inc.
Republic Steel Corp.
Rodney Metals Inc.
Secon Metals Corp.
Southwest Research Institute
Standard Pressed Steel Co.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Steel Improvement & Forge, The
Thompson Ramo Wooldridge Inc.
Titanium Metals Corp. of America
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Universal-Cyclops Steel Corp.
Vanadium Corp. of America
Var-Lac-Oid Chemical Co.
Wai Met Alloys Co.
Wallingford Steel Co.
Wyman-Gordon Co.

TOOLS, ALIGNMENT

Capital City Mfg. Co., Inc.
Dulock, Inc.
Ed-Berl Products, Inc.
***ENGIS EQUIPMENT CO.**
G-C Electronics Co.
Hunter Tool Co.
Jonco Aircraft Corp., Sub.-Fairchild Engine & Airplane Corp.
Keystone Electronics Corp.
***MARTIN CO., THE, DENVER DIV.**
Pennsylvania Tool & Mfg. Co., The
Richard Philip Co.
C. M. Smillie & Co.
Squiers Gage Co.
Temco Aircraft Corp.
Twix Mfg. Co., Inc.
Warren-Knight Co.
Western Tool & Mfg. Co., Inc.

TOOLS, HAND OR MECHANICAL

Acromark Co., The
Air Speed Tool Co.
Aircraft Tools, Inc.
Airetool Mfg. Co., The
H. D. Allen Mfg.
Billings & Spencer Co., The
Black & Decker Mfg. Co., The
Brown & Sharpe Mfg. Co.
Buckeye Tools Corp.
Calcor Corp.
Capewell Mfg. Co.
Chicago Rawhide Mfg. Co.
Detroit Stamping Co.
Dulock, Inc.
Duro Specialty Co., Inc.
Eyelet Tool Co. Inc.
Forsberg Mfg., Co., The

G-C Electronics Co.
B. F. Goodrich Aviation Products
Greene, Tweed & Co.
Hammett-Mercury-Rex Div.
Handicraft Tools, Inc., Div.-X-Acto, Inc.
Heli-Coil Corp.
Hi-Shear Rivet Tool Co.
Hunter Tool Co.
Ideal Industries, Inc.
Industrial Tools Mfg. Corp., Sub.-Pendleton Tool Industries, Inc.
International Electronic Research Corp.
B. Jadow Inc.
Jo-Line Tools, Inc.
Kelsey-Hayes Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Lantz Mfg. Co., Inc.
*MARTIN CO., THE, DENVER DIV.
Mathias Klein & Sons, Inc.
Milbar Corp.
Miller Falls Co.
Moody Machine Products Co., Inc.
Niagara Machine & Tool Works
Onsrud Machine Works, Inc.
Owatonna Toll Co. Precision Hydraulic Div.
Pennsylvania Tool & Mfg. Co., The
Proto Tool Co.
Skyproducts
C. M. Smillie & Co.
Snap-On-Tools Corp.
Squiers Gage Co.
L. S. Starrett Co., The
Superior Pneumatic & Mfg., Inc.
B. K. Sweeney Mfg. Co.
Taft-Peirce Mfg. Co., The
Temco Aircraft Corp.
Thor Power Tool Co.
U. S. Industries, Inc.
Vaco Products Co.
Vascoloy-Ramet Corp.
Vlchek Tool Co.
Waldes Kohinoor, Inc.
Wesrep Corp.
Western Tool & Mfg. Co., Inc.

TOOLS

a. Pneumatic Assembly
b. Resistance Soldering
c. Thermal Soldering
d. Ultrasonic Soldering
e. Wire Tapping

Aeronautical Machinists Inc., **a.**
Aircraft Tools, Inc., **a.**
Albertson & Co., Inc., **a.**
H. D. Allen Mfg.
Bendix Aviation Corp., **a.**
Black & Decker Mfg. Co., The, **a.**
Bowen-McLaughlin-York, Inc.
Buchanan Electrical Products Corp.
Buckeye Tools Corp., **a.**
Burklyn Co., **a.**
Circo Equipment Co., **d.**
Circo Ultrasonic Corp., **d.**
Cleco Air Tools, Div.-Reed Roller Bit Co., **a.**
Detroit Stamping Co., **a.**
Deutsch Co., The, Electronic Components Div., **a.**
Eyelet Tool Co. Inc., **a.**
Forsberg Mfg., Co., The
Gardner-Denver Co., **a.**
B. F. Goodrich Aviation Products, **a.**
High Speed Hammer Co., Inc., The, **a.**
Hi-Shear Rivet Tool Co., **a.**
Ideal Industries, Inc., **b.**
International Electronic Research Corp., **c.**
*MARTIN CO., THE, DENVER DIV., **a, b, c, e.**
Mc Kenna Labs., **d.**
Modern Design Div.-H. C. Schloer, Inc., **a.**
M. M. Newman Corp., **c.**
Onsrud Cutter Mfg. Co., Inc.
Pennsylvania Tool & Mfg. Co., The
Skyproducts, **a.**
C. M. Smillie & Co., **a.**
Squiers Gage Co.
Superior Pneumatic & Mfg., Inc., **a.**
Temco Aircraft Corp., **a.**
Thor Power Tool Co., **a.**
U. S. Industries, Inc., **a.**
United Supply Co., **a.**
P. Wall Mfg. Co., **c.**
Wassco Electric Products Corp., **b.**
Wesrep Corp.

TOROIDS

ACDC Electronics, Inc.
Acme Electric Corp.
Airpax Electronics Inc., Cambridge Div.
Airpax Electronics Inc., Seminole Div.
American Research & Mfg. Corp.
Arnold Engrg. Co., The
Atlas Engrg. Co. Inc.
Ballastran, Div.-Telex, Inc.
Barker & Williamson Inc.
CGS Labs., Inc.
Chicago Standard Transformer Corp.
Coil Co. of America
Control Circuits Inc.
Control Electronics Co., Inc.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Double E Products Co.
Dynacor, Inc.
Eastern Rotorcraft Corp.
Electro-Winders Co. Inc.
Engrg. Specialties
Erie Resistor Corp.
Fairfield Engrg. Corp.
Filtron Co., Inc.
Forbes & Wagner, Inc.
Freed Transformer Co., Inc.
Fugle-Miller Labs. Inc.
Guidance Controls Corp.
Gulton Industries, Inc.
Donald C. Harder Co.
Intercontinental Electronics Corp.
Johnson Electronics Inc.
Kwikset Powered Metal Products
Lab for Electronics, Inc.
Lycoming Div., Avco Corp.
*MAGNAVOX CO., THE
Magnetico, Inc.
Mid-West Coil & Transformer Co.
Motorola, Inc.
National Co., Inc.
National Moldite Co.
Philco Corp.-Govt. & Industrial Group
Polyphase Instrument Co.
Precision, Inc.
Qutronic Transformer Corp.
*RADIO CORP. OF AMERICA
Radio Development & Research Corp.
Railway Communications, Inc.
Redman Electronics Corp.
Rytron Co., Inc.
Sangamo Electric Co.
Servo-Tek Products Co.
Southwestern Industrial Electronics Co.
Specialties, Inc.
Standard Electronics Div.-Reeves Instrument Corp.
Sunair Electronics, Inc.
Telex, Inc.
Torwico Electronics, Inc.
Transformer Design, Inc. of Milwaukee
Transformers, Inc.
Tresco, Inc.
Triad Transformer Corp.
U. S. Science Corp., Div.-Topp Industries, Inc.
Universal Toroid Coil Winding, Inc.
Valor Instruments, Inc.
Varo Mfg. Co., Inc.
Virginia Electronics Co., Inc.
A. W. Welch Mfg. Co., Inc.
Westinghouse Electric Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

TOWERS

a. Antenna
b. Missile

ACF Industries Inc., **a.**
All Products Co., **a.**
Allied International Corp., **a.**
Allison Steel Mfg. Co., **a, b.**
Alpar Mfg. Corp., **a.**
American Machine & Foundry Co., **b.**
American Machine & Foundry Co., Greenwich Engrg. Div., **a, b.**
Antlab Inc., **a, b.**
Beacon Steel Corp., **a, b.**
Beaver-Advance Corp., **a.**
Belmar Wheel & Machine Co., Inc., **a.**
Bethlehem Steel Co., **a.**
Birdair Structures, Inc., **a.**
Blaw-Knox Equipment, Div.-Blaw-Knox Co., **a, b.**
Calcor Corp., **a, b.**
Chance Vought Aircraft, Inc., **a, b.**
Chicago Bridge & Iron Co., **b.**
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co., **a, b.**
Craig Systems, Inc., **a.**
Crane Co., Special Products Div., **a.**
Dresser-Ideco Co., Div.-Dresser Industries, Inc., **a, b.**
E-Z Way Towers, Inc., **a.**
Eastern Rotorcraft Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp., **a, b.**
General Bronze Electronics Corp., **a.**
HRB-Singer, Inc., Sub.-Singer Mfg. Co., **a.**
Lehigh Structural Steel Co., **a, b.**
Lofstrand Co., The, **a, b.**
MEG Products, Div.-Mandrel Industries, Inc., **a.**
*MARTIN CO., THE, DENVER DIV., **b.**
Microflect Co., Inc., **a.**
Northeast Metals Industries, Inc., **a.**
Opelika Welding, Machine & Supply Inc., **a, b.**
Pacific Automation Products, Inc., **a, b.**
Portland Copper & Tank Works Inc., **a, b.**
*RADIO CORP. OF AMERICA, **a, b.**
Robot Industries Inc., **a.**
Rohn Mfg. Co., **a.**
Sancor Corp., **a, b.**
Seiscor, Div.-Seismograph Service Corp., **a.**
Stainless Inc., **a, b.**
Technical Appliance Corp., **a.**
Thomas Mold & Die Co., **a.**
Tower Construction Co., **a.**
Tucson Instrument Corp., **a.**
Twin Coach Co., Aircraft-Missiles, **a, b.**
U. S. Pipe & Foundry Co., Steel & Tubes Div., **a.**
United States Steel Corp., **a, b.**
Waco Aircraft Co., **a.**
Wells Industries Corp., **a, b.**
Western Coil & Electrical Co., **a.**
Wind Turbine Co., **a.**

TRACERS, SIGNAL

TRG, Inc.

TRACKING SYSTEMS

ACF Industries Inc.
Admiral Corp.
American Machine & Foundry Co., Government Products, N. Y.
American Machine & Foundry Co., Greenwich Engrg. Div.
*ASKANIA-WERKE, U. S. BRANCH OFFICE
Bendix Aviation Corp.
Bermite Powder Co.
Collins Radio Co.
Cubic Corp.
Davidson Optronics, Inc.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Allen B. Du Mont Labs., Inc.
Eastman Kodak Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*EQUIPMENT DIV., RAYTHEON CO.
J. W. Fecker Div., American Optical Co.
Gates Radio Co.
General Devices, Inc.
General Electric Co., Heavy Military Electronics Dept.
General Electric Co., Ordnance Dept.
General Instrument Corp., Defense & Engrg. Products Group
Gordon Enterprises
Guided Missile Div., The Firestone Tire & Rubber Co.
Hallicrafters Co., The
Hoover Electronics Co.
Huyck Systems Co.
ITE Circuit Breaker Co., Special Products Div.
Kollmorgen Optical Corp.
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Librascope Div., General Precision, Inc.
Litton Industries, Maryland Div.
Lockheed Aircraft Corp., Missile & Space Div.
Lockheed Electronics Co., Stavid Div.
Northrop Corp.
Optomechanisms Inc.
Ordnance Research & Development Co., Div.-Bermite Powder Co.
Packard Bell Computer Corp.
Perkin-Elmer Corp.
Philco Corp.-Govt. & Industrial Group
Radiation, Inc.
Radio Condenser Co.
*RADIO CORP. OF AMERICA
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS
Radio Receptor Co., Inc., Sub.-General Instrument Corp.

Southwest Research Institute
Spectra Electronics Corp.
Sun Electric Corp., Aeronautical Div.
TRG, Inc.
Westinghouse Electric Corp.

TRANSCEIVERS, PORTABLE

Acton Laboratories Inc.
Aeronautical Electronics, Inc.
Allied International Corp.
Budd Lewyt Electronics, Inc.
Collins Radio Co.
Communications Research Co.
Dalmo Victor Co., Div.-Textron, Inc.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Electro-Voice, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fla. Aircraft Radio & Marine
General Instrument Corp., Defense & Engrg. Products Group
Globe Electronics, Div.-Textron Electronics, Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
ITT Federal Div., International Telephone & Telegraph Corp.
Interstate Electronics Corp.
E. F. Johnson Co.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Lear, Inc.
Lel, Inc.
***MAGNAVOX CO., The**
P. R. Mallory & Co. Inc.
Mason Electric Corp.
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
Projects Unlimited, Inc.
Radalab Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Seiscor, Div.-Seismograph Service Corp.
Simmonds Aerocessories, Inc.
Spectra Electronics Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Tamar Electronics, Inc.
Virginia Electronics Co., Inc.
Westinghouse Electric Corp.

TRANSCEIVERS, UHF

Admiral Corp.
Aeronautical Electronics, Inc.
Allied International Corp.
Bendix Aviation Corp.
Budd Lewyt Electronics, Inc.
Budelman Electronics Corp.
Collins Radio Co.
Curtiss-Wright Corp., Santa Barbara Div.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Instrument Corp., Defense & Engrg. Products Group
Guided Missile Div., The Firestone Tire & Rubber Co.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
Lear, Inc.
Lel, Inc.
Lockheed Electronics Co., Stavid Div.
***MAGNAVOX CO., THE**
Mason Electric Corp.
Motorola, Inc.
National Co., Inc.
Packard-Bell Electronics Corp.
Philco Corp.-Govt. & Industrial Group
RS Electronics Corp.
Radalab Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Simmonds Aerocessories, Inc.
Southwest Research Institute
Spectra Electronics Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Tamar Electronics, Inc.
Telechrome Mfg. Corp.
Tower Construction Co.
Westinghouse Electric Corp.

TRANSCEIVERS, VHF

Aeronautical Electronics, Inc.
Allied International Corp.
American Electronics, Inc.
Bendix Aviation Corp.
Bendix Aviation Corp., Cincinnati Div.
Budd Lewyt Electronics, Inc.
Budelman Electronics Corp.
Chance Vought Aircraft, Inc.
Collins Radio Co.
Communications Research Co.
Designers for Industry, Inc.
Allen B. Du Mont Labs., Inc.
Dynatronics, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fla. Aircraft Radio & Marine
Gates Radio Co.
General Instrument Corp., Defense & Engrg. Products Group
Globe Electronics, Div.-Textron Electronics, Inc.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hazeltine Electronics Div.-Hazeltine Corp.
ITT Federal Div., International Telephone & Telegraph Corp.
Lear, Inc.
Lel, Inc.
Lockheed Electronics Co., Stavid Div.
P. R. Mallory & Co. Inc.
Mason Electric Corp.
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radalab Inc.
***RADIO CORP. OF AMERICA**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Seiscor, Div.-Seismograph Service Corp.
Simmonds Aerocessories, Inc.
Southwest Research Institute
Spectra Electronics Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Tamar Electronics, Inc.
Tower Construction Co.
U. S. Science Corp., Div.-Topp Industries, Inc.
Westinghouse Electric Corp.

TRANSDUCERS

a. Accelerometer
b. Flow
c. Industrial
d. Measurement
e. Position
f. Pressure
g. Sonar
h. Strain
i. Temperature
j. Vibration

ASCOP Div., Electro-Mechanical Research, Inc., **f.**
Acoustica Associates, Inc., **b, d.**
Aeroprojects Inc., **c.**
Aeroscience, Inc., **b, d, f, h, j.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., a, f, i.**
American Machine & Foundry Co., Government Products, N. Y., **c, d, f, g.**
***ARNOUX CORP., i.**
Astra Tech, **i.**
Atlantic Research Corp., **a thru j.**
Automatic Timing & Controls, Inc., **b thru f.**
Automation Products, Inc., **c, d.**
Avien, Inc., **b.**
B & F Instruments, Inc., **a.**
B & K Instruments, Inc., **a.**
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Divs., **e, f, h.**
Barber-Colman Co., **i.**
Beckman & Whitley, Inc., Instrument Div., **i.**
Beech Aircraft Corp., **f.**
Bell & Gossett Co., **e.**
Belock Instrument Corp., **a, f.**
Bendix Aviation Corp., **a thru g, i, j.**
Bendix Aviation Corp.-Montrose Div., **e, f.**
Bendix-Pacific Div., Bendix Aviation Corp., **d, g.**
A. Biederman, Inc., **a, b, f, i.**
Bogue Electric Mfg. Co., **d, g.**
Bourns, Inc., **a, e, f.**
Branson Instruments, Inc.
***BRISTOL CO., THE, b, f.**
Brush Instruments, Div.-Clevite Corp., **d, e.**
Budd Co., The, **c, d, f, h.**
Bulova Research & Development Labs., Inc., **f.**
Bytrex Corp., **h.**
Clark Electronic Laboratories, **a thru f, h, j.**
Clevite Ordnance, Div.-Clevite Corp., **d, f, g.**
G. L. Collins Corp., **e, h.**
Colvin Labs., Inc., **c, f.**
Computer Instruments Corp., **a, c, f, j.**
Consolidated Controls Corp., **b, f, i.**
***CONSOLIDATED ELECTRODYNAMICS CORP., a, d, f, h, j.**
Control Data Corp., **a, d, e.**
Convair Instruments, Convair Div.-General Dynamics Corp., **i.**
Cox Instruments Div., George L. Nankervis Co., **b.**
Crescent Engrg. & Research Co., **b thru f, h, i.**
Curtiss-Wright Corp., Princeton Div., **g.**
Daystrom Inc., Pacific Div., **a thru g.**
Daystrom Inc., Transicoil Div., **a, e.**
Daytronic Corp., **d, e, h.**
Decker Corp., The, **c, d, f, j.**
Dejur-Amsco Corp., Electronic Sales Div., **d.**
***DEL MAR ENGRG. LABS., b.**
Henry G. Dietz Co., Inc., **f.**
Digital Sensors Inc., **d, e, f.**
Dynisco, Inc., **b, c, f, h.**
Eastman Kodak Co.
Edcliff Instruments, **a, d, e, f.**
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co., **f, i.**
Edco Corp., **g.**
Elgin Micronics, West Coast Div.-Elgin National Watch Co., **a.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **d f, g.**
Endevco Corp., **a, f, j.**
Engelhard Industries, Inc., **i.**
***EQUIPMENT DIV., RAYTHEON CO., g.**
Era Engrg. Inc., **a.**
Erie Resistor Corp., **g.**
Fairchild Controls Corp., **a, f.**
Fairchild Controls Corp., Components Div., **a, b, e, f.**
Fenwal Electronics, Inc., **b, i.**
Fenwal Inc., **i.**
Fischer & Porter Co., **b, f, i.**
General Electric Co., Apparatus Sales Div., **b, i.**
General Electric Co., Heavy Military Electronics Dept., **g.**
General Instrument Corp., Defense & Engrg. Products Group, **c, f, g, i.**
Genisco, Inc., **a, f, j.**
Genisco, Inc., Instrument Div., **a.**
Glassco Instrument Co., **f.**
Gray Mfg. Co., The, **a.**
Guided Missile Div., The Firestone Tire & Rubber Co., **a, f.**
Gulton Industries, Inc., **a, b, f, g, i, j.**
Hagan Chemicals & Controls Inc., **e, f.**
Hamlin, Inc., **a.**
George E. Harris & Co., Inc., **a, e, f.**
Haskel Engrg. & Supply Co., **f.**
Illinois Testing Laboratories, Inc., **i.**
Instrument Div., The Budd Co., **c, d, h, i.**
Integrated Dynamics Div., Globe Industries, Inc., **a, e.**
Kahn & Co., Inc., **c, i.**
***KEARFOTT DIV., GENERAL PRECISION, INC., a.**
Keystone Carbon Co., **i.**
Kistler Instrument Corp., **a, c, f, j.**
Kollsman Instrument Corp., Sub.-Standard Coil Products Co. Inc., **e, f.**
L & R Mfg. Co., **c.**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **j.**
Lear, Inc., **a thru j.**
Leeds & Northrup Co., **i.**
***WALLACE O. LEONARD, INC., a, b, d, e, f, j.**
***LEWIS ENGRG. CO., THE, i.**
Liquidometer Corp., The, **d, e.**

Litton Industries, Inc., **a.**
Lockheed Aircraft Corp., Missiles & Space Div., **a, d, e, f, h, i, j.**
MB Electronics, **g, j.**
Maico Electronics, Inc., **g.**
***MARTIN CO., THE, DENVER DIV., a, b, d, e, f, h, i, j.**
Mason-Neilan, **f.**
Massa Div.-Cohu Electronics, Inc., **a, f, g, j.**
Micro Gee Products, Inc., **d.**
Minatron Corp., **d, e.**
Mitchell Camera Corp., **f, i.**
Motorola, Inc., **g.**
George L. Nankervis Co., **b.**
Narda Ultrasonics Corp., The, **g.**
National Ultrasonic Corp.
Nilsen Mfg. Co., **d.**
Norden Div., United Aircraft Corp., **b, e, i.**
Northrop Corp., **a.**
Pace Engrg. Co., **a thru d, f.**
Pacific Scientific Co., **a.**
Patterson Moos Research, Div.-Leesona Corp., **f.**
Performance Measurements Co., **b, c, d, f, h, i.**
Photocon Research Products, **f.**
Piasecki Aircraft Corp., **h.**
Pickering & Co., Inc., **e.**
Polyphase Instrument Co., **h.**
Potter Aeronautical Corp., **b.**
Radio Condenser Co., **i.**
***RADIO CORP. OF AMERICA, g.**
Radio Development & Research Corp., **d, g.**
Rahm Instruments Div.-American Machine & Metals, **a thru d, f, g.**
Research Controls, **b, f.**
Research, Inc., **a, e.**
Revere Corp. of America, Sub., Neptune Meter Co., **b, f, i.**
Rosemount Engrg. Co., **a, f, i.**
Sangamo Electric Co., **g.**
Scanivalve Co., **f.**
Schaevitz Engrg., **a thru f.**
Servomechanisms, Inc., **d, f, i.**
Servonic Instruments, Inc., **e, f.**
Servo-Tek Products Co.
Sheffield Corp., The, Sub.-Bendix Aviation Corp., **d.**
Solar Mfg. Corp., **a, c, g, j.**
Sonotone Corp., **j.**
Southwest Research Institute, **a thru f, h, i, j.**
Southwestern Industrial Electronics Co., **j.**
Special Products Dept., Melpar, Inc., **a, f, i.**
Spectrol Electronics Corp., **e.**
Standard Controls, Inc., **b, f.**
Statham Development Corp., **a, f, i.**
Statham Instruments, Inc., **a thru f, h, j.**
Stephens Trusonic Inc., **f.**
Stromberg-Carlson Div.-General Dynamics Corp., **g.**
Sun Electric Corp., Aeronautical Div., **j.**
B. K. Sweeney Mfg. Co., **d, e, i.**
TRG, Inc., **g.**
***TABER INSTRUMENT CORP., f, i.**
Technology Instrument Corp., **a, d, e, f.**
Telecrome Mfg. Corp., **b thru f, h, i.**
Telex, Inc.
Texas Instruments Inc., **g.**
Trans-Sonics, Inc., **b, d, f, h, i.**
Ultradyne, Inc., **f.**
Unholtz-Dickie Corp, **g, j.**
United Control Corp., **e, f, i.**
U. S. Science Corp., Div.-Topp Industries, Inc., **a, e, f, i.**
U. S. Sonics Corp., **a, c thru g.**
United States Time Corp., **a.**
Universal Dynamics Corp., **f.**
Universal Toroid Coil Winding, Inc., **d.**
Valpey Crystal Corp., **f.**
Victory Engrg. Corp., **i.**
Vinson Mfg. Co. Inc., **b thru f.**
Waugh Engrg. Co., **b.**
Wells Industries Corp., **c, d, e, i.**
Westinghouse Electric Corp., **g.**
Westport Development & Mfg. Co., Inc., **f, i.**
Wiancko Engrg. Co., **a, f.**

TRANSFER EQUIPMENT

American Machine & Foundry Co.
American Machine & Foundry Co., Greenwich Engrg. Div.
Byron Jackson Pumps, Inc.
Cryogenic Engrg. Co.
Flight Refueling, Inc.
George Gorton Machine Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Janitrol Aircraft Div.-Midland-Ross Corp.
Lear, Inc.
***MARTIN CO., THE, DENVER DIV.**
Raven Industries Inc.
Standard Steel Corp., Cambridge Div.

TRANSFORMER WINDINGS

ACDC Electronics, Inc.
Acme Electric Corp.
Advanced Electronics, Inc.
Allen Electric & Equipment Co.
Arnold Magnetics Corp.
Coil Co. of America
Communication Accessories Co.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Electronic Transformer Co., Inc.
Electro-Winders Co., Inc.
Ferrotran Electronics Co., Inc.
Forest Electric Co., the
Fugle-Miller Labs. Inc.
Lear, Inc.
Leece-Neville Co., The
Merit Coil & Transformer Corp.
Mid-West Coil & Transformer Co.
National Coil Co.
Palo Alto Engrg. Co.
Permoflux Products Co.
Polyphase Instrument Co.
Rimak, Inc.
J. R. Robbins Co.
Standard Electronics Div.-Reeves Instrument Corp.
Stewart-Warner Electronics Div.
Telechrome Mfg. Corp.
Topper Mfg. Co., Inc.
Torwico Electronics, Inc.
Transformer Specialty Co.
Transformers, Inc.
Triad Transformer Corp.
U. E. Electronics Corp.
Virginia Electronics Co., Inc.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.

TRANSFORMERS

a. Audio
b. Fly Back
c. Foil Wound
d. General
e. High Voltage Power Supply
f. Instrument
g. Miniature
h. Output
i. Power
j. Precision Voltage Dividing
k. Pulse
l. Rf & if
m. Ultrasonic

ACDC Electronics, Inc., **a, d thru l.**
ACF Industries Inc., **a, d, g, h.**
ADC Inc., **a thru k, m.**
AMP Inc., **e, k.**
A. P. W. Co., **g, h.**
Ace Coil & Electronics Co., **k, l.**
Acme Electric Corp., **d, e, g, i, k.**
Airpax Electronics Inc., Cambridge Div., **a, f thru i, k.**
Airpax Electronics Inc., Seminole Div., **a, f thru i, k.**
Aladdin Electronics, Div.-Aladdin Industries Inc., **g, k, l.**
Allen Electric & Equipment Co., **d, i.**
American Machine & Foundry Co., Government Products Group, **c.**
American Rectifier Corp., **d, e, i.**
R. B. Annis Co., **f.**
Applied Radiation Corp., **e, k.**
Arnold Magnetics Corp., **a, d thru i.**
***ARNOUX CORP.**
Associated Engineers, Inc., **d, j.**
Atlas Engrg. Co. Inc., **a, c thru k, m.**
Ballastran, Div.-Telex, Inc., **a, c, d, e, g, h, i, k.**
Barker & Williamson Inc., **a, g, l.**
Barry Electronics Corp., **i.**
Barwood Electronics Inc., **a, d, f thru i.**
Bendix Aviation Corp., **f, g.**
Berkshire Transformer Corp., **a, d thru j, l.**
Bogue Electric Mfg. Co., **d, e, g, h, i.**
CG Electronics Corp., **g, k.**
CGS Labs., Inc., **l.**
Cable Electric Products Inc., **d, h, i.**
Caledonia Electronics & Transformer Corp., **a, e, g thru k.**
Cambridge Thermionic Corp., **a, l.**
Carol Electronics Corp., **a, d, f, i.**
Central Transformer Co., **a, c thru i, m.**
Chicago Electronic Engrg. Co., Inc., **a, d, f, g, i, j.**
Chicago Standard Transformer Corp., **a, b, d, f thru i, k.**
Circo Equipment Co., **m.**
Circo Ultrasonic Corp., **m.**
Coil Co. of America, **a, c thru m.**
G. L. Collins Corp., **j.**
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO., a, d thru m.**
Communication Accessories Co., **a, c, d, e, g thru k.**
Crest Transformer Corp., **a, d thru i.**
Custom Magnetics Inc., **a, d, e, h, i.**
Cycle Transformer Corp., **a, d thru k, m.**
Daystrom Inc., Weston Instruments Div., **f, j.**
De Havilland Aircraft of Canada, Ltd., Special Products Div., **g, i.**
Del Electronics Corp., **e, g, h, i.**
Delco Radio Div.-General Motors Corp., **f, g.**
De Witt Development Co., **i.**
Dinion Coil Co., Inc., **a, d thru i, k.**
Djeco, Div.-Djordjevic Engrg. Co., **a, d thru k.**
Double E Products Co., **a thru m.**
ESC Corp., **k.**
Eagle Electric Mfg. Co. Inc., **d.**
Edgerton, Germeshausen & Grier, Inc., **e, k.**
Eisler Engrg. Co., Inc., **e, i.**
Electro Engrg. Works, **a, d, e, g, i.**
Electronic Coils, Inc., **j.**
Electronic Transformer Co., Inc., **a, c, d thru k, m.**
Electrosolids Corp., **g, i.**
Electro-Winders Co. Inc., **d, f, g, k, l.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **a, e, j thru m.**
Epco Products Inc., **a, d, f thru i, k, m.**
Erie Resistor Corp., **g, k.**
FXR, Inc., **k.**
Ferrotran Electronics Co., Inc., **a, g, h, i.**
Filtron Co., Inc., **k.**
Fisher Engrg., Inc., **d, e, g thru m.**
Forbes & Wagner, Inc., **b, k, l.**
Ford Instrument Co., Div.-Sperry Rand Corp., **f, h, i, j.**
Forest Electric Co., The, **a, d, h, i.**
Freed Transformer Co., Inc., **a, d thru k, m.**
Fugle-Miller Labs. Inc., **f, g, l, m.**
Gates Electronic Co., **i.**
General Coil Products Corp., **l, m.**
General Controls Co., **f, i.**
General Electric Co., Apparatus Sales Div., **d, e, f, i, k.**
Paul E. Gerst & Co., **c, d.**
Gudeman Co., The, **k.**
Hamilton Watch Co.-Industrial Div., **g, k.**
Hammett-Mercury-Rex Div., **d, e, i.**
Donald C. Harder Co., **a, d, e, g, h, i, k, l.**
George E. Harris & Co., Inc., **d, f thru i, l.**
Hazeltine Electronics Div.-Hazeltine Corp.
Hewlett-Packard Co., **f.**
A. F. Holden Co., The, **d.**
Huyck Systems Co.
IMC Magnetics Corp., **k.**
Industrial Transformer Corp., **d thru i, k.**
Industron Corp., **e.**
Intercontinental Electronics Corp., **d, g, i, k.**
***INTERELECTRONICS CORP., a, d thru j, m.**
Jack & Heintz, Inc., **f, i.**
James Electronics Inc., **a, f, g, j.**
Johnson Electronics Inc., **g, k, l.**
Knopp Inc., **f.**
Kolton Electric Mfg. Co., **i.**
Lab. for Electronics, Inc., **a, b, d thru i, k, l, m**
Land-Air Inc., Sub.-California Eastern Aviation, Inc., **e, i, j.**
Landis & Gyr, Inc., **f.**
Langevin Div., The W. L. Maxson Corp., **a, g thru j.**
Lear, Inc., **a, d, f, g, i, j, l.**
Lee Electric & Mfg. Co., **e.**
Leece-Neville Co., The, **i.**
Line Material Industries-McGraw-Edison Co., **i.**
Litton Industries, Inc.
Lockheed Electronics Co., Stavid Div., **a, e, h, i, k.**
Lumen, Inc., **a, d, f, m.**
Magnetic Circuit Elements, Inc., **a, d thru k.**
Merit Coil & Transformer Corp., **a thru e, g, h, i, k, l.**
Microdot Inc., **f thru i, k.**
Microtran Co., Inc., **a, d, f, thru k, m.**

Mid-West Coil & Transformer Co., **a, c thru k.**
James Millen Mfg. Co. Inc., **l.**
J. W. Miller Co., **e, g, l.**
Sanford Miller Co., **i.**
Milro Controls Co., Inc., **g, j.**
Modelectric Products Corp., **g, k.**
National Coil Co., **a, d, f thru j, l, m.**
National Co., Inc., **k, l.**
Networks Electronic Corp., **h, i.**
New England Transformer Co., Inc., **a, c, d, g, h, i, k.**
New York Coil Co., Inc., **a, d thru l.**
New York Transformer Co. Inc., **a, d thru k, m.**
Nothelfer Winding Labs. Inc., **e, f, h thru m.**
Nytronics, Inc., Essex Electronics Div., **a, g, h, k, l.**
Ortho Filter Corp., **a, f thru k.**
Pacific Magnetic Corp., **a, d, f thru k.**
Palo Alto Engrg. Co., **a, d thru k.**
Pearson Electronics, Inc., **e, f, k.**
Penn-East Engrg. Corp., **a, g, h, i.**
Permoflux Products Co., **a, d, e, g, h, i.**
Peschel Electronics, Inc., **e.**
Polyphase Instrument Co., **a, c, f thru l.**
Precise Development Corp., **l.**
Pulse Engrg. Inc., **g, k.**
Qutronic Transformer Corp., **a, c, d, f thru j.**
RS Electronics Corp., **e, k, l.**
Radio Industries, Inc., **l.**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc., **d, g, j.**
Redman Electronics Corp., **k, l, m.**
Rytron Co., Inc., **d, g, i thru l.**
Sangamo Electric Co., **a, e thru k, m.**
Sciaky Brothers, Inc., **e, i, k.**
Scientific Electric Inc., **e, i.**
Servomechanisms, Inc., **a, e, g thru j.**
Servo-Tek Products Co., **f, g.**
Sonotone Corp., **g.**
Southwestern Industrial Electronics Co., **d thru l.**
Specialties, Inc., **k.**
Spellman High Voltage Co., **e.**
Standard Electronics Div.-Reeves Instrument Corp., **a, d thru m.**
Standard Winding Co., Inc., **l.**
Sterling Transformer Corp., **a, d thru k, m.**
Stewart-Warner Electronics Div., **k, l.**
Sunair Electronics, Inc., **i.**
Sunshine Scientific Instrument, **f.**
Superior Electric Co., The, **d, i.**
Technical Apparatus Builders, **d, e, h, i.**
Technitrol Engrg. Co., **k.**
Tele Coil Co., **b, g, l.**
Telechrome Mfg. Corp., **d, h, i, l.**
Telectro Industries Corp., **a, d, f, h, i, k.**
Telex, Inc., **a, d, e, g, h, k.**
Thermador Electrical Mfg. Co., **a, d thru k, m.**
Topper Mfg. Co., Inc., **d, f, g, h.**
Torwico Electronics, Inc., **a, f thru j.**
Transformer Design, Inc. of Milwaukee, **a, c thru k, m.**
Transformer Specialty Co., **d, i.**
Transformers, Inc., **a, c thru k, m.**
Trenton Transformer Corp., **d, e, f, h, i.**
Tresco, Inc., **a, c, d, f thru i, k.**
Triad Transformer Corp., **a thru k.**
U. E. Electronics Corp., **a, d, e, g, h, i, l, m.**
U. S. Science Corp., Div.-Topp Industries, Inc., **d, g, j.**
Universal Toroid Coil Winding, Inc., **g.**
Universal Transistor Products Corp., **e, g, i.**
Valor Instruments, Inc., **a, g, k, l.**
Vanguard Electronics Co., **l.**
Varo Mfg. Co., Inc., **a thru l.**
Vernistat Div., The Perkin-Elmer Corp., **j.**
Virginia Electronics Co., Inc., **a, c thru j, l.**
Wahlgren Magnetics, Div.-Marshall Industries **a, e, g thru k, m.**
Wesrep Corp., **e, f, i, l.**
Westinghouse Electric Corp., **a, d thru i, k, l.**
Wheeler Electronic Corp., Sub.-Sperry Rand Corp., **a, d, g, h, i, k.**

TRANSISTORS

a. Germanium
b. Germanium, Power
c. Photo
d. Silicon
e. Silicon, Power
f. Switching
g. Tetrode

Amperex Electronic Corp., **a thru f.**
Associated Engineers, Inc.
Bendix Aviation Corp., **a, b, f.**
Bendix Aviation Corp.-Semiconductor Products, Red Bank Div., **a, b, f.**
Bogue Electric Mfg. Co., **d, e.**
Britton Electronics Corp., **d, f.**
CBS Electronics, Div.-Columbia Broadcasting System, Inc., **a, b, f.**
Calvert Electronics Inc., **a, d.**
Clevite Transistor Products, Div.-Clevite Corp., **a, b, f.**
Cornell-Dubilier Electric Corp., **a.**
Crystalonics Inc., **d.**
Delco Radio Div.-General Motors Corp., **a, b, d, e, f.**
***DEL MAR ENGRG. LABS.**
Djeco, Div.-Djordjevic Engrg. Co.
Fairchild Semiconductor Corp., **d, e, f.**
General Electric Co. Ltd. of England, **a, b, d thru g.**
General Transistor Corp., **a, c, d, f.**
Hammett-Mercury-Rex Div., **a, b, d, e, f.**
George E. Harris & Co., Inc., **d, e.**
Hoffman Electronics Corp., Semiconductor Div., **d, e, f.**
Hughes Semiconductor Div.-Hughes Aircraft Co., **a, b, d, e, f.**
Wayne Kerr Corp.
Lear, Inc., **a, d, e, f.**
Minneapolis-Honeywell Regulator Co., Semiconductor Products Div., **a, b, d thru g.**
Motorola, Inc., **a, b, d thru g.**
Philco Corp.-Govt. & Industrial Group, **a thru f.**
Philco Corp., Lansdale Div., **a, b, d, f.**
***RADIO CORP. OF AMERICA, a thru g.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a, b.**
Radio Development & Research Corp., **a, d.**
Rauland Corp., The, **a, f.**
***SEMICONDUCTOR DIV., RAYTHEON CO., a, b, d, e, f.**
Silicon Transistor Corp., **d, e.**
Sperry Semiconductor Div., Sperry Rand Corp., **d, f.**
Sprague Electric Co., **a, d, f.**
Sylvania Electric Products Inc., Sylvania Electronic Tubes Div., **a, b, d, e, f.**
Sylvania Semiconductor Div., Sylvania Electric Products Inc., **a, b, f.**
TRG, Inc., **d, e.**
Technical Apparatus Builders, **d.**
Texas Instruments Inc., **a thru g.**
Transitron Electronic Corp., **a, d thru g.**
Trans-Sil Corp., **e.**
Tung-Sol Electric, Inc., **a, b, f.**
Westinghouse Electric Corp., **b thru f.**

TRANSMISSION LINE, WIRE & CABLE

Aluminuum Co. of America
American Super-Temperature Wires, Inc.
***ANDREW CORP.**
William Brand, Rex Div.-American Enka Corp.
Cable Electric Products Inc.
Dayton Aircraft Products, Inc.
Jefferson Electronic Products
Kaiser Aluminum & Chemical Sales, Inc.
Leviton Mfg. Co., Inc.
MEG Products, Div.-Mandrel Industries, Inc.
***MARTIN CO., THE, DENVER DIV.**
Phelps Dodge Copper Products Corp.
Prodelin Inc.
***RADIO CORP. OF AMERICA**
Reynolds Metals Co.
Rome Cable Div.-Alcoa
Southwire Co.
Surprenant Mfg. Co.
Tamar Electronics, Inc.
Telcon, Inc.
Vector Mfg. Co.
Victor Electric Wire & Cable Corp.

TRANSMISSION LINES, MICROWAVE

Airtron, Div.-Litton Industries
***ANDREW CORP.**
Bogart Mfg. Corp.
Collins Radio Co.
Diamond Antenna & Microwave Corp.
Douglas Microwave Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Bronze Electronics Corp.
Gilfillan Bros. Inc.
Gorham Electronics-Div.-Gorham Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Lieco, Inc.
***MARTIN CO., THE, DENVER DIV.**
Meridian Metalcraft, Inc.
Microwave Associates, Inc.
Omega Labs., Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.-Govt. & Industrial Group
Prodelin Inc.
Radar Design Corp.
***RADIO CORP. OF AMERICA**
Sanders Associates, Inc.
TRG, Inc.
Technicraft, Div.-Electronic Specialty Co.
Transco Products, Inc.
Victor R. F. & Microwave Co.
Waveline, Inc.

TRANSMITTERS

Adler Electronics, Inc.
Aeronautical Electronics, Inc.
Allied International Corp.
Amerac Inc.
American Missile Products Co., Inc.
Babcock Radio Engrg., Inc.
Blonder-Tongue Labs. Inc., Special Products Div.
Budd Lewyt Electronics, Inc.
Budelman Electronics Corp.
Burton-Rodgers, Inc.
CG Electronics Corp.
Collins Radio Co.
Communications Research Co.
Continental Electronics Mfg. Co., Sub.-Ling-Altec Electronics Inc.
Crosby-Teletronics Corp.
Daven Co., The
Designers for Industry, Inc.
Dorsett Electronic Labs., Inc.
Du Kane Corp.
Allen B. Du Mont Labs., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
Fla. Aircraft Radio & Marine
Gates Radio Co.
General Devices, Inc.
General Instrument Corp., Defense & Engrg. Products Group
Globe Electronics, Div.-Textron Electronics, Inc.
Gonset Div.-Young Spring & Wire Corp.
Gorham Electronics-Div.-Gorham Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hallicrafters Co., The
Hazeltine Electronics Div.-Hazeltine Corp.
ITI Electronics, Inc.
ITT Federal Div., International Telephone & Telegraph Corp.
Interstate Electronics Corp.
Kahn Research Labs., Inc.
Lear, Inc.
Lenkurt Electric Co., Inc.
Levinthal Electronic Products, Inc.
Litton Industries, Maryland Div.
***MAGNAVOX CO., THE**
Manson Labs., Inc.
Mason Electric Corp.
W. L. Maxson Corp., The
James Millen Mfg. Co. Inc.
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Nevada Air Products Co.
Northrop Corp.
Philco Corp.-Govt. & Industrial Group
Production Research Corp., Sub.-Radio Condenser Co.
Radiation, Inc.
Radio City Products Co., Inc.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Seeburg Corp., The
Seiscor, Div.-Seismograph Service Corp.
Skiatron Electronics & Television Corp.
Specialties, Inc.
Spectra Electronics Corp.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Standard Electronics Div.-Reeves Instrument Corp.
Stewart-Warner Electronics Div.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Technical Materiel Corp., The
Telechrome Mfg. Corp.
Telectro Industries Corp.
Texas Instruments Inc.

Virginia Electronics Co., Inc.
Westinghouse Electric Corp.
Wheeler Electronic Corp., Sub.-Sperry Rand Corp.
Winder Aircraft Corp. of Florida

TRANSMITTERS, PORTABLE & MOBILE RADIOTELEPHONE

Adler Electronics, Inc.
Aeronautical Electronics, Inc.
Allied International Corp.
Blonder-Tongue Labs. Inc., Special Products Div.
Budd Lewyt Electronics, Inc.
Burton-Rodgers, Inc.
Collins Radio Co.
Communications Co.
Communications Research Co.
Daven Co., The
Designers for Industry, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Fla. Aircraft Radio & Marine
General Instrument Corp., Defense & Engrg. Products Group
Globe Electronics, Div.-Textron Electronics, Inc.
Gonser Div.-Young Spring & Wire Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
Kahn Research Labs., Inc.
Lear, Inc.
Lenkurt Electric Co., Inc.
Mason Electric Corp.
Motorola, Inc.
Munston Electronic Mfg. Corp.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Projects Unlimited, Inc.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Radio Specialty Mfg., Co.
Spectra Electronics Corp.
Standard Electronics Div.-Reeves Instrument Corp.
State Testing Laboratory Inc.
Stewart-Warner Electronics Div.
Stromberg-Carlson Div.-General Dynamics Corp.
Sun Electric Corp., Aeronautical Div.
Virginia Electronics Co., Inc.

TRANSPONDERS

ACF Industries Inc.
Advance Industries, Inc.
Avien Inc.
Budd Lewyt Electronics, Inc.
Collins Radio Co.
Cubic Corp.
Emerton, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp., Defense & Engrg. Products Group
Guided Missile Div., The Firestone Tire & Rubber Co.
George E. Harris & Co., Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
Hoover Electronics Co.
***HORKEY-MOORE ASSOCIATES, SUB.-HOUSTON FEARLESS CORP.**
ITT Federal Div., International Telephone & Telegraph Corp.
Lear Inc.
***MAGNAVOX CO., THE**
W. L. Maxson Corp., The
Motorola Inc.
Packard-Bell Electronics Corp.
Ralph M. Parsons Co., The, Electronics Div.
Production Research Corp., Sub.-Radio Condenser Co.
RS Electronics Corp.
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Sanders Associates, Inc.
Sperry Gyroscope Co., Div.-Sperry Rand Corp.
Stewart-Warner Electronics Div.
Sun Electric Corp., Aeronautical Div.
Tamar Electronics, Inc.
Telechrome Mfg. Corp.
Texas Instruments Inc.
Wells Industries Corp.

TRANSPORT UNITS

Basic Tool Industries, Inc.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Caterpillar Tractor Co., Defense Products Dept.
Craig Systems, Inc.
Crane Carrier Corp.
Douglas Aircraft Co., Inc.
Food Machinery & Chemical Corp., Ordnance Div.
Freuhauf Trailer Co., Military Equipment Div.
Gremco, Inc.
International Steel Co.
Lyncoach & Truck Co. Inc.
***MARTIN CO., THE, DENVER DIV.**
Potter Instrument Co., Inc.
Pryor Mfg. Co.
Telectro Industries Corp.
Trailmobile Inc.
Weaver Mfg. Co., Div.-Dura Corp.
Wells Industries Corp.
Wolverine Diesel Power Co.

TRIM TABS

Breeze Corporations, Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Lear, Inc.
Monrovia Aviation Corp.
Weber Aircraft Corp.

TRIPODS

Brooks & Perkins, Inc.
Cable Electric Products Inc.
Davidson Optronics, Inc.
Electronic Applications, Inc.
Mitchell Camera Corp.
Optomechanisms Inc.
South River Metal Products Co., Inc.
Warren-Knight Co.

TUBE

a. Cooling Units
b. Pin Straighteners
c. Pullers
d. Seal Leads
e. Shields
f. Sockets

Alden Products Co., f.
American Brass Co., The f.
Associated Engrg. & Mfg. Corp., d.
Augat Brothers, Inc. a, f.
Beimar Wheel & Machine Co., Inc., e.
Bendix Aviation Corp., a.
Birtcher Corp., The, a, e.
Budd Lewyt Electronics, Inc. a.
CBS Electronics, Div.-Columbia Broadcasting System, Inc., b, c.
Eastern Industries Inc., a.
Hugh H. Eby Co., e.
Electro Corp., e, f.
Electronic Parts Mfg. Co., Inc., d.
Garlock Packing Co., The-Electronic Products f.
General Electric Co., Lamp Metals & Components Dept., d.
International Electronic Research Corp., a, e, f.
Jettron Products Inc., f.
E. F. Johnson Co., f.
C. B. Kaupp & Sons, Inc., e.
Kensico Tube Co., Div.-Robinson Technical Products Inc.
Kling Metal Spinning & Stamping Co., e.
Livingston Electronic Corp., e, f.
Metal Textile Corp. Div.-General Cable Corp., a.
James Millen Mfg. Co. Inc., e f.
Modine Mfg. Co. a.
Mycalex Corp. of America f.
Precision Apparatus Co., Inc. b.
***RADIO CORP. OF AMERICA**, f.
Radio Frequency Co., Inc., f.
Remler Co., f.
Milton Ross Metals Co., The b, f.
Standard-Thomson Corp., Clifford Mfg. Co. Div., a.
Star Expansion Industries Corp., b.
United Aircraft Products, Inc., a.
Vector Electronic Co., Inc., b, e, f.
Vilter Mfg. Co., The, a.
Wells Industries Corp., a.
Westinghouse Electric Corp., d.
York Div., Borg-Warner Corp., a.
Zippertubing Co., The, a, e.

TUBE PARTS

Airdrome Parts Co.
Alite Div., U. S. Stoneware Co.
American Brass Co., The
Art Wire & Stamping Co.
Associated Engrg. & Mfg. Corp.
Autoscrew Co., Inc.
B. H. Aircraft Co., Inc.
Coors Porcelain Co.
Corning Glass Works
Eitel-McCullough, Inc.
Electronic Parts Mfg. Co., Inc.
Fansteel Metallurgical Corp.
Gar Products Corp.
General Electric Co., Lamp Metals & Components Dept.
Janitrol Aircraft Div.-Midland-Ross Corp.
Kemet Co., Div.-Union Carbide Corp.
King Labs., Inc.
Lancaster Glass Corp.
Norrich Plastics Corp.
Norrich Screw Machine Products
Pennsylvania Tool & Mfg. Co., The
***RADIO CORP. OF AMERICA**
Sylvania Electric Products Inc., Sylvania Electronic Tubes Div.
Thor Ceramics Inc.
Wall Colmonoy Corp., Stainless Processing Div.
Warren Components, Div.-El-Tronics, Inc.
Westingnouse Electric Corp.

TUBES

a. ATR
b. Backward Wave
c. Ballast
d. Battery Charger
e. Bolometer
f. Cathode, Multiple Gun
g. Cathode Ray
h. Cathode Ray, Instrument Use
i. Ceramic
j. Cold Cathode
k. Computer, Storage
l. Counter Beam
m. Electrometer
n. Electron Multiplier
o. Gamma Ray, Nuclear
p. Geiger Counter, Nuclear
q. Geiger Mueller
r. Glow or Discharge
s. Ignitron
t. Infrared
u. Ionization
v. Klystron
w. Magnetron
x. Miniature
y. Noise Source
z. Phototubes
a-l Phototubes, Multiplier
b-l Pirani
c-l Power Amplifier
d-l Projection
e-l Receiving
f-l Rectifying
g-l Scintillation
h-l Scintillation, Nuclear
i-l Sparkgap
j-l Strobe
k-l Subminiature
l-l Switching
m-l Thyratron
n-l TR
o-l Transducer
p-l Transmitting
q-l Transmitting-Receiving
r-l Traveling Wave
s-l Ultra-Violet
t-l Vacuum
u-l Voltage Reference or Regulating
v-l X-Ray

***AEROJET-GENERAL CORP.**, t.
Aerolux Light Corp., j, r, t, i-l, j-l, s-l, t-l, u-l.
American Electronics Inc., o.
American Electronics, Inc., g, n, k, m, v, e-l, f-l, j-l, u-l.
American Lava Corp., i.
American Speedlight Corp., j-l.
Amglo Corp., j, r, j-l, s-l.
Amperex Electronic Corp., j, j, n thru q, s, v thru z, a-l, c-l, e-l, f-l, h-l, k-l, l-l, m-l, p-l, u-l, v-l.
Amperite Co., Inc., e.
Applied Radiation Corp., v.
Associated Engineers, Inc., t-l.
B. H. Aircraft Co., Inc.
Baird-Atomic, Inc., e, j, k, p, r, h-l, k-l, l-l, v-l.
Barker Sales Co., h, j, m.
Barry Electronics Corp., g, h, s, v, w, x, z, c-l, f-l, k-l, m-l, p-l, q-l, t-l.
Bendix Aviation Corp., b, j, r, v thru y, c-l, e-l, f-l, i-l, m-l, u-l.

Bendix Aviation Corp., Red Bank Div., a, b, i, j, k, o, q, r, v, x, y, z, c-l, e-l, f-l, i-l, k-l, l-l, m-l, q-l, r-l, t-l, u-l.
Blonder-Tongue Labs. Inc., Special Products Div., g, t, z.
Braun-Knecht-Heimann Co., Industrial Div., q.
Burroughs Corp., l.
Burroughs Corp., Electronic Tube Div., l, r, y.
CBS Electronics, Div.-Columbia Broadcasting System, Inc., g, j, x, z, c-l, e-l, f-l, l-l, p-l, q-l, t-l, u-l.
CBS Laboratories, Div.-Columbia Broadcasting System, f, g, h, n, t, w, z, a-l.
Calvert Electronics Inc., a thru d, f thru i, n thru s, v thru z, a-l, b-l, c-l, e-l thru n-l, q-l, r-l, t-l, v-l.
Carborundum Co., Refractories Div., i.
Central Electronic Mfrs., Div.-Nuclear Corp. of America, q, y, b-l, c-l, f-l, l-l, n-l, p-l, t-l, u-l.
Chatham Electronics Div.-Tung-Sol Electric Inc., c, i, j, r, x, z, c-l, e-l, f-l, k-l, l-l, m-l, p-l, q-l, t-l, u-l.
Chicago Miniature Lamp Works, r.
Consolidated Vacuum Corp., b-l, t-l.
Continental Electric Co., d, t, z, b-l, f-l, j-l, m-l, p-l, t-l.
Diamond Power Specialty Corp., j.
Dieco, Div.-Djordjevic Engrg. Co., d, f-l, u-l.
Du-Co Ceramics Co., i.
Allen B. Du Mont Labs., Inc., a, f, g, h, n, t, a-l.
Edgerton, Germeshausen & Grier, Inc., g, h, i, r, i-l, j-l, m-l, u-l.
Thomas A. Edison Ind. Instrument Div.-McGraw-Edison Co., s-l.
Edwards High Vacuum Ltd., b-l.
Eitel-McCullough, Inc., i, v, c-l, f-l, p-l, r-l.
Electronic Tube Corp., f, g, h.
Electron-Radar Products, z.
Electrons Inc., f-l, m-l.
Emerson Sub-Emerson Radio & Phonograph Corp., t, v, w, c-l, h-l, l-l, o-l, r-l.
Engelhard Industries Inc., s-l.
Eureka Williams Corp., g, h.
Field Emission Corp., i-l, t-l, u-l, v-l.
General Electric Co., Cathode Ray Tube Dept., g.
General Electric Co. Ltd. of England, a, b, g thru k, m, q, v, w, y, c-l, e-l, f-l, m-l, n-l, p-l, q-l, r-l, t-l, u-l.
General Electric Co. X-Ray Dept., v-l.
General Electrodynamics Corp., g, h, k, t, a-l.
General Radio Co., j-l.
Haleby Electronics Co., j.
Hammett-Mercury-Rex Div., b, d, f, g, h, i, m, n, s, v, w, c-l, f-l, l-l, m-l, o-l, p-l, q-l, t-l, v-l.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., u.
Huggins Labs. Inc., b, r-l.
Hughes Semiconductor Div.-Hughes Aircraft Co., k-l.
ITT Components Div., International Telephone & Telegraph Corp., b, f, g, i, k, m, t, v, w, y, z, c-l, d-l, f-l, l-l, m-l, p-l, r-l, t-l.
Image Instruments Inc., k.
Infrared Industries Inc., t, z.
Intercontinental Electronics Corp., f, g, k.
International Electronics Corp., b, h, i, j, l thru x, z, a-l, c-l, e-l, thru h-l, k-l thru r-l, t-l, u-l.
Isolantite Mfg. Corp., i.
Kip Electronics Corp., c, j, k-l, m-l, t-l.
M. Kirchberger & Co., Inc., i.
Kuthe Labs. Inc., f-l, m-l.
Lewis & Kaufman, b, c-l, f-l, p-l, t-l.
Litton Industries Inc., a, b, g, v, w, y, n-l, q-l, r-l.
Mackay Research Labs., g, h, n, r, t, w, z, a-l, t-l.
McMillan Companies The, t, d-l.
Microwave Associates Inc., a, e, r, w, y, i-l, n-l, p-l, q-l.
*MICROWAVE & POWER TUBE DIV., RAYTHEON CO., a, b, v, w, n-l, r-l.
National Beryllia Corp., i.
National Ceramic Corp., i.
National Co. Inc., n.
National Electronics Inc., d, s, m-l.
National Union Electric Corp., g, r, x, u-l.
Northrop Corp., j, r.
Nuclear Development Lab., o, p, q.
Nuclear Measurements Corp., o, p, q, g-l, h-l.
Nuclear-Chicago Corp., o, p, q, u, g-l, h-l.
Ohmart Corp., The, o, p, q, g-l, h-l.
Philco Corp.-Govt. & Industrial Group, f, g, t, x, e-l, k-l, l-l.
Philco Corp., Lansdale Div., g, h, j, t, x, y, c-l thru f-l, k-l, l-l, s-l, t-l, u-l.
Philips Electronic Instruments, q, v-l.
Polarad Electronics Corp., b, i, v.
Radiation Research Corp., j, u-l.
*RADIO CORP. OF AMERICA, a thru d, f thru l, n thru z, a-l, c-l thru h-l, k-l thru u-l.
*RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a, f thru i, k, m, n, t, w, x, z, a-l, c-l, e-l, f-l, k-l, m-l, o-l thru r-l, t-l.
Raulang Corp., The, g.
*RAYTHEON CO., INDUSTRIAL COMPONENTS DIV., f thru m, p thru s, x, c-l, e-l, f-l, i-l, k-l, m-l, p-l, q-l, t-l, u-l.
*RECEIVING TUBE DIV., RAYTHEON CO., x, c-l, e-l, f-l, q-l, t-l.
Research, Inc., s.
Resitron Labs., Inc., g thru j, o, t, u, f-l, i-l, l-l, p-l, t-l, v-l.
Milton Roy Co., m.
Santa Barbara Research Center, t.
Semi-Elements, Inc., t, g-l, h-l.
Skiatron Electronics & Television Corp., g.
Sonotone Corp., x, e-l, k-l, t-l.
Sperry Electronic Tube Div., Sperry Rand Corp., v, c-l, r-l.
Sperry Gyroscope Co., Div.-Sperry Rand Corp., v, r-l.
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., e.
State Labs. Inc., c-l, e-l, f-l, k-l, m-l, p-l, q-l, t-l.
Sewart Engrg. Co., b.
F. J. Stokes Corp., u.
Stromberg-Carlson, San Diego, General Dynamics Corp., f, g, j, k.
Superior Electric Co., The, u-l.
Superior Steatite & Ceramic Corp., i.
Sylvania Electric Products Inc., Special Tube Operations, a, b, i, l, r, u, v, w, b-l, n-l, r-l.
Sylvania Electric Products Inc., Sylvania Electronic Tubes Div., f thru j.
Technical Apparatus Builders, d, g, t, v, w, x, e-l, k-l, p-l.
Thermal American Fused Quartz Co., Inc., i.
Thermosen Inc., x, y, f-l, t-l, u-l.
Thomas Electronics, Inc., g.
Tracerlab Inc., p, q.
Tung-Sol Electric, Inc., g, j, r, x, z, c-l, e-l, f-l, k-l thru n-l, t-l, u-l.
Ultra-Violet Products, Inc., j, x, s-l.
V & H Radio & Electronics, a thru z, a-l thru v-l.
Vacuum Tube Products, Div.-Hughes Aircraft Co., f, g, h, j, k, r, u, b-l, c-l, f-l, l-l, m-l, t-l.
Veeco Vacuum Corp., u.
Voi-Shan Electronics, b, v, r-l.
Wells Industries Corp., t, z, a-l.
Westinghouse Electric Corp., g, h, k, l, p, r, s, t, v, w, a-l, c-l thru h-l, m-l, q-l thru t-l, v-l.
Westline Products Div.-Western Lithograph Co., t.
N. Wood Counter Lab., q, g-l.

TUBING

a. Aluminum
b. Asbestos
c. Brass or Copper
d. Capillary
e. Ceramic
f. Fibre
g. Finned
h. Flexible Metal
i. Fused Quartz
j. Glass Fibre Insulation
k. Glass, Precision
l. Metal & Alloy
m. Metal Hose, Flexible
n. Mica
o. Molybdenum
p. Monel
q. Nickel
r. Paper
s. Phenolic
t. Plastic
u. Precious Metal
v. Seamless
w. Silver
x. Steel
y. Steel, Stainless
z. Tantalum
a-l Titanium
b-l Tungsten
c-l Varnished Cambric Insulation
d-l Varnished or Lacquered
e-l Waveguide
f-l Woven or Knitted Wire

Abesto Corp., b, s, t, c-l, d-l.
Aero Leather Products Co., j.
*AEROJET-GENERAL CORP., x.
Aircom Inc., e-l.
Airtron, Div.-Litton Industries, e-l.
Alite Div., U. S. Stoneware Co., e.
All Boro Metal Products Co., Inc., y.
Allied Plastics Supply Corp., b, f, h, m, n, r, s, t, c-l, d-l.
Allied Research & Engrg., Div.-Allied Record Mfg. Co., q, e-l.
Alpha Metals, Inc., l.
Alpha Wire Corp., a, j, t, d-l.
Aluminum Co. of America, a, g, l, e-l.
American Agile Corp., t.
American Brass Co., The c, h, l, m, v.
American Instrument Co., Inc., p, q, x, y.
American Latex Products Corp., t.
American Lava Corp., e.
American Nickel Alloy Mfg. Corp., p, q.
American Super-Temperature Wires, Inc., j, t.
American Tubing Co., Inc., a, c, l, p, q, u, v, x, y, z, a-l.
Ampco Metal Inc., c, l, v.
Anaconda Metal Hose Div., The American Brass Co., d, h, m, t, e-l.
Anchor Metal Co. Inc., l.
Anchor Plastics Co., Inc., t.
Arrowhead Products Div.-Federal-Mogul Bower Bearings, Inc., e, f, h, j thru m, s, t, y, e-l, f-l.
Asheville-Schoonmaker Mica Co., n.
Associated Engrg. & Mfg. Corp., i, o, z, b-l.
Auburn Mfg. Co., The, b, f, r, s, t, c-l.
Avica Corp., h, m.
Avon Tube Div.-Higbie Mfg. Co., x.
B. & C. Insulation Products, Inc., j, c-l.
Semor Bache & Co., k.
Bendix Filter Div., Bendix Aviation Corp., y, f-l.
Bentley Harris Mfg. Co., j, d-l.
Bethlehem Steel Co., l, v, x, y.
J. Bishop & Co. Platinum Works, d, l, o, p, q, u, v, x, y, z, a-l, f-l.
Blaco Mfg. Co., h, t.
Blossom Mfg. Co. Inc., t, c-l.
Bohn Aluminum & Brass Corp., a.
Bonny Mfg. Corp., t.
Borden Chemical Co., t.
Borden Chemical Co., The Resinite Dept., t, d-l.
Bram Metallurgical Chemical Co., a, c, i, l, n thru q, u, v, w, y, z, a-l, b-l.
William Brand, Rex Div.-American Enka Corp., j, t, c-l, d-l.
Braun-Knecht-Heimann Co., Industrial Div., k.
Breeze Corporations Inc., g, h, m, f-l.
Bridgeport Brass Co., a, c, d, g, l, o, p, q, u, v, y, z, a-l.
Milton H. Brooks & Son Engraving & Mfg. Co. Inc., j, s, t.
Budd Co., The f, t.
Cadillac Plastic & Chemical Co., s, t.
Carborundum Co., The e.
Carborundum Co., Latrobe Plant, Refractories Div., e.
Carborundum Co., Refractories Div., e, f.
Carpenter Stee Co., The l, q, y, a-l.
Carpenter Steel Co., The, Alloy Tube Div., g, y.
Centralab Div.-Globe-Union, Inc., e.
Chase Brass & Copper Co., Inc., c, g, l, t, v, y, e-l.
Chemplast Inc., t.
Climax Molybdenum Co. of Michigan, o, b-l.
Cobra Metal Hose Div. Dk Mfg. Co., h, l, m, p, q, a-l.
Comco Plastics Inc., f, s, t.
Continental Diamond Fibre Corp., f, n, s, t.

Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co., t, v, x.
Co-operative Industries, Inc., h, m.
Coors Porcelain Co., e.
Corning Glass Works, e, k.
Crucible Steel Co. of America, l, p, v, x, y, a-l.
Crystal-X Corp., s, t.
Curtiss-Wright Corp., Metals Processing Div., a, g, l, p, v, x, a-l, e-l.
Damascus Tube Co., g, l, y, z, a-l b-l.
Dana Corp., v.
Darcoid Co. Inc., The, b, t.
Dell Optics Co., Ltd., i, k.
Demornay-Bonardi, e-l.
Deringer Metallurgical Corp., u, w.
Diamonite Products Mfg. Co., e.
Division Lead Co., l.
Dixon Corp., t.
Dow Chemical Co., The, a, l.
Du-Co Ceramics Co., e.
Dunbar-Kapple Inc.-Aircraft Components Div., h, m, y.
Dura Plastics of N. Y., Inc., t.
Eastern Smelting & Refining Corp., u, w.
Electric Steel Foundry Co., l, p, q, x, y, a-l.
Electrical Insulation Co., Inc., e, r, s.
Electrical Refractories Co., The, e.
Electronic Parts Mfg. Co., Inc., c, o, q, x, y.
Eljay Corp., f, s, t.
Ellwood Ivins Steel Tube Works Inc., l, v, y, e-l.
Emerson Plastics Corp., t.
Enfab Inc., j.
Engelhard Industries, Inc., a, c, e-l.
Fansteel Metallurgical Corp., l, o, u, v, z, b-l.
Federal Metal Hose Corp., h, m.
Fibercraft, Inc., s, t.
Fischer & Porter Co., d, k.
Fisher & Crome, s, t.
Flexible Tubing Corp., j, t.
Flexonics Corp., h, l, m, y.
Fluorocarbon Co., The, t.
Formica Corp., s, t.
Form-It Products, Inc., r.
Franklin Fibre-Lamitex Corp., f, i, r, s, t.
Garlock Packing Co., The-Electronic Products, t.
General American Transportation Corp., t.
B. F. Goodrich Aviation Products, t.
B. F. Goodrich Industrial Products Co., t.
Griscom-Russell Co., The, g.
Hallett Mfg. Co., h, m.
Halogen Insulator & Seal Corp., t.
Hammett-Mercury-Rex Div., t, e-l.
Handy & Harman, u, w.
Harvey Aluminum, a, g, l, o, x, z, a-l, b-l.
Haskel Engrg. & Supply Co., m.
Haynes Stellite Co., Div.-Union Carbide Corp., l, z.
Heil Process Equipment Corp., t.
Hitemp Wires Inc., t.
Homalite Corp., The, t.
Huntington Alloy Products Div.-The International Nickel Co., Inc., l, p, q.
C. G. Hussey & Co., Div.-Copper Range Co., c.
Walter J. Hyatt Co., The, t.
Illumitronic Engrg. Co., s, t.
Imperial Brass Mfg. Co., The, t, v.
Insulation Mfrs. Corp., b, f, i, n, r, s, t, c-l, d-l.
Isolantite Mfg. Corp., e.
Johnson Metal Hose, Inc., h, m.
Jonesville Paper Tube Corp., r.
Kaiser Aluminum & Chemical Sales, Inc., a.
M. Kirchberger & Co., Inc., e.
Kirkhill Rubber Co., t.
Lamtex Industries Inc., f, i, t, v, e-l.
Lapham Hickey Steel Corp., x, y.
La Pointe Industries Inc., a.
Lapp Insulator Co., Inc., Radio Specialties Div., e.
Leach & Garner Co., Indsl. Div., c, l, u, v, w, e-l.
Le Fiell Mfg. Co., a, c, l, o, v, x, y.
Lewis & Saunders, Inc., g.
Lieco, Inc., e-l.
Thomas J. Long, Inc., f, s, t.
Lunn Laminates, Inc., t.
Luzerne Rubber Co., t.
M & Q Plastic Products, d, t.
Mackenzie Walton Corp., c, d, g, v, f-l.
McMillan Companies, The, i.
Metal Forming Corp., Div.-Vanadium-Alloys Steel Co., l, p, q, y, z, a-l.
Mica Fabricating Co., e, f, n, s, t, c-l.
Mica Insulator Div.-Minnesota Mining & Mfg. Co., n, s, t.
Microwave Associates, Inc., e-l.
***MICROWAVE & POWER TUBE DIV., RAYTHEON CO., e.**
***MINNESOTA MINING & MFG. CO., e, h, n, r, t, c-l, d-l.**
NUMEC-Nuclear Materials & Equipment Corp., e.
National Beryllia Corp., e.
National Ceramic Co., e.
National Copper & Smelting Co., c.
National Tube Div.-United States Steel Corp., l, q, t, v, x, y.
National Vulcanized Fibre Co., f, i, s, t.
Natvar Corp., i, t, c-l.
New England Electrical Works, Inc., d.
New England Tape Co., Div.-United-Carr Fastener Corp., t.
New Jersey Wood Finishing Co., t.
Norrich Plastics Corp., a, c, e, f, i, r, s, t, v, x, y, d-l.
Norrich Screw Machine Products, a, f, i, r, s, t.
Norton Co., New Products Dept., e.
Ohio Seamless Tube Div.-Copperweld Steel Co., v, x.
Olin Mathieson Chemical Corp., Metals Div., a.
Olin Mathieson Chemical Corp., N. Y., a, c, u.
Owens-Corning Fiberglas Corp., f, i, t, c-l, d-l.
Pacific Tube Co., l, v, x.
Paramount Paper Tube Corp., b, f, r, d-l.
Penn Fibre & Specialty Co., Inc., f, s, t.
Phelps Dodge Copper Products Corp., c, l, v, e-l.
Plastic Age Sales, Inc., i, t.
Polymer Corp., The, t.
Precision Tube Co., Inc., a, c, l, p, q, v, x, y.
Pressed Steel Tank Co., o, p, q, v, x, z, a-l, b-l.
Raybestos-Manhattan, Inc., b, s, t.
Refractories Div., The Carborundum Co., e.
Ren Plastics, Inc., t.
Republic Steel Corp., l, t, v, x, y, a-l.
Resinite Corp. Div.-Precision Paper Tube Co., b, n, s.
Resistoflex Corp., b, h, m, t, f-l.
Revere Copper & Brass Inc., a, c, g, l, v, x, y.
Reynolds Metals Co., a, e-l.
Fred T. Roberts & Co., t.
Rohn Mfg. Co., x.
Rome Cable Div.-Alcoa, a, x.
Milton Ross Metals Co., The, i, s, t.
Joseph T. Ryerson & Son, Inc., a, l, t, v, x, y.
St. Regis Paper Co., Panelyte Div., r, s, t.
Sandvik Steel, Inc., x, y.
Sanford Plastics Corp., t.
Saylor Electric Products Corp., b, f, i, t.
Ray A. Scharer & Co., t.
Scovill Mfg. Co., c, p, v.
Seaman Products, Div.-Seaman Paper Co., f, i.
Servicair Co., h.
Service Steel Div., l, v, x, y.
W. S. Shamban & Co., i.
Shenango Furnace Co., The, Centrifugally Cast Products Div., c, l, p, q.
Sheridan-Gray, Inc., i.
Sillcocks-Miller Co., t.
South River Metal Products Co., Inc., a, x.
Southern Plastics Co., t.
Sterling Glass Corp., k.
A. T. Stevens Co., b, f.
Stevens Products, Inc., f, i, s, t.
Stone Paper Tube Co., Div.-Stone Straw Corp., r, s, t.
Superior Steatite & Ceramic Corp., e.
Superior Tube Co., d, l, p, q, v, x, y, z, a-l, e-l.
Surprenant Mfg. Co., t, f-l.
Swan Rubber Co., t.
Synthane Corp., b, f, i, s, t.
Taylor Fibre Co., s, t.
Technicraft, Div.-Electronic Specialty Co., h, m, v, e-l.
Tetrafluor, Inc., t.
Texas Instruments Inc., l, u, w, z, a-l, e-l.
Thermal American Fused Quartz Co., Inc., i.
Thermax Wire Corp., f-l.
Thermionic Aeronautical Div., o, z, b-l.
Thermoid Div.-H. K. Porter Co., Inc., t.
Thor Ceramics, Inc., a, e, s, t.
Timken Roller Bearing Co., The, v, x, y.
Tingstol Co., f, s, t.
Titanium Metals Corp. of America, a-l.
Titeflex, Inc., h, m, p, v, y.
Trent Tube Co., p, q, v, y, a-l, e-l.
Tube Distributors Co. Inc., d, o, p, q, v, x, y, a-l.
Tube Methods Inc., v, y.
Tube Reducing Corp., l, o, p, v, x, y, z, a-l.
Tubesales, a, d, l, p, q, v, x, y, z, a-l, b-l, e-l.
Uniform Tubes, Inc., a, c, d, l, p, q, u thru y.
Union Asbestos & Rubber Co., b, f, j.
U. S. Pipe & Foundry Co., Steel & Tubes Div., l, v, x, y.
U. S. Steel Supply Div., United States Steel Corp., l, v, x, y.
United States Steel Corp., v, x, y.
United Wire & Supply Corp., a, c, d, g, q, v.
Universal Unlimited, Inc., t.
Utility Brass & Copper Corp., a, c, h, m, e-l.
Vanadium-Alloys Steel Co., l, p, q, x, y.
Vanton Pump & Equipment Corp., t.
Varflex Corp., t, c-l, d-l.
Var-Lac-Oid Chemical Co., z, a-l, b-l.
Wah Chang Corp., l, v, z.
Wall Tube & Metal Products Co., p, q, v, y.
Wallingford Steel Co., y.
Western Pneumatic Tube Co., l, p, q, u, y, z, a-l.
Westinghouse Electric Corp., e, i, j, t.
Westinghouse Electric Corp., Micarta Div., f, i, n, r, s, t, c-l, d-l
Wilmington Fibre Specialty Co. f, s.
Yardley Plastics Co., t.
Young Development Div., Hercules Powder Co., f, i, t.
Zippertubing Co., The, a, b, c, f, h, i, m, t, f-l.
Zirconium Corp. of America, e.

TUBULAR FABRICATIONS & ASSEMBLIES

Advanced Products Co., The
***AERO-GENERAL CORP.**
Aeroquip Corp., Jackson Div.
Ainslie Corp.
Alite Div., U. S. Stoneware Co.
Allied Plastics Supply Corp.
Allison Steel Mfg. Co.
Alloy Products Corp.
American Tube Bending Co., Inc.
American Tubing Co., Inc.
American Welding & Mfg. Co., The
Arnolt Corp.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Avon Tube Div.-Higbie Mfg. Co
B. H. Aircraft Co., Inc.
Beaton & Corbin Mfg. Co., The
Beech Aircraft Corp.
Belmar Wheel & Machine Co., Inc.
Bendix Filter Div., Bendix Aviation Corp.
Benson Mfg. Co.
Bethlehem Steel Co.
J. Bishop & Co., Platinum Works
E. W. Bliss Co.
Brooks & Perkins, Inc.
Cobra Metal Hose Div. DK Mfg. Co.
Colonial Aircraft Corp.
Continental-Emsco Co., Div.-The Youngstown Sheet & Tube Co.
Corning Glass Works
Craig Systems, Inc.
Crane Co., Special Products Div.
Crystal-X Corp.
Custom Products Corp.
Electrical Insulation Co., Inc.
Electrical & Mechanical Design Co.
Electronic Parts Mfg. Co., Inc.
Ellwood Ivins Steel Tube Works Inc.
Elzee Metal Products Co., Inc.
Fairchild Aircraft & Missiles Div., Fairchild Engine & Airplane Corp.
Farwell Metal Fabricating
Fibercraft, Inc.
Flexonics Corp.

General Findings & Supply Co., Industrial Div.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hanlon & Wilson Co., The
Haskel Engrg. & Supply Co.
Janitrol Aircraft Div.-Midland-Ross Corp.
Kellett Aircraft Corp.
Kennedy Aircraft Supply Co.
Lamtex Industries Inc.
***LAVELLE AIRCRAFT CORP.**
Le Fiell Mfg. Co.
Lewis & Saunders, Inc.
Lofstrand Co., The
Thomas J. Long, Inc.
MB Electronics
Mackenzie Walton Corp.
Marmon Div., Aeroquip Corp.
Marquardt Corp., The
McCathron Boiler Works Co., Inc.
Menasco Mfg. Co.
Metal Fabricators Corp.
Metal Forming Corp., Div.-Vanadium-Alloys Steel Co.
Norrich Plastics Corp.
Norrich Screw Machine Products
Northeast Metals Industries, Inc.
Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Parts Engrg. Co., Inc.
Pastushin Industries, Inc.
Penn-Michigan Mfg. Corp.
Richard Philip Co.
Piasecki Aircraft Corp.
Portland Copper & Tank Works Inc.
Precision Tube Co., Inc.
Pressed Steel Tank Co.
REF Mfg. Corp.
Redco Corp.
Edw. Renneburg & Sons Co.
Resistoflex Corp.
Reynolds Metal Co., Sheffield Missile Plant
Rimak, Inc.
J. R. Robbins Co.
Roto Finish-Ransohoff
Sancor Corp.
Skyline Products, Inc.
Superior Industrial Machine Co.
Temco Aircraft Corp.
Thermionic Aeronautical Div.
Tube Reducing Corp.
Twin Coach Co., Aircraft-Missiles
Uniform Tubes, Inc.
United Aircraft Products, Inc.
United States Chemical Milling Corp.
Veet Industries
Virginia Electronics Co., Inc.
Waco Aircraft Co.
Wall Colmonoy Corp., Stainless Processing Div.
Weber Aircraft Corp.
Wells Industries Corp.
Western Div., Aeroquip Corp.
Wolverine Diesel Power Co.
Woolf Aircraft Products, Inc.
Young Development Div., Hercules Powder Co.

TUNERS

a. AM
b. Antenna
c. Automatic
d. FM
e. FM & AM
f. Klystron
g. Microwave
h. Permeability

Aircom Inc., **f, g.**
Airtron, Div.-Litton Industries, **g.**
Allied International Corp., **a, b, c.**
Amerac Inc., **f, g.**
American Machine & Foundry Co., Government Products, N. Y., **b.**
Bendix Aviation Corp., Cincinnati Div., **a, d, e.**
Blonder-Tongue Labs., Inc., **e.**
Blonder-Tongue Labs. Inc., Special Products Div., **a, d, e.**
S. G. Brown, **a, d.**
Budd Lewyt Electronics, Inc., **g.**
Cameraflex Div., The, Federal Mfg. & Engrg. Corp., **d.**
Chance Vought Aircraft, Inc., b.
Collins Radio Co., **a thru e, h.**
Crosby-Teletronics Corp., **d, e.**
Delco Radio Div.-General Motors Corp., **a, c, d, e.**
***DEL MAR ENGRG. LABS., d.**
Demornay-Bonardi, **g.**
Designers for Industry, Inc., **a, d, e, g.**
Diamond Antenna & Microwave Corp., **f, g.**
Don-Lan Electronics Inc., **b, g.**
Douglas Microwave Co., Inc., **g.**
Electronic Applications, Inc., **d, f, g.**
Emertron, Sub.-Emerson Radio & Phonograph Corp., **a, d thru g.**
Empire Products Sales Corp., **f, g.**
FXR, Inc., **g.**
Ferrotran Electronics Co., Inc., **h.**
General Bronze Electronics Corp., **b, g.**
General Instrument Corp., Defense & Engrg. Products Group, **g.**
John Gombos Co., Inc., **g.**
Gonset Div.-Young Spring & Wire Corp., **a, e, h.**
Gorham Electronics-Div.-Gorham Mfg. Co., **g.**
Hammarlund Mfg. Co., The, **a.**
Hewlett-Packard Co., **g.**
J-V-M Microwave Co., **g.**
La Pointe Industries Inc., **g.**
Lear, Inc., **b.**
Lieco, Inc., **g.**
Loral Electronics Corp., **a, c, e, f, g.**
P. R. Mallory & Co. Inc., **e, h.**
W. L. Maxson Corp., The, **f, g.**
Meridian Metalcraft, Inc., **g.**
Microwave Associates, Inc., **g.**
J. W. Miller Co., **a, d.**
Motorola, Inc., **a, c thru g.**
Narda Microwave Corp., The, **g.**
National Co., Inc., **a thru h.**
Nevada Air Products Co., **b.**
Paco Electronics Co., Inc., **a, d, e.**
Philco Corp.-Govt. & Industrial Group, **a thru d, g.**
Polarad Electronics Corp., **f, g.**
Polytechnic Research & Development Co., Inc., **g.**
Portland Copper & Tank Works Inc., **b, f, g.**
Radar Design Corp., **g.**
Radio Condenser Co., **a thru e, g, h.**
***RADIO CORP. OF AMERICA, a thru h.**
***RADIO CORP. OF AMERICA, DEFENSE ELECTRONICS PRODUCTS, a, c, d, e, g.**
Radio Receptor Co., Inc., Sub.-General Instrument Corp., **g.**
Rantec Corp., **g.**
H. H. Scott, Inc., **d, e.**
Sperry Electronic Tube Div., Sperry Rand Corp., **f.**
Sperry Microwave Electronics Co., Div.-Sperry Rand Corp., **g.**
Standard Winding Co., Inc., **b.**
Stewart-Warner Electronics Div., **a thru d, g.**
Stromberg-Carlson Div.-General Dynamics Corp., **a, d thru g.**
TRG, Inc., **g.**
Tamar Electronics, Inc., **g.**
Technical Materiel Corp., The, **b.**
Technicraft, Div.-Electronic Specialty Co., **g.**
United Shoe Machinery Corp., **g.**
U. S. Gear Corp., **f, g.**
Victor R. F. & Microwave Co., **g.**
Virginia Electronics Co., Inc., **a, b, c.**
Waveline, Inc., **g.**

TUNGSTEN

Associated Engrg. & Mfg. Corp.
Bergen Carbide Co.
Bergen Wire Rope Co.
Bram Metallurgical Chemical Co.
Climax Molybdenum Co. of Michigan
Custom Tool & Mfg. Co.
Delta Chemical Works, Inc.
Electronic Parts Mfg. Co., Inc.
Elmet Div.-North American Philips Co., Inc.
Fansteel Metallurgical Corp.
Firth Sterling Inc.
General Electric Co., Lamp Metals & Components Dept.
General Electric Co., Rocket Engine Section
Gibson Electric Co.
Harvey Aluminum
Hughes Tool Co., Aircraft Div.
Johnston & Funk Metallurgical Corp.
NUMEC-Nuclear Materials & Equipment Corp.
Rembar Co., Inc., The
Stauffer Chemical Co.
Steel Improvement & Forge, The
Sylvania Electric Products Inc., Chemical & Metallurgical Div.
Thermionic Aeronautical Div.
Union Carbide Metals Co., Div.-Union Carbide Corp.
United Mineral & Chemical Corp.
Var-Lac-Oid Chemical Co.
Wah Chang Corp.
Wai Met Alloys Co.
Westinghouse Electric Corp.

TUNING DEVICES

Bendix Aviation Corp., Cincinnati Div.
CGS Labs., Inc.
Collins Radio Co.
Croname Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Empire Products Sales Corp.
Gates Radio Co.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammarlund Mfg. Co., The
Houston Fearless Corp.
Lear, Inc.
P. R. Mallory & Co. Inc.
James Millen Mfg. Co. Inc.
Motorola, Inc.
National Co., Inc.
Philco Corp.-Govt. & Industrial Group
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Spiroid Div., Illinois Tool Works
U. S. Gear Corp.
Victor R. F. & Microwave Co.
Western Gear Corp.-Precision Products Div.

TUNING DEVICES, RECEIVER MECHANICAL

Collins Radio Co.
Eastern Industries Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Bronze Electronics Corp.
General Instrument Corp., Defense & Engrg. Products Group
Gorham Electronics-Div.-Gorham Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hammarlund Mfg. Co., The
Houston Fearless Corp.
Lear, Inc.
P. R. Mallory & Co. Inc.
W. L. Maxson Corp., The
James Millen Mfg. Co. Inc.
National Co., Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Spiroid Div., Illinois Tool Works
Stewart-Warner Electronics Div.
Teleflex Inc.
Western Gear Corp.-Precision Products Div.

TUNING DEVICES, TRANSMITTER MECHANICAL

Collins Radio Co.
Eastern Industries Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Gates Radio Co.
General Bronze Electronics Corp.
General Instrument Corp., Defense & Engrg. Products Group
Gorham Electronics-Div.-Gorham Mfg. Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hammarlund Mfg. Co., The
Houston Fearless Corp.
P. R. Mallory & Co. Inc.
W. L. Maxson Corp., The
James Millen Mfg. Co. Inc.
National Co., Inc.
Radio Condenser Co.
***RADIO CORP. OF AMERICA**
Radio Receptor Co., Inc., Sub.-General Instrument Corp.
Spiroid Div., Illinois Tool Works
Stewart-Warner Electronics Div.
Teleflex Inc.
Western Gear Corp.-Precision Products Div.

TURBINE ASSEMBLIES

***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
American Welding & Mfg. Co., The
Bell Aircraft Corp., Niagara Frontier Div.

Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
Christie Machine Works
Clark Bros. Co., Div.-Dresser Operations, Inc.
Falcon Machine & Tool Co.
Fenn Mfg. Co., The
General Electric Co., Rocket Engine Section
Herlo Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Jarvis Corp.
Kelsey-Hayes Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Kerns Mfg. Corp.
Lycoming Div., Avco Corp.
Marquardt Corp., The
McGregor Mfg. Corp.
Napier Engines Inc.
Parts Engrg. Co., Inc.
Solar Aircraft Co.
***STALKER CORP., THE**
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Western Gear Corp.-Precision Products Div.
Whiton Machine Co., The
York Div., Borg-Warner Corp.

TURBINE SHAFTS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bethlehem Steel Co.
A. M. Byers Co.
Christie Machine Works
Clark Bros. Co., Div.-Dresser Operations, Inc.
Fenn Mfg. Co., The
Herlo Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Kelsey-Hayes Co.
Lycoming Div., Avco Corp.
Marquardt Corp., The
McGregor Mfg. Corp.
Napier Engines Inc.
National Forge Co.
Schellens-True Corp.
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Tube-Turns Div., Chemetron Corp.
Whiton Machine Co., The
York Div., Borg-Warner Corp.

TURBINE WHEELS

Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
American Brake Shoe Co.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
Benndix Utica Div., Bendix Aviation Corp.
Bethlehem Steel Co.
Christie Machine Works
Clark Bros. Co., Div.-Dresser Operations, Inc.
George Gorton Machine Co.
Hamilton Standard, Div.-United Aircraft Corp.
Havnes Stellite Co., Div.-Union Carbide Corp.
Herlo Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Jarvis Corp.
Kelsey-Hayes Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Kerns Mfg. Corp.
Lycoming Div., Avco Corp.
Marquardt Corp., The
McGregor Mfg. Corp.
Napier Engines Inc.
Parker-Hartford Corp., The
Schellens-True Corp.
Solar Aircraft Co.
Stalker Corp., The
Standard Steel Works, Div.-Baldwin-Lima-Hamilton Corp.
Steel Products Engrg. Co., Div.-Kelsey-Hayes Co.
Tapco Group, Thompson Ramo Wooldridge Inc.
Therm, Inc.
Thompson Ramo Wooldridge Inc.
Westinghouse Electric Corp.
Whiton Machine Co., The
York Div., Borg-Warner Corp.

TURBINES, AIR

Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. OF ARIZONA**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Utica Div., Bendix Aviation Corp.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Coppus Engrg. Corp.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Jarvis Corp.
Kelsey-Hayes Co.
Marquardt Corp., The
McGregor Mfg. Corp.
Stratos, Div.-Fairchild Engine & Airplane Corp.
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Worthington Corp.

TURBO FANS

***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Utica Div., Bendix Aviation Corp.
Clark Bros. Co., Div.-Dresser Operations, Inc.
Continental Aviation & Engrg. Corp.
Dean & Benson Research, Div.-Benson Mfg. Co.
Jarvis Corp.
Kelsey-Hayes Co.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Spencer Turbine Co.
***STALKER CORP., THE**
Worthington Corp.

TURBO JET ENGINES

***AIRESEARCH MFG. OF ARIZONA**
Allison Div., General Motors Corp.
Continental Aviation & Engrg. Corp.
Falcon Machine & Tool Co.
Kelsey-Hayes Co., Utica Drop Forge & Tool Div.
Lycoming Div., Avco Corp.
Pratt & Whitney Aircraft Div., United Aircraft Corp.

TURBO PUMPS

Aircraft Accessory Turbine Dept.-General Electric Co.
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP.**
Allison Div., General Motors Corp.
Bell Aircraft Corp., Niagara Frontier Div.
Bendix Aviation Corp.
Bendix Utica Div., Bendix Aviation Corp.
J. C. Carter Co., The
Christie Machine Works
Herlo Corp.
Jarvis Corp.
Kelsey-Hayes Co.
Lycoming Div., Avco Corp.
McGregor Mfg. Corp.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Rocketdyne Div.-North American Aviation Inc.
Tapco Group Thompson Ramo Wooldridge In.
Thompson Ramo Wooldridge Inc.
Worthington Corp.

TURNTABLES, SOUND EQUIPMENT

Beacon Steel Corp.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Collins Radio Co.
Pickering & Co., Inc.
***RADIO CORP. OF AMERICA**
Wakefield Engrg. Co.

TURRETS, CAMERA

Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Gordon Enterprises
Librascope Div., General Precision, Inc.
Optomechanisms Inc.
Philco Corp.-Govt. & Industrial Group
***RADIO CORP. OF AMERICA**
Wollensak Optical Co.

ULTRASONIC EQUIPMENT

Acoustica Associates, Inc.
Aeroprojects Inc.
Alcar Instruments, Inc.
Automation Industries, Inc.
Bearing Inspection, Inc.
Bendix Aviation Corp.
Bendix Aviation Corp., Pioneer-Central Div.
Blackstone Corp.
Branson Instruments, Inc.
Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Circo Equipment Co.
Circo Ultrasonic Corp.
Clevite Ordnance, Div.-Clevite Corp.
***COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.**
Curtiss-Wright Corp., Metals Processing Div.
Curtiss-Wright Corp., Princeton Div.
Curtiss-Wright Corp., Santa Barbara Div.
Dallons Semiconductors, Div.-Dallons Labs.
Delavan Mfg. Co.
Designers for Industry, Inc.
Detrex Chemical Industries, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
***EQUIPMENT DIV., RAYTHEON CO.**
General Instrument Corp., Defense & Engrg. Products Group
General Kinetics Inc.
Gulton Industries, Inc.
Instrument Div., The Budd Co.
International Electronics Corp.
Kay Electric Co.
L & R Mfg. Co.
Magnaflux Corp., Sub.-General Mills, Inc.
Massa Div.-Cohu Electronics, Inc.
McKenna Labs.
Muirhead Instruments Inc.
Narda Ultrasonics Corp., The
National Ultrasonic Corp.
Pioneer Industries Div., Almar-York Co. Inc.
***RADIO CORP. OF AMERICA**
Radio Frequency Co., Inc.
Roto Finish-Ransohoff
Scientific Electric Inc.
Sheffield Corp., The, Sub.-Bendix Aviation Corp.
Solar Mfg. Corp.
Southwest Research Institute
Sperry Products Co., Div.-Howe Sound Co.
Standard Electronics Div.-Reeves Instrument Corp.
Sunshine Scientific Instrument
Superior Electric Co., The
Turco Products, Inc.
Ultrasonic Engineering Co.
Westinghouse Electric Corp.
Wye Industries

URANIUM

American Potash & Chemical Corp., National Northern Div.
Century Electronics & Instruments, Inc.
City Chemical Corp.
Delta Chemical Works, Inc.
Engelhard Industries, Inc
W. R. Grace & Co. Davison Chem. Div., Nuclear Reactor Mat. Plant
NUMEC-Nuclear Materials & Equipment Corp.
Sylvania-Corning Nuclear Corp.
United Mineral & Chemical Corp.
Vanadium Corp. of America
Van-Lac-Oid Chemical Co.

VACUUM ALUMINIZERS

Allied International Corp.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Consolidated Vacuum Corp.
Cosmo Instruments Inc.
Courter Products, Div.-Mode Engrg. & Mfg. Inc.
Edwards High Vacuum Ltd.

General Vacuum Corp.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Kinney Vacuum Div., The New York Air Brake Co.
Metaplast Co., Inc.
Scientific Engrg. Labs., Inc.
F. J. Stokes Corp.
Swedlow Inc.
Swift Textile Metalizing & Laminating Corp.
Temperature Engrg. Corp.
Vacuum Specialties Co., Inc.
Veeco Vacuum Corp.

VACUUM SYSTEMS & CONTROLS

Accessory Products Co., Div.-Textron Inc.
Aerotec Industries Inc., Aircraft Equipment Div.
Arde-Portland, Inc.
***ASSOCIATED TESTING LABS., INC.**
Aviation Instrument Mfg. Corp.
Beach-Russ Co.
Bendix Aviation Corp.
Bruning Co., The
A. W. Cash Valve Mfg. Corp.
Chicago Bridge & Iron Co.
Components Corp.
Conoflow Corp.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Consolidated Vacuum Corp.
Cosmic Instruments Inc.
Cryogenic Engrg. Co.
Delta Design Inc.
Edwards High Vacuum Ltd.
Ellison Draft Gage Co., Inc.
Garwin, Inc.
General Vacuum Corp.
Guardite Co., Div.-American-Marietta Co.
Haskel Engrg. & Supply Co.
High Vaccum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Walter J. Hyatt Co., The
***ITEMCO, INC.**
Janitrol Aircraft Div.-Midland-Ross Corp.
Kahn & Co., Inc.
Kerns Mfg. Corp.
Kinney Vacuum Div., The New York Air Brake Co.
Lamson Corp., The
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
John Mohr & Sons
Oxygen Equipment & Service Co.
Pneu-Hydro Valve Corp.
***RADIO CORP. OF AMERICA**
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Red Point Corp.
Rimak, Inc.
Scientific Engrg. Labs., Inc.
Spencer Turbine Co.
Standard Steel Corp., Cambridge Div.
F. J. Stokes Corp.
Tactair Valve Div.-Aircraft Products Co.
Temperature Engrg. Corp.
United Electric Controls Co.
Vacuum Specialties Co., Inc.
Veeco Vacuum Corp.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.
Wells Industries Corp.

VACUUM UNITS

Accessory Products Co., Div.-Textron Inc.
Aro Equipment Corp., The
Atlas Engrg. Corp.
Beach-Russ Co.
Clark Bros. Co., Div.-Dresser Operations, Inc.
***CONSOLIDATED ELECTRODYNAMICS CORP.**
Consolidated Vacuum Corp.
Cosmic Instruments Inc.
Edwards High Vacuum Ltd.
Garwin, Inc.
High Vaccum Equipment Corp., Sub.-Robinson Tech. Products, Inc.
Invincible Vacuum Cleaner Mfg. Co.
Kerns Mfg. Corp.
Kinney Vacuum Div., The New York Air Brake Co
Lamson Corp., The
Arthur S. La Pine & Co.
Leiman Brothers, Inc.
Litton Engrg. Labs.
Oxygen Equipment & Service Co.
***RADIO CORP. OF AMERICA**
Red Point Corp.
Resitron Labs., Inc.
Scientific Engrg. Labs., Inc.
Standard Steel Corp., Cambridge Div.
F. J. Stokes Corp.
Temperature Engrg. Corp.
Vacuum Research Co.
Vacuum Specialties Co., Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.

VALVE GUIDES

Accessory Products Co., Div.-Textron Inc.
American Brake Shoe Co.
Ampco Metal, Inc.
George W. Dahl Co., Inc.
General Controls Co.
Kieley & Mueller, Inc.
***MARTIN CO., THE, DENVER DIV.**
Thompson Ramo Wooldridge Inc.

VALVE OPERATOR

Accessory Products Co., Div.-Textron Inc.
Allenair Corp.
Anderson, Greenwood & Co.
***ANNIN CO., THE**
Barbar-Colman Co.
***BEAVER PRECISION PRODUCTS INC.**
Conoflow Corp.
George W. Dahl Co., Inc.
Darling Valve & Mfg. Co.
Digital Sensors Inc.
Fisher Governor Co.
General Controls Co.
B. H. Hadley, Inc.
Hammel-Dahl Div.-General Controls Co.
Hydra-Power Corp.
Jamesbury Corp.
Kieley & Mueller, Inc.
Ledeen Inc.
Leslie Co.
***MARTIN CO., THE, DENVER DIV.**
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Research Controls
Robbins Aviation, Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Sargent Engrg. Corp.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Sirvalco Systems Corp.
Skinner Electric Valve Div., The Skinner Chuck Co.
Talley Corp., The
Vacuum Research Co.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

VALVE OPERATOR, ELECTRIC

Accessory Products Co., Div.-Textron Inc.
Actuation Research Corp.
Allenair Corp.

***ANNIN CO., THE**
Atkomatic Valve Co., Inc.
Automatic Switch Co.
Barber-Colman Co.
Belfab Corp., The
Conoflow Corp.
Darling Valve & Mfg. Co.
Digital Sensors Inc.
Fisher Governor Co.
General Controls Co.
Guided Missile Div., The Firestone Tire & Rubber Co.
Hammel-Dahl Div.-General Controls Co.
Hays Corp., The
Hydra-Power Corp.
Jamesbury Corp.
Kieley & Mueller, Inc.
Kingston Electronics-Div.-Kingston Industries Inc.
Lear, Inc.
Marotta Valve Corp.
***MARTIN CO., THE, DENVER DIV.**
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Petch Mfg. Co.
Research Controls
Robbins Aviation, Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Sargent Engrg. Corp.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Skinner Electric Valve Div., The Skinner Chuck Co.
Talley Corp., The
United Control Corp.
Valcor Engrg. Corp.
Veeco Vacuum Corp.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.

VALVE OPERATOR, HYDRAULIC

Accessory Products Co., Div.-Textron Inc.
Acme Industrial Co.
Actuation Research Corp.
***ANNIN CO., THE**
Belfab Corp., The
Bendix Aviation Corp.
George W. Dahl Co., Inc.
Darling Valve & Mfg. Co.
Digital Sensors Inc.
Foster Wheeler Corp.
General Controls Co.
General Regulator Corp.
Guided Missile Div., The Firestone Tire & Rubber Co.
B. H. Hadley, Inc.
Hammel-Dahl Div.-General Controls Co.
Haskel Engrg. & Supply Co.
Hydra-Power Corp.
Hydromatics, Inc.
Integral Corp.
Jamesbury Corp.
Kieley & Mueller, Inc.
Kohler Co.
Lear, Inc.
Ledeen Inc.
***MARTIN CO., THE, DENVER DIV.**
Mason-Neilan
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Oil-Dyne, Inc.
Peacock Engrg. & Mfg. Co.
Pegasus Labs., Inc.
Petch Mfg. Co.
Research Controls
Robbins Aviation, Inc.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div.
Rockwood Sprinkler Co., Div.-The Gamewell Co.
Ronson Hydraulic Units Corp.
Rucker Co., The
Sargent Engrg. Corp.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp.
Sirvalco Systems Corp.
A. O. Smith Corp., Smith-Erie Div.
Uniflow Valve Corp.
United Aircraft Products, Inc.
Vickers Inc.
Vickers, Inc., Mich.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp.
Whittaker Controls, Div.-Telecomputing Corp.

VALVES

a. Accumulator Charging
b. Acid
c. Acid Resistant
d. Air
e. Anti-Gravity
f. Automatic Shutoff
g. Automatic Shutoff, Hydraulic
h. Bleeder
i. By-Pass
j. Check & Check Relief
k. Check-Hydraulic, Gas
l. Control
m. Cryogenic
n. Diaphragm
o. Dump
p. Electronic Solenoid
q. Engine Inlet
r. Exhaust
s. Float
t. Globe
u. Helium
v. High Pressure Gas
w. Hydraulic System
x. Hydrogen
y. Motor Operated
z. Needle
a-1. Plug
b-1. Pneumatic
c-1. Power Control
d-1. Pressure Regulating
e-1. Propellant
f-1. Relief & By-Pass
g-1. Restrictor
h-1. Rocket Fuel

i-1. Rotary
j-1. Sequence
k-1. Servo

l-1. Shuttle
m-1. Shuttle Solenoid
n-1. Solenoid
o-1. Strainer
p-1. Suction Regulating
q-1. Surge
r-1. Thermostatic
s-1. Throttling
t-1. Transfer
u-1. Vacuum Selector & Check
v-1. Vapor Tight
w-1. Venturi Opening

ACF Industries Inc., c, d, j, n, v, y, z, a-1, b-1, d-1, f-1, i-1, n-1, r-1, s-1, t-1, v-1, w-1.
Accessory Controls & Equipment Corp., d, r, v, b-1, d-1.
Accessory Products Co., Div.-Textron Inc., a, d, f, l thru p, r thru v, y, z, a-1 thru j-1, l-1 thru q-1, s-1, t-1, u-1, w-1.
Actuation Research Corp., a, f, g, m, n, u thru y, a-1, b-1, d-1, g-1, h-1, m-1.
Adel Precision Products of Calif., Div.-General Metals Corp., d, f, g, i thru l, o, v, w, y, b-1, c-1, f-1, i-1, j-1, l-1, n-1.
Aero Supply Mfg. Inc., c, d, f thru j, l thru p, s, u, v, x, y, c-1, d-1, f-1, h-1, i-1, k-1 thru q-1, s-1, t-1.
*AEROJET-GENERAL CORP., b, c, d, l, m, e-1, h-1.
Aerotec Industries Inc., Aircraft Equipment Div., d thru p, s, u thru y, b-1, c-1, d-1, f-1, h-1, l-1, m-1, n-1, s-1, u-1, w-1.
Agricultural Aviation Engineering Co. Inc., i, l, o, y, i-1, o-1, t-1, w-1.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc., m, u, v, d-1.
Airborne Research & Development Corp., f, i, j, m, r, u, v, d-1, f-1, q-1, u-1.
Aircraft Accessory Turbine Dept.-General Electric Co., l, d-1, k-1.
Airdrome Parts Co., w.
*AIRESEARCH MFG. OF ARIZONA, a, d thru y, a-1 thru w-1.
*AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., d, f, j, l thru p, u, v, x, y, z, a-1, b-1, d-1, k-1, n-1, p-1, q-1, s-1.
Alco Valve Co., s, w, c-1, d-1, n-1.
Allen Aircraft Products, Inc., f, i, j, k, m, n, o, s, w, z, a-1, b-1, d-1, f-1, p-1, q-1, u-1.
Allenair Corp., d, f, h, j, l, n, b-1, l-1, m-1, n-1.
Allied Control Co., Inc., n-1.
Allied International Corp., j, k, s, v, b-1, d-1, f-1, g-1.
Allis-Chalmers
Allison Div., General Motors Corp., w, k-1.
Alloy Steel Products Co., c, j, m, t, u, v, x, y, z, h-1.
Altair, Inc., j, p, v, b-1, d-1, g-1, l-1.
American Agile Corp., c, t.
American Brake Shoe Co.
American Brake Shoe Co., Kellogg Div., q-1.
American Instrument Co., Inc., f thru o, u thru x, z, b-1, d-1, f-1, n-1.
American Power Jet Co., d-1, f-1.
American Standard Products, Inc.
Ampco Metal, Inc., c, a-1.
Anderson, Greenwood & Co., a thru d, h thru k, m, o, t thru y, a-1, b-1, e-1, f-1, h-1, s-1, t-1, v-1, w-1.
*ANNIN CO., THE, f, g, i, j, l, t, v, w, y, b-1, s-1.
Arkwin Industries, Inc., d, f thru q, s, w, z, a-1 thru d-1, f-1, g-1, i-1, j-1, l-1, m-1, n-1, p-1, q-1, s-1.
Armament Div.-Universal Match Corp., l, v, e-1.
Arnav Aircraft Associates, Inc., h, j, k, w, z, g-1, h-1, u-1.
Aro Equipment Corp., The, j, m, p-1.
Aro-Firewel Co. Inc., Sub.-The Aro Equip. Corp., e, j, m, o, v, d-1, f-1.
Raymond Atchley, Inc., k-1.
Atkomatic Valve Co., Inc., b, c, d, f, g, o, p, t thru x, e-1, f-1, h-1, n-1, s-1, v-1.
Automatic Switch Co., b, c, d, f, g, i, l, n, p, r, t, u, v, x, z, b-1, c-1, n-1, q-1.
Automatic Timing & Controls, Inc., l, d-1.
Auto-Valve Inc., h, i, j, o, z, b-1, g-1, o-1.
Barber-Colman Co., d, f, h, i, j, l, y, b-1, i-1, j-1, s-1.
Barksdale Valves, d, l, w, b-1, n-1.
Bastian-Blessing Co., The, d, h, i, j, l, m, n, t, u, v, x, z, d-1, f-1, p-1, u-1.
Beckman & Whitley, Inc., Missile Products Div., e-1.
Belfab Corp., The, a thru y, b-1, c-1, d-1, f-1, g-1, h-1, k-1, q-1, s-1, u-1, v-1, w-1.
Bellows-Valvair Divs., d, n, p, b-1, d-1, n-1.
Benbow Mfg. Corp., d, f, g, i thru l, u, v, w, b-1, d-1, f-1, g-1, n-1.
Bendix Aviation Corp., l, p, w, b-1, c-1, h-1, k-1, n-1.
*BENDIX AVIATION CORP., HAMILTON DIV., w, k-1.
Bendix Aviation Corp., Pioneer-Central Div., j, m, f-1.
*BENDIX PRODUCTS DIV., BENDIX AVIATION CORP., n-1.
Bendix-Pacific Div., Bendix Aviation Corp., g, h, i, l, p, w, y, b-1, d-1, f-1, g-1, j-1 thru n-1, t-1.
Bendix Utica Div., Bendix Aviation Corp., d, f thru l, n, o, p, v, b-1, c-1, d-1, f-1, j-1, k-1, n-1, p-1, s-1.
Benson Mfg. Co., j, m, e-1, h-1.
Bobrick Aero Missile Products, c, d, f, j, k, m, r, v, w, b-1, d-1, f-1, g-1, h-1, l-1, n-1.
Bowser Inc., Defense Div., j, w, x.
Bruning Co., The, d, j, k, w, b-1, f-1, g-1
Burklyn Co., j, k.
Cadillac Gage Co., l, w, b-1, k-1.
Caltron Products Co., n-1.
Captive Seal Corp., a, d, f thru l, o, p, u thru y, b-1 thru h-1, j-1, l-1, m-1, n-1, p-1 thru w-1.
Carleton Aviation Co., Inc., a thru d, f, g, j, l, m, n, u thru x, b-1, d-1, e-1, f-1, h-1, p-1.

J. C. Carter Co., The, f, i, j, l, o, s, y, d-1 thru h-1, s-1, t-1, w-1.
A. W. Cash Valve Mfg. Corp., i, n, w, d-1, f-1, r-1.
Chance Vought Aircraft, Inc., w, k-1.
Chase Brass & Copper Co., Inc., j, t, z.
Chiksan Co., Sub.-Food Machinery & Chemical Corp., c, m, v, y, a-1.
Clark Controller Co., The, d, l, n, r, n-1.
Clover Industries, Inc., a-1.
Commercial Shearing & Stamping Co., j, l, w, d-1, f-1.
Components Corp., b, c, d, g, i, l, m, o, u thru y, b-1, c-1, e-1, h-1, i-1, n-1, v-1.
Conax Corp., n, o, v, w, x, e-1, v-1.
Conoflow Corp., c, d, f, l, n, t, v, b-1, c-1, d-1, s-1.
Consolidated Controls Corp., d, f, g, i thru m, o, q, w, y, b-1, c-1, d-1, f-1, h-1, k-1, l-1, n-1, p-1, q-1, r-1.
Consolidated Diesel Electric Corp., j, t.
Consolidated Vacuum Corp., l, t, z, b-1, d-1, e-1, h-1, t-1, u-1.
Coppus Engrg. Corp., f, g.
Cornelius Co., The, Aero Div., d, e, j, k, n, o, r, v, b-1, d-1, f-1, g-1.
Cornell Deep Drawing Co. Div.-Lanes Industries Corp., d, f, g, j, k, l, u thru x, z, a-1, b-1, d-1, f-1, j-1, n-1, s-1.
Crane Co., b, c, d, i, j, m, n, t, u, v, y, z, d-1, e-1, f-1, h-1.
Crane Co., Industrial Products Group, b, c, d, i, j, m, n, t, v, y, z, a-1, d-1, f-1, h-1 s-1.
Cryogenic Engrg. Co., m.
George W. Dahl Co., Inc.
Dalmo Victor Co., Div.-Textron, Inc., w, k-1.
Darling Valve & Mfg. Co., b, c, d, i, j, k, u, v, y, w-1.
Joe Davidson & Associates, d, i, j, l, p, v, w, y, z, f-1, i-1, w-1.
Dean & Benson Research, Div.-Benson Mfg. Co., m, e-1, h-1.
De Havilland Aircraft of Canada, Ltd., Special Products Div., p, v, b-1, g-1, i-1, n-1.
Denison Engrg. Div., American Brake Shoe Co., g, h, j, k, l, p, w, y, d-1, f-1, j-1, k-1, n-1, q-1.
Detroit Stamping Co.
Dezurik Corp. b, c, d, f, g, i, l, u, w, y, a-1, b-1, e-1, h-1, s-1, t-1, v-1.
Dill Mfg. Co., The, a, d.
Dukes Co., Inc., w.
Dumont Engrg. Co., k.
Dynamic Controls Corp., d, l, m, o, p, v, w, b-1, d-1, f-1, n-1, t-1, v-1.
Eastern Industries Inc., k-1.
Eckel Valve Co., a thru d, h, i, l, m, o, p, u thru x, b-1, f-1, h-1, n-1, v-1, w.
Eclipse Fuel Engrg. Co., l, n, y, d-1, n-1.
Eddington Metal Specialty Co., d-1.
Edwards High Vacuum Ltd., l, n, p, z, b-1, d-1, u-1.
Electrol Inc., a, g, i, j, o, p, w, z, b-1, d-1, f-1, i-1, j-1, l-1, m-1, n-1.
Era Engrg. Inc., g.
Essex Mfg., Co., Inc., j, m, l-1.
Fae Instrument Corp., p.
Fairbanks Co., The, d, j, t, z, s-1.
Fansteel Metallurgical Corp., b.
Fischer & Porter Co., c, d, l, n, y, b-1, d-1.
Fisher Governor Co., f, l, m, s, v, b-1, d-1.
Flight Refueling, Inc., b, f, g, j thru m, o thru s, u thru x, a-1, b-1, d-1, e-1, f-1, n-1, q-1.
Fluid Regulators Corp., a, h, j, w, d-1, f-1, g-1, h-1, j-1, n-1.
Frebank Co., m, u, v, w, b-1, j-1, n-1.
Frick Co., s, t, v, f-1, n-1.
Futurecraft Corp., b, c, d, f thru n, p, t thru z, b-1 thru f-1, h-1, i-1, j-1, l-1, m-1, n-1, p-1, q-1, s-1.
Galland-Henning Mfg. Co., Nopak Div., d, l, w, z, b-1, i-1, n-1.
Garwin, Inc., d, i, j, z, f-1, p-1, u-1.
General Controls Co., c, d, f, i thru l, n, p, r thru y, a-1 thru e-1, h-1, i-1, n-1, o-1, r-1, s-1, t-1.
General Kinetics Inc., a thru p, s thru z, a-1 thru w-1.
Gilfillan Bros. Inc., d, h thru l, p, w, b-1, d-1, i-1, k-1, n-1.
J. D. Gould Co., n-1.
Great Lakes Mfg. Corp., d, h thru k, p, w, b-1, d-1, f-1, g-1, n-1, u-1.
Grinnell Co., c, d, n, o, t, u, x, c-1, s-1.
Grove Valve & Regulator Co.
Guided Missile Div., The Firestone Tire & Rubber Co., b, d, f, q, b-1, e-1, h-1, i-1, k-1.
B. H. Hadley, Inc., a thru p, r thru z, b-1 thru n-1, p-1 thru t-1, v-1.
Hamilton Standard, Div.-United Aircraft Corp., f, i, j, l, o, b-1, d-1, f-1.
Hammel-Dahl Div.-General Controls Co., c, d, l, n, s thru v, z, a-1, b-1, d-1, f-1, h-1, n-1, s-1.
Hammett-Mercury-Rex Div., a, t, n-1.
Harman Equipment Co., j.
George E. Harris & Co., Inc., j, m, p, w, x, b-1, d-1, h-1.
Haskel Engrg. & Supply Co., a thru l, n, p, s, u thru x, z, a-1 thru d-1, f-1, g-1, k-1 thru n-1, q-1, t-1, u-1, v-1.
Hays Mfg. Co., n, n-1, o-1.
Herlo Corp., h thru l, n thru s, w, z, a-1 thru f-1, h-1, l-1 thru o-1, r-1, u-1.
High Vacuum Equipment Corp., Sub.-Robinson Tech. Products, Inc., d-1, u-1.
Highland Engrg. Co., n, f-1.
Hills-McCanna Co., c, d, f, g, n, y, s-1.
Hoefner Corp., b, c, d, f, g, i thru o, u thru x, b-1, d-1, e-1, f-1, h-1, k-1, l-1, o-1, r-1, s-1, t-1.
Hofman Labs., Inc., m.
Hoke Inc., c, d, f, j, k, l, n, t thru x, z, a-1, b-1, d-1, n-1, s-1, v-1.
Hughes Tool Co. Aircraft Div., d, j, l, r, u, v, w, y, b-1, d-1, e-1, j-1, k-1, n-1.
Huyck Systems Co., g, i, j, k, o, p, w, y, b-1, d-1, f-1 thru i-1, k-1 thru n-1, t-1, w-1.

Walter J. Hyatt Co., The, a thru d, f thru p, s thru x, z, a-1, b-1, d-1 thru n-1, t-1, u-1, v-1.
Hydra-Power Corp., g thru m, o, p, v, w, y, b-1, c-1, d-1, f-1 thru n-1, t-1.
Hydraulic Press Mfg. Co., The, Div.-Koehring Co., g thru j, p, w, c-1, d-1, f-1, j-1, k-1, l-1, n-1, q-1.
Hydraulic Research & Mfg. Co., f, g, i thru l, o, p, w, a-1, c-1, d-1, f-1, j-1, k-1, n-1, t-1.
Hydromatics, Inc., f, g, l, m, o, u thru y, b-1, e-1, h-1, i-1, s-1.
Ideal-Aerosmith, Div.-Royal Industries, Inc., b, c, d, l, z, k-1.
Imperial Brass Mfg. Co., The, c, z, a-1.
Interno Mfg. Corp., j, z, v-1.
Integral Corp., a, b, f, g, h, j, k, m, t, w, z, a-1 b-1, f-1, g-1, n-1.
Intercontinental Dynamics Corp., b-1, d-1.
Interstate Electronics Corp., f, g, l, m,

p, u, x, d-l, f-l, k-l, m-l, n-l, r-l.
Interstate Engrg. Corp., d, f thru j, l, m, q, s, u, w thru z, b-l, c-l, d-l, f-l, g-l, i-l, n-l, t-l.
James, Pond & Clark, Inc., a, b, d, h thru k, m, s, u thru x, a-l, b-l, f-l, g-l, l-l.
Jamesbury Corp., b, d, f, i, m, u thru y, e-l, h-l, s-l, v-l.
Janitrol Aircraft Div.-Midland-Ross Corp., d, f thru p, v, w, b-l, d-l, f-l, l-l, m-l, n-l, r-l, t-l, u-l.
Jeffrey Mfg. Co., The, i-l.
*KEARFOTT DIV., GENERAL PRECISION, INC., l, k-l.
Kemp Aero Products, a thru p, u thru x, z, b-l, c-l, d-l, f-l, g-l, h-l, j-l thru n-l, p-l thru t-l.
Kerns Mfg. Corp.
Kidco Inc., i, j, w, f-l, j-l thru n-l.
Kidde Aero-Space Div., Walter Kidde & Co., Inc., d, j, v, b-l, d-l, f-l, g-l, k-l, n-l.
Kieley & Mueller, Inc., a thru d, f thru i, l thru o, r thru z, b-l thru f-l, i-l, o-l, p-l, s-l, t-l, w-l.
Kingston Electronics-Div.-Kingston Industries Inc., y.
Kinney Vacuum Div., The New York Air Brake Co.
Koenler Aircraft Products Co., Inc., f, g, i thru s, u thru y, b-l, d-l thru h-l, n-l, o-l, q-l, s-l, t-l, u-l.
Kohler Co., c, d, f thru l, n, o, r, s, t, v, w, z, a-l, b-l, d-l, f-l, g-l, h-l, u-l.
Koontz-Wagner Electric Co., Inc., a thru f, i, l, m, p, u, v, w, a-l, b-l, c-l, e-l, m-l, n-l.
Ladish Co., b, c, j, n, t, y, z, a-l, o-l, u-l.
Langley Corp., j, w, b-l.
Lapp Insulator Co., Inc., Radio Specialties Div., b, c.
Lear, Inc., a thru l, n thru s, v, w, y, b-l, c-l, e-l thru n-l, p-l, q-l, s-l thru v-l.
Ledeen Inc., v, b-l, l-l.
*WALLACE O. LEONARD, INC., a, b, d, f thru r, u thru x, b-l, thru h-l, k-l, n-l, q-l, s-l, w-l.
Leslie Co., c, d, f, g, l, m, n, u, v, w, b-l, c-l, d-l, p-l, r-l, s-l, t-l.
Lithium Corp. of America Inc., The Fulton-Irgon Div., o, v, b-l, e-l, h-l.
Lockheed Aircraft Corp., Missiles & Space Div., m, o, u.
Lundy Mfg. Corp., d, f, n, y.
Luzerne Rubber Co., b, c, j, s, a-l.
M. C. Mfg. Co., i, j, l, m, p, u thru x, b-l, d-l, f-l, g-l, i-l, j-l, l-l, n-l, t-l.
Marman Div., Aeroquip Corp., j.
Marotta Valve Corp., a thru d, f thru m, o, p, u thru x, a-l, b-l, d-l, thru h-l, j-l, l-l, m-l, n-l, p-l, v-l.
Marsh Instrument Co., Div.-Colorado Oil & Gas Corp., d, n, s, t, w, z, d-l, n-l, o-l, r-l.
Mason-Neilan, l, m, n, s, t, y, z, a-l, b-l, d-l, f-l, s-l.
Mead Specialties Co., Inc., d, h, l, o, b-l, d-l, l-l, n-l.
Mechanical Air Controls, Inc., d, p, b-l.
Menasco Mfg. Co., b, c, d, f, i, l thru p, r, t, u, v, x, y, b-l, c-l, e-l, h-l, m-l, n-l, s-l, u-l.
Midwestern Instruments, Inc., p, k-l.
Minneapolis-Honeywell Regulator Co., Missile Equipment Div.
Mitchell Camera Corp.
National Cylinder Gas, Div.-Chemetron Corp., u, v, x, d-l.
National Welding Equipment Co., u, x.
National Water Lift Co., Div.-Cleveland Pneumatic Industries Inc., l, m, o, p, w, c-l thru f-l, h-l thru k-l, n-l, s-l, t-l.
New York Air Brake Co., The, Watertown Div., w.
Newark Wire Cloth Co. o-l.
Northrop Corp., l, p, c-l, k-l.
Opw-Jordan, b, c, d, f, i, j, l, n, b-l, d-l, f-l, p-l, r-l s-l, v-l.
Ohlson Empire Inc., j, r, s, t, z, d-l, f-l, n-l, o-l.
Oil-Dyne, Inc., w.
Oil-Rite Corp., h, n-l.
On Mark Couplings, Inc., a thru d, f, g, i, k, m, u thru y, b-l, e-l thru h-l, l-l, t-l.
Oxygen Equipment & Service Co., n, u, v, x, z, p-l, u-l.
Ozone Metal Products Corp., a, g thru l, o, p, w, z, b-l, c-l, d-l, f-l, g-l, i-l thru n-l.
PSP Engrg. Co., Div.-IMC Magnetics Corp., N. Y., d, l, p, b-l, n-l.
Parker Hydraulics Div., Parker-Hannifin Corp., a, j, l, w, f-l.
Parker-Hannifin Corp., g, l, v, w, y, b-l, d-l, f-l, g-l, j-l, k-l, n-l.
Peacock Engrg. & Mfg. Co., d, h thru m, v, w, b-l, d-l, e-l, f-l, j-l, l-l.
Pegasus Labs., Inc., j, p, d-l, k-l, n-l.
Pesco Products Div.-Borg-Warner Corp., k-l.
Richard Philip Co.
Pneu-Hydro Valve Corp., a thru s, u thru z, a-l, thru j-l, l-l thru w-l.
Wm. Powell Co., The, c, d, i, j, l, m, t, y, z, a-l, e-l, f-l, s-l.
Powers Regulator Co., The, n, t, b-l, d-l, r-l.
Precision Equipment Co., Inc., j, k, m, u thru x, z, a-l, b-l, d-l, f-l, h-l, s-l, t-l, w-l.
Propellex Chemical Div., Chromalloy Corp., e-l.
Puritan Aerospace Div.-Puritan Compressed Gas Corp., b-l.
R-P&C Valve Div., American Chain & Cable Co., Inc., t, a-l.
Randall Engrg. Corp., c, d, j, k, m, n, u thru x, b-l, d-l, f-l, n-l.
Reaction Motors Div., Thiokol Chem. Corp., j, m, r, d-l, f-l, w-l.
Republic Mfg. Co., a, c, d, f thru l, n, o, p, t thru z, a-l, b-l, d-l, f-l thru j-l, l-l, n-l, o-l, s-l, u-l.
Research Controls, b, c, d, i, l thru o, u, v, x, y, z, b-l, d-l h-l, s-l.
Resistoflex Corp., c.
Revere Corp. of America, Sub., Neptune Meter Co., s.
Rivett Lathe & Grinder Inc., l, w, b-l, d-l, f-l, n-l.
J. R. Robbins Co., g, h, i, l, o, p, w, b-l, c-l, d-l, g-l, j-l, l-l, m-l, n-l, q-l, t-l.
Robbins Aviation, Inc., c, d, t, u, w thru z, a-l, b-l, s-l.
Robertshaw-Fulton Controls Co., A & I Div., d, i, u, v, w, y, b-l, d-l, f-l, n-l.
Robertshaw-Fulton Controls Co., Fulton Sylphon Div., l, n, s, t, v, w, y, z, b-l, d-l, f-l, n-l, r-l, s-l, u-l, v-l.
Rocketdyne Div.-North American Aviation, Inc. x.
Rockwood Sprinkler Co., Div.-The Gamewell Co., d, f, g, m, y, h-l, o-l.
Ronson Hydraulic Units Corp., a, c, d, g thru m, o, p, r, u thru z, a-l thru g-l, i-l thru n-l, q-l, t-l.
Rotex Punch Co., Inc., d, h, l, n-l.
Milton Roy Co., j, f-l.
Ruland Mfg. Co., Inc., a, z, b-l.
Ryan Industries, Inc., Dept M., m.
S-P Mfg. Corp., The, b-l.
Sanders Associates, Inc., w, k-l.
Santa Barbara Research Center, k, m, v, x, b-l, d-l, v-l.
Sargent Engrg. Corp., d, g, i thru p, u thru z, a-l thru d-l, f-l, g-l, i-l thru n-l, s-l, t-l, v-l, w-l.
Schaffer Air Industries, Inc., a.
Schutte & Koerting Co., f, h, i, j, r, s, t, y, d-l, f-l, o-l.
Scott Aviation Corp., d, f, v, d-l, i-l.
Scovill Mfg. Co., d.
Sealol Corp., j, k, f-l, h-l.
Sierra Engrg. Co., j, l, d-l, f-l, p-l.
Sierra-Schroeder Controls, Div.-Idaho Maryland Mines Corp., a, f thru m, o, p, u, v, w, y, z, a-l thru g-l, i-l, j-l, l-l, m-l, n-l, r-l thru u-l.
Simmonds Aerocessories, Inc., a thru d, f, g, l, m, n, s thru z, a-l thru k-l, q-l, t-l, u-l, v-l.
Sinclair-Collins Valve Co., Div.-IBEC, c, d, k, j, n, b-l, s-l.
Sirvalco Systems Corp., b, c, d, f thru i, l, m, o, p, q, u thru y, b-l, d-l, e-l, h-l, i-l, n-l, p-l, s-l.
Skinner Electric Valve Div., The Skinner Chuck Co.
Skyvalve, Inc., b, c, d, g, i, j, l, m, v, w, x, b-l, d-l, f-l, h-l, k-l, n-l, v-l.
A. O. Smith Corp., Smith-Erie Div., w, d-l, f-l
Solar Aircraft Co., a, h, i, l, f-l.
South Wind Div., Stewart Warner Corp., i, m, w, d-l, f-l.
Southwestern Valve Corp., b, c, d, j, k, m, t thru y, a-l, b-l, d-l, e-l, f-l, h-l, j-l, l-l, n-l, s-l, t-l, w-l.
Standard Steel Corp., Cambridge Div., m, t, v, x, e-l, t-l.
F. J. Stokes Corp., u-l.
A. U. Stone & Co., Inc., a, c, d, e, l thru m, u thru x, b-l, d-l thru h-l, o-l s-l.
Stratos Div.-Fairchild Engine & Airplane Corp., d, f, i, j, m, x, b-l, d-l, f-l.
Sun Electric Corp., Aeronautical Div., h, j, k, f-l.
Sweetland Engrg. Co., d, w, b-l.
Tactair Valve Div.-Aircraft Products Co., d, j, k, l, p, v, w, b-l, d-l, g-l, j-l, n-l.
Talley Corp., The, d, f, h, i, k, l, m, o, p, u, v, x, y, b-l, c-l, n-l.
Tapco Group, Thompson Ramo Wooldridge Inc., i, j, p, w, y, b-l, f-l.
Taylor-Winfield Corp., d, n-l.
Technical Development Co., a-l.
Thompson Ramo Wooldridge Inc., i, j, p, q, r, w, y, b-l, f-l.
Transco Products, Inc., y, b-l, n-l.
Uniflow Valve Corp., b thru i, l thru o, r, t thru z, b-l, d-l, e-l, h-l, s-l, t-l, v-l.
United Aircraft Products, Inc., c, d, f thru o, v, w, z, b-l, c-l, d-l, f-l thru r-l, t-l, u-l, v-l.
United Control Corp., i, b-l.
United States Chemical Milling Corp., n, s, i-l, k-l, n-l, o-l, q-l.
Vacuum Research Co.
Valcor Engrg. Corp., b, c, d, f thru i, k, m, n, p, u thru x, z, a-l, b-l, h-l, l-l, m-l, n-l, t-l, v-l, w-l.
Vanton Pump & Equipment Corp., b, c.
Vap-Air Aeronautical Products Div., Vapor Heating Corp., d, b-l, d-l.
Veeco Vacuum Corp., p, b-l, n-l, s-l, v-l.
Versa Products Co., Inc., d, l, n, b-l, j-l, l-l, n-l.
Vickers Inc., a, g, i thru l, p, w, y, c-l, d-l, f-l, j-l, k-l, n-l, t-l.
Vickers Inc., Div.-Sperry Rand, a, g thru m, p, w, c-l, d-l, f-l, i-l, k-l, n-l.
Vickers, Inc., Mich., a, f thru o, w, z, a-l, c-l, d-l, f-l, h-l, j-l thru n-l, s-l, t-l.
Vinson Mfg. Co. Inc., a thru e, g thru p, u thru y, a-l thru d-l, f-l, g-l, i-l thru n-l, q-l, s-l thru v-l.
Waterman Hydraulics Corp., f, g, i thru m, p, w, x, g-l, h-l, n-l, q-l, s-l.
*WEATHERHEAD CO., THE, d, f thru n, p, q, s, t, v, w, y, z, b-l thru f-l, h-l, k-l, n-l, o-l, p-l.
Weba, Inc., d, g thru j, f-l, g-l, q-l.
Western Sky Industries, k, m, u thru x, d-l.
Westline Products Div.-Western Lithograph Co., d.
Weston Hydraulics Ltd., Sub.-Borg-Warner Corp., b, c, d, f thru p, u thru x, a-l thru h-l, j-l thru n-l, q-l, t-l.
Whiton Machine Co., The, b-l, m-l.
Whittaker Controls, Div.-Telecomputing Corp., b, c, d, f, g, j thru s, u, v, w, y, z, a-l, b-l, d-l, f-l thru i-l, k-l thru n-l, q-l, t-l.
Worthington Corp., d, l, n, v, w, y, b-l, c-l, d-l, p-l, s-l.

VAPORIZERS, LIQUID OXYGEN

Air Products, Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Cryogenerators, Inc.
Hofman Labs., Inc.
Linde Co., Div.-Union Carbide Corp.
Ronan & Kunzl, Inc.
Ronan & Kunzl, Inc., Cryogenic Div.
Ryan Industries, Inc. Dept. M.
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Superior Air Products Co.

VARNISH

Acme Wire Co.
Avondale Co., The
Better Finishes & Coatings Inc.
Borden Chemical Co.
Columbia Technical Corp.
Dow Corning Corp.
E. I. Du Pont De Nemours & Co. Inc.
Emerson & Cuming, Inc.

Felton-Sibley & Co., Inc.
Furane Plastics, Inc.
Horsey, Robson & Co. Inc.
Insulation Mfrs. Corp.
Kish Industries, Inc.
Krylon, Inc.
Maas & Waldstein Co.
Midland Industrial Finishes Co.
*MINNESOTA MINING & MFG. CO.
Naz-Dar Co.
Penetone Co., The
Raffi & Swanson, Inc.
Raybestos-Manhattan, Inc.
Sauereisen Cements Co.
Schenectady Varnish Co., Inc.
Silicones Div.-Union Carbide Corp.
Special Products Dept., Melpar, Inc.
Standard-Toch Chemicals, Inc.
Vita-Var Corp.
Westinghouse Electric Corp., Micarta Div

VESSELS

Aerocal Div., Aeronca Mfg. Corp.
Alloy Products Corp.
American Instrument Co., Inc.
Ampco Metal, Inc.
Arde-Portland, Inc.
Bethlehem Steel Co.
Brooks & Perkins, Inc.
Brunswick Balke Collender Co., The, Defense Products Div.
California Stamping & Mfg. Co.
Cornell Deep Drawing Co., Div.-Lanes Industries Corp.
Farwell Metal Fabricating
Foster Wheeler Corp.
General American Transportation Corp.
Graver Tank & Mfg. Co., Div.-Union Tank Car Co.
Hahn & Clay
Hofman Labs., Inc.
Ingersoll Kalamazoo Div., Borg-Warner Corp.
Kahn & Co., Inc.
Kaiser Fleetwings, Inc.
Kennametal Inc.
Lycoming Div., Avco Corp.
Menasco Mfg. Co.
National Forge Co.
National Tube Div.-United States Steel Corp.
Nooter Corp.
Norris-Thermador Corp.
Portland Copper & Tank Works Inc.
Pressed Steel Tank Co.
Ryan Industries, Inc., Dept. M.
Southwest Research Institute
Standard Steel Corp., Cambridge Div.
Trailmobile Inc.
Uni-Flex Mfg. & Engrg. Inc.
U. S. Pipe & Foundry Co., Steel & Tubes Div.
Vilter Mfg. Co., The
Weber Aircraft Corp.
Wells Industries Corp.
Young Development Div., Hercules Powder Co.

VIBRATION ABSORBERS

American Brass Co., The
American Felt Co.
American Latex Products Corp.
*AMERICAN STEEL FOUNDRIES, HAMMOND DIV.
Anaconda Metal Hose Div., The American Brass Co.
Wallace Barnes Div. Associated Spring Corp.
Barry Controls Inc.
Bushings, Inc.
Cobra Metal Hose Div. DK Mfg. Co.
Continental Felt Co.
Cordo Chemical Corp.
D K Mfg. Co.
Dayton Rubber Co., The
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Enfab Inc.
Felters Co., The
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
Flock Process Co. Inc.
General Tire & Rubber Co., The, Industrial Products Div.
B. F. Goodrich Industrial Products Co.
George E. Harris & Co., Inc.
Houdaille Industries, Inc., Buffalo Hydraulics Div
Hydra-Power Corp.
K. W. Johnson & Co., Inc.
Johnson Metal Hose, Inc.
Kemp Aero Products
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lord Mfg. Co.
MB Electronics
Northrop Corp.
Owens-Corning Fiberglas Corp.
Propulsion Test Facilities Div.-MB Electronics
Roberts Toledo Rubber Co., The
Robinson Technical Products, Inc.
Rose Mfg. Co.
Rubbercraft Corp. of California
Simmonds Aerocessories, Inc.
Southwest Research Institute
A. T. Stevens Co.
Sun Electric Corp., Aeronautical Div.
Taylor Devices, Inc.
United States Rubber Co.
Vibration Isolation Products

VIBRATION CONTROLS

Barry Controls Inc.
Bushings, Inc.
Dow-Elco, Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Enfab Inc.
Firestone Indsl. Products Co., Div.-Firestone Tire & Rubber Co.
Houdaille Industries, Inc., Buffalo Hydraulics Div.
Hydra-Power Corp.
K. W. Johnson & Co., Inc.
Kahn & Co., Inc.
Ling Electronics Div.-Ling-Altec Electronics, Inc.
Lord Mfg. Co.
MB Electronics
Modern Design Div.-H. C. Schloer, Inc.
Northrop Corp.
Pegasus Labs., Inc.
Robinson Technical Products, Inc.
Southwest Research Institute
Sun Electric Corp., Aeronautical Div.
Unholtz-Dickie Corp.

VIBRATORS, INSTRUMENT PANEL

Emertron, Sub.-Emerson Radio & Phonograph Corp.
MB Electronics
Telkor, Inc.

VIBRATORS, MULTIVIBRATORS

Compudyne Corp.
Cornell-Dubilier Electric Corp.
Delco Radio Div.-General Motors Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
Land-Air Inc., Sub.-California Eastern Aviation, Inc.
MB Electronics
Northrop Corp.
Stewart-Warner Electronics Div.

VIBRATORS, ULTRASONIC

Aeroprojects Inc.
Bendix Aviation Corp.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
General Eylectric Co., Heavy Military Electronics Dept.
MB Electronics
Massa Div.-Cohu Electronics, Inc.
National Ultrasonic Corp.
Southwest Research Institute
Westinghouse Electric Corp.

VISES

Brown & Sharpe Mfg. Co.
Cincinnati Milling Machine Co., The
Emmert Mfg. Co.
Fenn Mfg. Co., The
Miller Falls Co.
Richards-Wilcox Mfg. Co.
Swayne Robinson & Co.
Vinco Corp

VISCOMETERS

American Instrument Co., Inc.
Automation Products, Inc.
Bendix Aviation Corp. Cincinnati Div.
J. W. Fecker Div., American Optical Co.
Fischer & Porter Co.
Fisher Scientific Co.
Gardner Laboratory, Inc.
General Electric Co., Apparatus Sales Div.
Hallikainen Instruments
Southwest Research Institute
United States Testing Co., Inc.

VOLTAGE SUPPLIES, DECADE

Calvert Electronics Inc.
Datascan Inc.
Daven Co., The
Davenport Mfg. Co.
Djeco, Div.-Djordjevic Engrg. Co.
Electro Instruments, Inc.
John Fluke Mfg. Co., Inc.
Hammett-Mercury-Rex Div.
Hewlett-Packard Co.
Modern Design Div.-H. C. Schloer, Inc.
*RADIO CORP. OF AMERICA
Radio Development & Research Corp.
Southwestern Industrial Electronics Co.
Superior Electric Co., The
Tel-Instrument Electronics Corp.
Varo Mfg. Co., Inc.

VOLTMETERS

Adage, Inc.
Airpax Electronics Inc., Cambridge Div.
Airpax Electronics Inc., Seminole Div.
American Machine & Foundry Co., Government Products Group
Assembly Products, Inc.
B & H Instrument Co., Inc.
Beckman Instruments, Inc., Berkeley Div.
Beckman-Systems Div.
Bendix Aviation Corp., Cincinnati Div.
Boonton Electronics Corp.
*BRISTOL CO., THE
Bruno-New York Industries Corp.
Burr-Brown Research Corp.
Burton-Rogers Co., Sales Div.-Hoyt Electrical Instruments
Calvert Electronics Inc.
Carol Electronics Corp.
Columbia Electric Mfg. Co.
*CONSOLIDATED ELECTRODYNAMICS CORP.
Cubic Corp.
Daven Co., The
Daystrom Inc., Weston Instruments Div.
Decker Corp., The
Dejur-Amsco Corp., Electronic Sales Div.
Electric Design & Mfg. Co.
Electro Instruments, Inc.
Electronic Applications, Inc.
Empire Products Sales Corp.
Epic, Inc.
Esterline-Angus Co., The
Flow Corp.
John Fluke Mfg. Co., Inc.
Franklin Electronics Inc.
General Electric Co., Apparatus Sales Div.
Hammett-Mercury-Rex Div.
Helipot Div.-Beckman Instruments, Inc.
Hewlett-Packard Co.
Hickok Electrical Instrument Co., The
Hoyt Electrical Instrument Works., Inc., Burton Rogers Co.
Ideal Precision Meter Co., Inc.
Industrial Devices, Inc.
Interstate Electronics Corp.
Jennings Radio Mfg. Corp.
Kay Electric Co.
Keithley Instruments, Inc.
Wayne Kerr Corp.
Kin Tel Div.-Cohu Electronics, Inc.
Marconi Instruments
Marion Instrument Div.-Minneapolis-Honeywell Regulator Co.
Meters Inc.
Metronix, Inc., Sub.-Assembly Products, Inc.
Motorola, Inc.
National Electronics
New England Scientific Instruments Co.
Non-Linear Systems Inc.
Pace Electrical Instruments Co., Inc.
Pace Electronics Co. Inc.
Q. V. S. Inc.
*RADIO CORP. OF AMERICA
*RCA, RCA SERVICE CO., GOVT. SERVICE DEPT., SYSTEMS ENGRG. FACILITY
Rawson Electrical Instrument Co.
Sangamo Electric Co.
Sensitive Research Instrument Corp.
Servo-Tek Products Co.
Sierra Electronic Corp., Div.-Philco Corp.
Simpson Electric Co.
Southwestern Industrial Electronics Co.
Specialty Electronics Development Corp.

Sun Electric Corp., Aeronautical Div.
Sunshine Scientific Instrument
Systron Corp.
Technology Instrument Corp.
Trio Laboratories, Inc.
Triplett Electrical Instrument Co.
Wacline, Inc.
W. M. Welch Scientific Div., W. M. Welch Mfg. Co.
Westinghouse Electric Corp.

WARNING UNITS, FUEL PRESSURE

ACF Industries Inc.
Aero Instrument Co.
Aerotec Industries Inc., Aircraft Equipment Div.
Bendix Aviation Corp.-Montrose Div.
A. Biederman, Inc.
CG Electronics Corp.
California Plasteck Inc.
Consolidated Controls Corp.
Crescent Engrg. & Research Co.
Custom Component Switches, Inc.
Daystrom Inc., Pacific Div.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
George E. Harris & Co., Inc.
Leach Corp.
***MARTIN CO., THE, DENVER DIV.**
Meletron Corp.
Radar Relay, Inc.
Simmonds Aerocessories, Inc.
Southwest Research Institute
Westport Development & Mfg. Co., Inc.

WARNING UNITS, TEMPERATURE

Avien, Inc.
B & H Instrument Co., Inc.
A. Biederman, Inc.
CG Electronics Corp.
California Plasteck Inc.
Conax Corp.
Consolidated Controls Corp.
Daystrom Inc., Pacific Div.
Thomas A. Edison Ind. Instrument Div.-Mc Graw-Edison Co.
Fenwal Inc.
Illinois Testing Laboratories, Inc.
Kidde Aero-Space Div., Walter Kidde & Co., Inc.
Lab. for Electronics, Inc.
Leach Corp.
***MARTIN CO., THE, DENVER DIV.**
Norwalk Thermostat Co.
Santa Barbara Research Center
Simmonds Aerocessories, Inc.
Southwest Research Institute
Special Products Dept., Melpar, Inc.
Spectra Electronics Corp.
Torwico Electronics, Inc.
Trepac Corp. of America
United Control Corp.
Wells Industries Corp.
Westport Development & Mfg. Co., Inc.

WASHERS

a. Brass
b. Ceramic
c. Felt
d. Fibre
e. Insulating
f. Lock
g. Metal
h. Mica
i. Plastic
j. Rubber

Abalon Precision Mfg. Corp., **a, g.**
Abesto Corp., **c, d, e.**
Accurate Specialties Co., Inc., **g.**
Acorn Bearing Co., **a.**
Aero Gasket Corp., **a, c, e, g, j.**
Aero Spares, Inc., **a, f, g.**
Aerotron Supply Co., **a, f, g.**
Airhardware, Inc., **a, d, f, g.**
All Specs Corp., **a, f, g.**
Allied Plastics Supply Corp., **a, b, d thru j.**
Allmetal Screw Products Co., Inc., **f, g.**
Alloys Unlimited Inc., **g.**
Aluminum Co. of America, **f, g.**
Alvo Nut & Bolt Co., Inc., **a, f, g.**
Amatom Electronic Hardware Co., Inc., **a, d, e, i.**
American Agile Corp., **i.**
American Brass Co., The, **a, e, g.**
American Felt Co., **c, d, e, i.**
American Insulator Corp., **i.**
American Latex Products Corp., **e, i.**
American Lava Corp., **b.**
American Standard Products, Inc., **a, g.**
Amplex Div.-Chrysler Corp., **g.**
Anchor Metal Co., Inc., **g.**
Anchor Packing Co., The, **c, j.**
Anti-Corrosive Metal Products Co., Inc., **e, f, g, i.**
Asheville-Schoonmaker Mica Co., **h.**
Atlas Screw & Specialty Co., **f, g.**
Auburn Mfg. Co., The, **a thru e, g thru j.**
Autoscrew Co., Inc., **a, d, f, g, i.**
Aviation Textile Associates **a thru j.**
Wallace Barnes Div. Associated Spring Corp., **g.**
L. J. Barwood Mfg. Co., Inc., **a, c, d, e, g thru j.**
Beemer Engrg. Co., **g.**
Bellowes Co., The, **f.**
Belmar Wheel & Machine Co., Inc., **a, d, e, g.**
Belmont Smelting & Refining Works, Inc., **g.**
Bentley, Harris Mfg. Co., **e.**
Best Aircraft Corp., **a, f, g.**
Bethlehem Steel Co., **g.**
Birnbach Radio Co., Inc., **e, f, g, i.**
Bonny Mfg. Corp., **e, i.**
California Stamping & Mfg. Co., **a, d, g.**
Carborundum Co., The, **b, e.**
Carborundum Co., Latrobe Plant, Refractories Div., **b.**
Centrolab Div.-Globe-Union, Inc., **b.**
Chase Brass & Copper Co., Inc., **a.**
Chemplast, Inc., **e, i.**
Chicago Rawhide Mfg. Co., **j.**
Colonial Rubber Co., **j.**
Comco Plastics Inc., **d, e, i.**
Connecticut Hard Rubber Co., The, **i.**
Continental Diamond Fibre Corp., **d, e, h, i.**
Continental Felt Co., **c.**
Continental Rubber Works, **j.**
Continental Screw Co., **a, g.**
Coors Porcelain Co., **b.**
Corning Glass Works, **b.**
Crystal-X Corp., **i.**
Darcoid Co., Inc., The, **i, j.**
R. E. Darling Co., Inc., **e, j.**
Dell Optics Co., Ltd.
Detroit Stamping Co., **a, d, f, g.**
Diamonite Products Mfg. Co., **b.**
Division Lead Co., **g.**
Dixon Corp., **e, i.**
John L. Dore Co., **e, i.**
Du-Co Cemamics Co., **b, e.**
R. C. Dudek & Co., **f.**
Dura Plastics of N. Y., Inc., **i.**
Duramic Products, Inc., **b, e.**
Eaton Mfg. Co., **f.**
Eaton Mfg. Co., Reliance Div., **b, f, g.**
Electrical Refractories Co., The, **b.**
Eljay Corp., **d, e, i.**
Emeloid Co., Inc., The, **i.**
Emerson Plastics Corp., **b, d, e, h, i.**
Enfab Inc., **e.**
Excelsior Leather Washer Mfg. Co., Inc., **c, d, i, j.**
Federal Screw Products Inc., **a, d, f, g, j.**
Ferroxcube Corp. of America, **b.**
Fisher & Crome, **d, e, i.**
Fluorocarbon Co., The, **i.**
Franklin Fibre-Lamitex Corp., **d, e, i.**
Frenchtown Porcelain Co., **b.**
G-C Electronics Co., **d.**
Garlock Packing Co., **c, d, e, i, j.**
George K. Garrett Co., Inc., **a, f, g.**
Gasket Mfg. Co., Inc., **a, c, d, e, g thru j.**
General Electric Co., Lamp Metals & Components Dept., **g, j.**
General Gasket Inc., **a, c, d, e, g, i, j.**
Gladding, McBean & Co., **b.**
B. F. Goodrich Industrial Products Co., **i, j.**
Goshen Rubber Co., Inc., **j.**
Grayhill, Inc., **e, i.**
Greene, Tweed & Co., **j.**
Gries Reproducer Corp., **e, i.**
Guarantee Specialty Mfg. Co., **a, g.**
Gulton Industries, Inc., **b.**
Halogen Insulator & Seal Corp., **i.**
H. M. Harper Co., **a, f, g.**
Holub Industries, Inc., **g.**
E. F. Houghton & Co., **j.**
Insulation Mfrs. Corp., **d, e, h, i.**
Isolantite Mfg. Corp., **b, e.**
Keystone Bolt & Nut Corp., **a, f, g.**
Keystone Electronics Corp., **e.**
M. Kirchberger & Co., Inc., **b, e.**
Kling Metal Spinning & Stamping Co., **a, g, h.**
Lamtex Industries Inc., **e, i.**
Link-Belt Co., **f.**
Thomas J. Long, Inc., **d, i.**
Mechanical Felt & Textiles Co., **c.**
Mechanical Rubber Products Co., **d, j.**
Mercury Air Parts Co., Inc., **a thru j.**
Mica Fabricating Co., **b, d, e, h, i.**
Mica Insulator Div.-Minnesota Mining & Mfg. Co., **e, h.**
***MINNESOTA MINING & MFG. CO., b, h.**
Minnesota Rubber Co., **j.**
J. I. Morris Co., **a, f, g.**
Mycalex Corp. of America, **e.**
National Beryllia Corp., **b, e.**
National Ceramic Co., **b.**
National Vulcanized Fibre Co., **d, e, i.**
New England Spring Mfg. Co., Inc., **a, f.**
Norrich Plastics Corp., **a, d, e, g, i, j.**
Norrich Screw Machine Products, **a, b, d, e, g, i, j.**
Ohlson Empire Inc., **a, f, g.**
Olin Mathieson Chemical Corp., N. Y., **a.**
Penn Fibre & Specialty Co., Inc., **a, c, d, e, g thru j.**
Philadelphia Steel & Wire Corp., **f.**
Richard Philip Co., **a.**
Polymer Corp., The, **e, i.**
Quaker City Felt Co., **c.**
Raybestos-Manhattan, Inc., **e, i, j.**
Reeves Bros. Inc., Vulcan Rubber Div., **j.**
Fred T. Roberts & Co., **j.**
Roberts Toledo Rubber Co., The, **j.**
Rogers Corp., **d, e, i, j.**
Milton Ross Metals Co., The, **i.**
Rubbercraft Corp. of California, **e, j.**
Russell Mfg. Co., **i.**
SKF Industries, Inc., **f.**
St. Regis Paper Co., Panelyte Div., **e, i.**
Sanford Plastics Corp., **i.**
Ray A. Scharer & Co., **i, j.**
W. S. Shamban & Co., **c, d, i.**
Shenango Furnace Co., The, Centrifugally Cast Products Div., **a.**
Shur-Lok Corp., **f, g.**
Sillcocks-Miller Co., **i.**
Sinclair Mfg. Co., **a, d, g, i.**
Southern Plastitcs Co., **i.**
Sparta Mfg. Co., Div.-U. S. Ceramic Tile Co., **e, i.**
Spaulding Fibre Co., Inc., **d, e, i.**
Springfield Brass Co., Inc., **a.**
Spruce Pine Mica Co., **e.**
Star Porcelain Co., The, **b.**
Star Stainless Screw Co., **f, g.**
Stevens Co. Inc., **a, g.**
Superior Industrial Machine Co., **g.**
Superior Steatite & Ceramic Corp., **b, e.**
Synthane Corp., **e.**
T. O. D. Mfg. Co. Inc., **a, g.**
Taylor Fibre Co., **d, e, i.**
Technical Ply-Woods Sales, **d.**
Tetrafluor, Inc., **i.**
Thompson-Brewer & Co. Div.-American Machine & Foundry Co., **a, f, g.**
Thomson, Judson L., **a, g.**
Thor Ceramics, Inc., **b, g, i.**
Twix Mfg. Co., Inc., **a, g, h.**
United Shoe Machinery Corp., **a.**
U. S. Plastic Molding Corp., **i.**
United States Rubber Co., **j.**
Universal Unlimited, Inc., **i.**
Vector Electronic Co., Inc., **e.**
Victor Mfg. & Gasket Co., **a, c, d, g, i.**
Victor Tool & Mfg., Inc., **a, c, d, e, g, i.**
Virginia Plak Co., **i.**
Waterbury Companies, Inc., **i.**
Western Felt Works & Acadia Synthetic Products Div., **c, j.**
Westinghouse Electric Corp., Micarta Div., **i.**
Whitehead Stamping Co., **a, d, g.**
Wilmington Fibre Specialty Co., **d, e.**
Wrought Washer Mfg. Co., **a, d thru j.**
Zirconium Corp. of America, **b.**

WATER INJECTION EQUIPMENT

Allison Div., General Motors Corp.
Barnstead Still & Sterilizer Co.
Bendix Aviation Corp.
***BENDIX PRODUCTS DIV., BENDIX AVIATION CORP.**
Bendix Utica Div., Bendix Aviation Corp.
J. C. Carter Co., The
Curtiss-Wright Corp., Santa Barbara Div.
Delavan Mfg. Co.
Holley Carburetor Co.

Hydra-Power Corp.
Lear, Inc.
*MARTIN CO., THE, DENVER DIV.
Meletron Corp.
Pratt & Whitney Aircraft Div., United Aircraft Corp.
Pryor Mfg. Co.
Southwest Research Institute
Tapco Group, Thompson Ramo Wooldridge Inc.
Thompson Ramo Wooldridge Inc.
Transco Products, Inc.

WAVE TRAPS

Cameraflex Div., The, Federal Mfg. & Engrg. Corp.
Emhart Mfg. Co., Maxim Div.
General Bronze Electronics Corp.
Hammett-Mercury-Rex Div.
Kentucky Metal Products Co.
James Millen Mfg. Co. Inc.
J. W. Miller Co.
*RADIO CORP. OF AMERICA
TRG, Inc.

WAVEGUIDE PRESSURE-DEHYDRATOR SYSTEMS

Aircom Inc.
Airtron, Div.-Litton Industries
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Budd Lewyt Electronics, Inc.
Cornelius Co., The, Aero Div.
Dalmo Victor Co., Div.-Textron, Inc.
Driaire, Inc.
General Bronze Electronics Corp.
Great Lakes Mfg. Corp.
Hammett-Mercury-Rex Div.
Kahn & Co., Inc.
Pittsburgh Lectrodryer Div.-McGraw-Edison Co.
J. F. Pritchard & Co. of California
*RADIO CORP. OF AMERICA
Robbins Aviation, Inc.
TRG, Inc.
Trinity Equipment Corp.
Universal Dynamics Corp.
Wells Industries Corp.

WAVEGUIDES, FLEXIBLE

Airtron, Div.-Litton Industries
Anaconda Metal Hose Div., The American Brass Co.
*ANDREW CORP.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Bogart Mfg. Corp.
Brach Mfg. Corp.
Co-Operative Industries, Inc.
Dahlstrom Metallic Door Co.
Joe Davidson & Associates
John L. Dore Co.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*ENGIS EQUIPMENT CO.
General Bronze Electronics Corp.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammett-Mercury-Rex Div.
George E. Harris & Co., Inc.
Lieco, Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Marman Div., Aeroquip Corp.
Microwave Associates, Inc.
*RADIO CORP. OF AMERICA
Southwest Research Institute
TRG, Inc.
Technicraft Div.-Electronic Specialty Co.
Telerad Mfg. Corp.
Universal Mfg. Co., Inc.

WAVEGUIDES, RIGID

ACF Industries Inc.
Advanced Engineering Div., D. S. Kennedy & Co.
Ainslie Corp.
Airtron, Div.-Litton Industries
Allied Research & Engrg., Div.-Allied Record Mfg. Co.
*ANDREW CORP.
Arrowhead Products, Div.-Federal-Mogul-Bower Bearings, Inc.
Bendix Aviation Corp.
Bogart Mfg. Corp.
Brach Mfg. Corp.
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Chemalloy Electronics Corp.
Dahlstrom Metallic Door Co.
Dalmo Victor Co., Div.-Textron, Inc.
Joe Davidson & Associates
Demornay-Bonardi
Diamond Antenna & Microwave Corp.
Don-Lan Electronics Inc.
Douglas Microwave Co., Inc.
Emertron, Sub.-Emerson Radio & Phonograph Corp.
*ENGIS EQUIPMENT CO.
Gabriel Co., The, Gabriel Electronics Div.
General Aniline & Film Corp., Ansco Div.
General Bronze Electronics Corp.
General Electric Co., Ordnance Dept.
Gilfillan Bros., Inc.
John Gombos Co., Inc.
Goodyear Aircraft Corp.
Gorham Electronics-Div.-Gorham Mfg. Co.
Hammett-Mercury-Rex Div.
George E. Harris & Co., Inc.
Henry & Miller Industries, Inc.
Indsl. Prod.-Danbury Knudsen Div.-Amphenol-Borg Electronics Corp.
J-V-M Microwave Co.
*KEARFOTT DIV., GENERAL PRECISION, INC.
D. S. Kennedy & Co.
Kerns Mfg. Corp.
Leach & Garner Co., Indsl. Div.
Lieco, Inc.
Litton Industries, Inc.
Litton Industries, Maryland Div.
Marman Div., Aeroquip Corp.
Meridian Metalcraft, Inc.
Metal Fabricators Corp.
Microwave Associates, Inc.
Narda Microwave Corp., The
Narmco Mfg. Co.
Northrop Corp.
Omega Labs., Inc.
Phelps Dodge Copper Products Corp.
Philco Corp.-Govt. & Industrial Group
Richard Philip Co.
Piasecki Aircraft Corp.
*RADIO CORP. OF AMERICA
Ramo-Wooldridge, Div.-Thompson Ramo Wooldridge Inc.
Scientific-Atlanta, Inc.
Skyline Electric & Mfg. Co.
Southest Research Institute
Specialty Electronics Development Corp.
TRG, Inc.
Technicraft, Div.-Electronic Specialty Co.
Telerad Mfg. Corp.
Texas Instruments Inc.
United Aircraft Products, Inc.
Universal Mfg. Co., Inc.
Utility Brass & Copper Corp.
Waveline, Inc.

WAX

American Oil & Supply Co.
George Basch Co., The
Biwax Corp.
Borden Chemical Co.
Delta Chemical Works, Inc.
Engelhard Industries, Inc.
Esso Standard, Div.-Humble Oil & Refining Co.
Finnell System, Inc.
Hastings Plastics, Inc.
International Wax Refining Co.
Kano Labs.
Merix Chemical Co.
*MINNESOTA MINING & MFG. CO.-CHEMICAL DIV.
Mitchell Rand Mfg. Corp.
Penetone Co., The
Southwest Research Institute
Stevenson Bro. & Co.
Trio Chemical Works, Inc.
Zophar Mills Inc.

WELDERS, SPOT

Aeroprojects Inc.
Air Reduction Sales Co., Div.-Air Reduction Co., Inc.
Allen Electric & Equipment Co.
American Welding & Mfg. Co., The
California Stamping & Mfg. Co.
*COMMERCIAL APPARATUS & SYSTEMS DIV., RAYTHEON CO.
Eisler Engrg. Co., Inc.
Ewald Instruments
Federal Electronic Products Inc.
Henry & Miller Industries, Inc.
Hughes Tool Co., Aircraft Div.
Linde Co., Div.-Union Carbide Corp.
Litton Engrg. Labs.
Metal & Thermit Corp.
National Cylinder Gas, Div.-Chemetron Corp.
Peer, Inc.
Pioneer Industries Div., Almar-York Co. Inc.
Research, Inc.
Sciaky Brothers, Inc.
Scientific Electric Inc.
Taylor-Winfield Corp.
Trindl Products, Ltd.
Vacuum Tube Products, Div.-Hughes Aircraft Co.
Vickers Inc., Electric Products Div.
Weldmatic Div., Unitek Corp.

WIND TUNNELS

Aeroscience, Inc.
Beacon Steel Corp.
Bethlehem Steel Co.
Chicago Bridge & Iron Co.
Dynametrics Corp.
General American Transportation Corp.
Industrial Equipment Div., Baldwin Lima Hamilton Corp.
Lockheed Aircraft Corp., Missiles & Space Div.
R. C. Mahon Co., The
Nooter Corp.
Nordberg Mfg. Co.
Northrop Corp.
Opelika Welding, Machine & Supply Inc.
Pacific Coast Engrg. Co.
Edw. Renneburg & Sons Co.
Standard-Thomson Corp., Clifford Mfg. Co. Div.
Task Corp.
Roland Teiner Co., Inc.
U. S. Science Corp., Div.-Topp Industries, Inc.
Western Gear Corp.-Precision Products Div.
Westinghouse Electric Corp.

WINDINGS, TRANSFORMER

Advanced Electronics, Inc.
Allen Electric & Equipment Co.
De Havilland Aircraft of Canada, Ltd., Special Products Div.
Electronic Transformer Co., Inc.
Industron Corp.
Lear, Inc.
Leece-Neville Co., The
Mid-West Coil & Transformer Co.
National Coil Co.
Polyphase Instrument Co.
Rimak, Inc.
Sangamo Electric Co.
Southwestern Industrial Electronics Co.
Stratfield Co., The

WINDOWS, WAVEGUIDE

American Beryllium Co.
Central Electronic Mfrs., Div.-Nuclear Corp. of America
Ceramaseal, Inc.
Demornay-Bonardi
Douglas Microwave Co., Inc.
Hammett-Mercury-Rex Div.
*KEARFOTT DIV., GENERAL PRECISION, INC.
Microwave Associates, Inc.
National Beryllia Corp.
Parker Seal Co., Div.-Parker-Hannifin Corp.
Portland Copper & Tank Works Inc.
Sage Labs., Inc.
Sylvania Electric Products Inc., Special Tube Operations
Tapco Group, Thompson Ramo Wooldridge Inc.
Technicraft, Div.-Electronic Specialty Co.
Transco Products, Inc.

WIRE

a. Aluminum
b. Annunciator
c. Antenna
d. Asbestos Insulated
e. Berylluim Copper
f. Ceramic Insulated
g. Cut & Stripped
h. Enameled
i. Filament
j. Fine Wire Specialties
k. Forms
l. Glass Insulated
m. Gold Plated
n. Guy

o. Harnesses
p. High Voltage
q. Hook-Up
r. Litz
s. Magnet
t. Marking Service
u. Mesh
v. Metal Plated
w. Metal Shielded
x. Monel
y. Nickel Clad Copper
z. Phosphor Bronze

a-1. Plastic Insulated
b-1. Platinum
c-1. Recording
d-1. Reels
e-1. Resistance & Filament
f-1. Shielded
g-1. Silicon Bronze
h-1. Silver Plated
i-1. Stainless Steel
j-1. Strippers, Mechanical
k-1. Tantalum
l-1. Teflon Insulated
m-1. Thermocouple
n-1. Zirconium

ACF Industries Inc. **o.**
Accurate Specialties Co., Inc., **a, j, k, v, y, h-1.**
Acme Wire Co., **h, j, l, s.**
Acromark Co., The, **t.**
Aero Research Instrument Co., Inc., **f, w, m-1.**
Aero Spares, Inc., **i-1.**
***AIRESEARCH MFG. CO., DIV.-THE GARRETT CORP., o, p, q, w, a-1, f-1, l-1.**
Alden Products Co., **o.**
All Boro Metal Products Co., Inc., **i-1.**
Alloys Unlimited, Inc., **a, h, j, m, v, b-1, h-1, j-1.**
Alpha Metals, Inc., **j, k.**
Alpha Wire Corp., **c, g, h, l, o, p, q, s, w, z, a-1, f-1, h-1 l-1.**
Aluminum Co. of America, **a.**
American Brass Co., The **e, p, z, g-1, l-1.**
American Brazing Alloys Corp., **a, z, g-1, i-1.**
American Electric Cable Co., **c, g, o, p, q, a-1, e-1, f-1.**
American Leonic Mfg. Co., **a, e, g, i, j, m, n, q, r, s, v thru z, b-1, e-1, g-1, h-1, i-1, k-1 thru n-1.**
American Super-Temperature Wires, Inc. **d, h, l, p thru s, w, a-1, f-1, l-1.**
Ampco Metal, Inc., **e, x, z, g-1.**
Amperex Electronic Corp., **m-1.**
Anaconda Wire & Cable Co., **a thru f, h, j, l, p, q, s, w, y, z, a-1, b-1, f-1, g-1, h-1, l-1.**
Anchor Metal Co., Inc., **a, j.**
Ansonia Wire & Cable Co., The, **a, b, c, g, l, p, q, w, a-1, f-1.**
Armco Steel Corp., **i-1.**
Art Wire & Stamping Co., **j, k.**
Associated Engrg. & Mfg. Corp., **i, j, y, k-1.**
Associated Spring Corp., Ohio Div., **k.**
Semon Bache & Co., **l.**
Barker Sales Co., **h, r, s, a-1.**
Wallace Barnes Div. Associated Spring Corp., **j, k.**
Belden Mfg. Co., **h, l, p thru s, l-1.**
Bendix Filter Div., Bendix Aviation Corp., **j, u.**
Berkshire Electric Cable Co., **c, g, j, l, o, p, q, u, a-1, f-1, m-1.**
Bestcraft Products Co., Inc., **u.**
Bethlehem Steel Co., **j, n.**
Birnbach Radio Co., Inc., **a, c, d, g thru j, l, n thru q, s, z, a-1, f-1, g-1, l-1.**
J. Bishop & Co., Platinum Works, **i, m, u, v, x, y, b-1, e-1, m-1.**
Bjorksten Research Labs. for Industry, Inc., **a, f, l, a-1.**
Boston Insulated Wire & Cable Co., **p, f-1, h-1, l-1**
Bram Metallurgical Chemical Co., **e, j, m, r, u, v, x, y, z, b-1, e-1, h-1, i-1, k-1 m-1, n-1**
William Brand Rex Div.-American Enka Corp., **c, i, o, p, q, t, a-1, l-1.**
Breeze Corporations Inc., **o, u.**
Bridgeport Brass Co., **a, x, y, z, g-1., k-1, n-1.**
Bristo Brass Corp., The, **g-1.**
Buffalo Wire Works Co. Inc., **u.**
Cable Electric Products Inc., **b, d, g, o, q, a-1**
Calcon Mfg. Co., Inc., **c, g, j, n thru q, w.**
Cambridge Wire Cloth Co., The, **j, k, u.**
Carborundum Co., The, **n-1.**
Carol Cable Div.
Carpenter Steel Co., The, **j, i-1.**
Chase Brass & Copper Co., Inc., **a, z, g-1, i-1.**
Chemplast, Inc., **l-1.**
Chester Cable Corp., Sub.-Miami Copper Co., **b, j, l, p, q, w, a-1, f-1, l-1.**
Sigmund Cohn Corp., **a, h, i, j, m, v, b-1, m-1.**
Collyer Insulated Wire Co., **d, p, a-1.**
Colonial Alloys Co., **a, j, x.**
Continental Sensing, Inc., **m-1.**
Continental Wire Sales Corp., **d, l, p, q, w, a-1, f-1, l-1.**
Copperweld Steel Co., Wire & Cable Div., **n.**
Cord Products Co., **o.**
Cornish Wire Co. Inc., **b, l, o, q, a-1, f-1.**
Crucible Steel Co. of America, **s, x, i-1.**
Dalweld Co. Inc., **a, z, g-1, i-1.**
R. E. Darling Co., Inc., **o, w, f-1, l-1.**
Dayton Aircraft Products, Inc., **c.**
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editorial . . .

Brinkmanship and What Follows

In the present state of our foreign affairs forecasting is a hazardous occupation. Some eventualities, however, do seem obvious to anyone who reads or listens.

Unless there is a radical shift in the tempers and attitudes of Soviet leaders or some extraordinary maneuvers on the part of ours which will reduce the tension—these things we may look for:

A big increase in the constant alert status of SAC's missile-carrying B-52 force.

An increased tempo in production of *Atlas, Titan, Minuteman* and *Polaris,* with a greater authorization of overtime.

An increase in the number of *Polaris* submarines and the new hydrofoils.

A speedup of the ballistic air-to-ground *Skybolt* program.

Reinstatement of the Mach-3 B-70 which, as the successor to the B-52, would carry the *Skybolt.*

More emphasis on mobility—which means more emphasis on the *Minuteman* and the *Polaris.*

Far greater production of short-range tactical missiles, most of them atomic-tipped, for use by the Army.

A cautious production emphasis on the Air Force's *Samos* and *Midas,* the reconnaissance and early warning satellites.

The latest Russian satellite has been referred to as little more than a larger version of the American *Discoverer* and proves, it is said, only two things. One we knew before—that the Russians have a big booster which works on schedule. The other is that they may be close to solving the re-entry problem for humans. Maybe that is all—but let's wait and see.

The 4½-ton monster may, however, serve to jar the National Aeronautics and Space Administration out of its orderly technological progress schedule into a speedup of the Astronaut program.

All of these eventualities will mean more money for the nation's military and space program—money measured in millions if not billions. The FY 1961 budget already includes some $9.5 billion for the overall missile/-space program.

At the insistence of Congress, if not of the Administration, this sum could easily reach $11 billion or more before adjournment this year.

Certainly a good case will be made for increasing our production of the mobile missiles, whether carried by freight car, submarine or airplane. And it will be difficult to deny the Army's pleas for more tactical missiles in view of the obvious gap which exists between the ground forces of the East and those of the West.

It is difficult to believe that—in the face of the Soviet threat—the Administration will find it possible to resist the pressure from the people and the Congress for an increased military defense program and space program. For if the two were likely to become important issues in the coming presidential campaign—now they are certain to be.

You can't practice brinkmanship on the one hand and plump for disarmament on the other. They just aren't compatible.

Clarke Newlon

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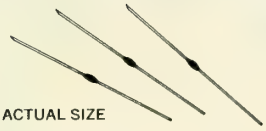
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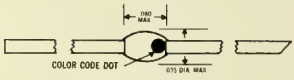


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1N898	50	100	.025 (10V) .5 (40V)	5 (10V) 20 (40V)	100K	0.3
1N899	100	5	.025 (10V) .1 (80V)	5 (10V) 20 (80V)	100K	0.3
1N900	100	50	.025 (10V) .1 (80V)	5 (10V) 20 (80V)	100K	0.3
1N901	100	100	.025 (10V) .5 (80V)	5 (10V) 20 (80V)	100K	0.3
1N902	200	10	.025 (10V) 1.0 (100V)	5 (10V) 15 (100V)	200K	0.3

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Circle No. 60 on Subscriber Service Card.

June 6, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



Model Minuteman on Rails

SPECIAL REPORT:
Minuteman—Biggest U.S. Missile P
To Get 600 on Launchers by '65 10

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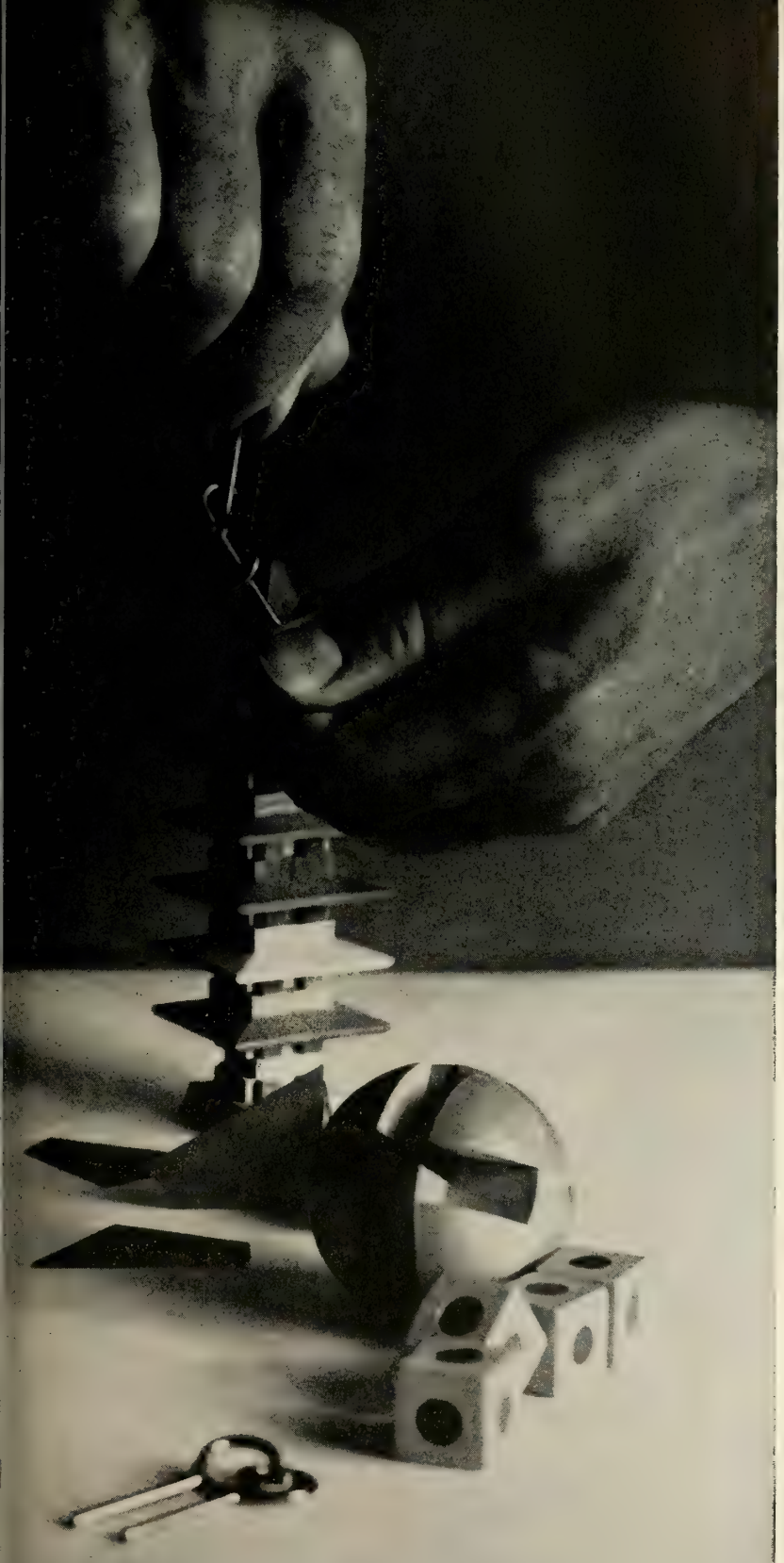
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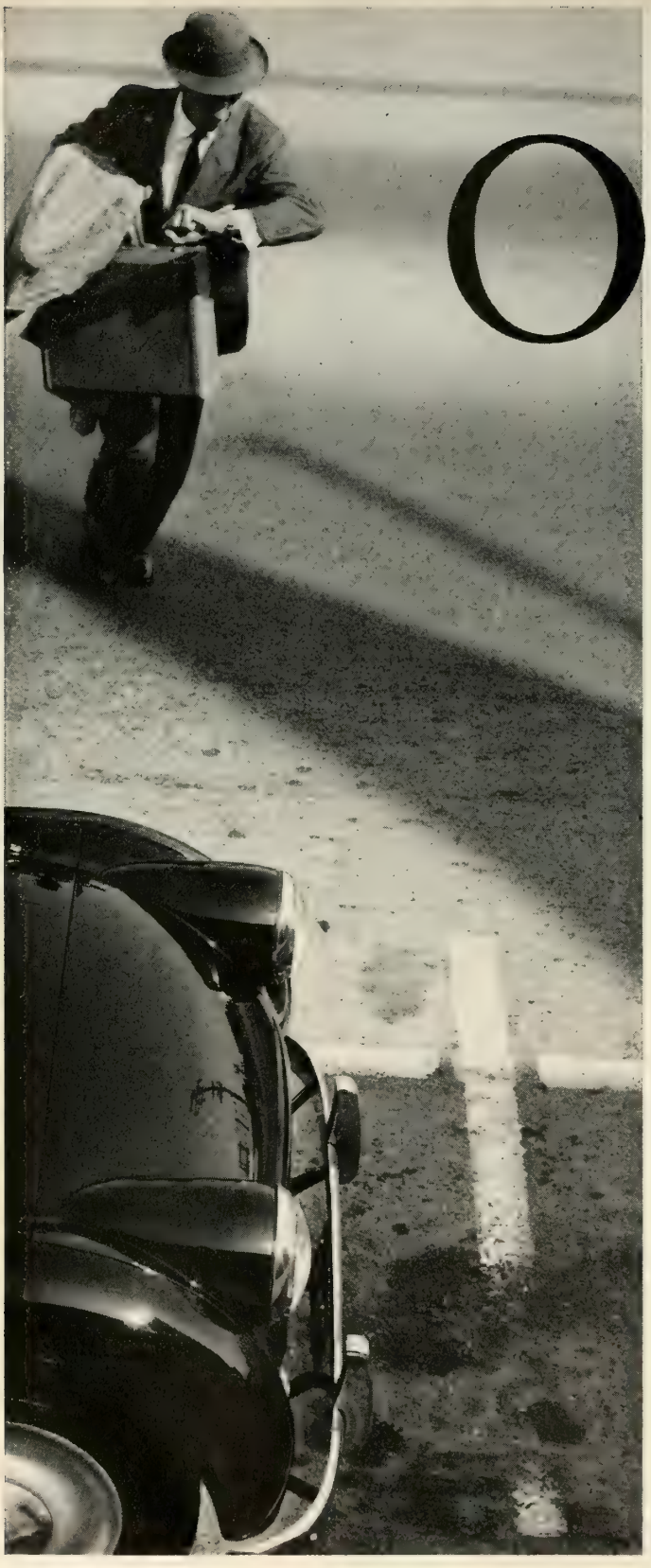
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Operations Research positions are now open at SDC's Lodi, New Jersey and Santa Monica, California facilities for scientists at several levels of experience. Please send your inquiry to Mr. R. W. Frost, SDC, 2414 Colorado Avenue, Santa Monica, California.

"Application of Computer Simulation to Production System Design," a paper by Allen J. Rowe, is available upon request. Send request to Mr. Rowe at SDC.

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THE MISSILE / SPACE WEEKLY

missiles and rockets

June 6, 1960 Volume 6, No. 23

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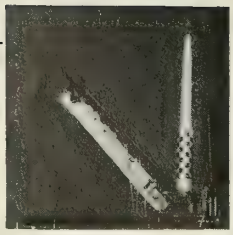
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THE COVER

Minuteman model rises on its transporter-erector, being developed by AMF and ACF industries. M/R was given an exclusive demonstration of its operation. See p. 40.

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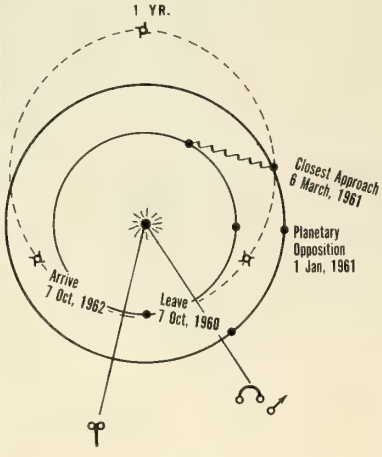
letters

Mars Probe Proposal

To the Editor:

In choosing flight trajectories for interplanetary probes, the formulation of mission objectives is generally so complex that a strict mathematical optimization process becomes hopeless. And even after locating what appears to be an acceptable orbit, it is usually worthwhile to explore nearby alternatives as well. One often discovers new factors which might provide a more desirable overall trip, even though it is not "optimal" in the strictest sense.

Reports appearing in the press and in many trade journals indicate that a Mars probe flight may be attempted this fall, about October 1, when the orbital positions of the earth and Mars combine to offer two local minimum-energy trip possibilities. The departure requirements for these particular trips indicate a speed of about 39,600 ft./sec. necessary for the shorter trip (about 209 days), and about 38,600 ft./sec. for the longer one (about 360 days).



If, however, the launching is delayed for about one week, then a number of orbits are available for which only modest increases in departure speeds over the minimum values will permit trips having several very desirable compensating characteristics: (1) short transit times to Mars, (2) the possibility of continuing unaided on a nominal orbit beyond Mars and eventually reaching earth again—that is, a nonstop round trip, (3) relatively short communication distances from launching until well after arrival at Mars*, and again for several months while returning to earth, (4) an approach speed back at earth which is low enough to encourage the attempted recovery of an instrumented package.

Nominal data for a typical such trip are as follows:

Departure date from earth, Oct. 7, 1960.

Date of closest approach to Mars, March 6, 1961.

Arrival at earth, Oct. 7, 1962.

Trip time on first leg, 150 days.

Total trip time, 2 years.

Departure speeds:

(a) Hyperbolic excess, 3.27 mi./sec.

(b) Equivalent ballistic launch speed at earth's surface, 40,500 ft./sec.

Relative asymptotic departure directions:

(a) Equatorial right ascension, measured eastward from the vernal equinox, 95°.

(b) Declination relative to equator, +37°.

Transfer orbit eccentricity, .37.

Semi-major axis, 1.6 A.U.

Inclination of transfer plane to ecliptic, +3°.

Aphelion/perihelion, 2.17 A.U./1.0 A.U.

Relative speed at closest approach to Mars*, 4.64 mi./sec.

Communication distance to vehicle at its closest approach to Mars*, 1.03 A.U.

Arrival speeds at earth:

(a) Hyperbolic excess, 3.27 mi./sec.

(b) Equivalent surface ballistic arrival speed, 40,500 ft./sec.

Although round trips involving either shorter travel times or lower relative speeds may be found, this particular orbit seems to strike an exceptionally harmonious balance among the various parameters associated with missions of present-day capabilities.

*We assume that the vehicle remains far enough removed from Mars that the trajectory is unperturbed by it (which may simplify the midcourse guidance problem). If the approach is closer, a minor correctional impulse may be employed to regain the nominal orbit.

Stanley E. Ross, Tactical-Strategic Systems
Missiles and Space Div., Lockheed Aircraft Corp.
Sunnyvale, Calif.

Post-Cycling Firings

To the Editor:

In the April 11, 1960 issue of "Missiles and Rockets," Page 35, there is reported the successful firing of a solid rocket grain at –68°F after repeated temperature cycling from –75°F to +165°F. Weight of the grain was not reported, but from the context one might assume it was a laboratory scale unit. It is further reported that prior to this firing "no really high-performance rocket motor had ever been made that could be fired successfully at low temperatures after temperature cycling."

Without detracting from this achievement, I should like to report that Olin Mathieson Chemical Corporation has successfully fired a number of high-perform-

ance, solid rocket engines after the engines were heated and cooled several times over the range of −65°F to +160°F. All of these engines were large enough to be operational. Most were prototype units weighing less than 500 lbs. But, to prove the point we have gone to much larger grains for a few firings. We would be glad to furnish more details to those interested. All firings, even those made at temperature extremes, were normal with no malfunctions due to the severe shock cycling conditions. The propellant used in each case was an inexpensive, easily processed fluid type, developed jointly by Olin Mathieson, Redstone's Ordnance Missile Laboratory Division, and Rohm & Haas Redstone Laboratories.

John D. Ireland, Huntsville Rep.
Olin Mathieson Chemical Corp.
Huntsville, Ala.

We'd like to ask both Olin Mathieson and Grand Central Rocket Co., which accomplished the firing reported April 11, to express in numbers what they mean by "high performance." We suspect the answers are classified.—Ed.

ARC Shares Credit

To the Editor:

In your April 18, 1960 issue you published a short description of the plastisol binder system for solid propellants developed at the Atlantic Research Corp. To avoid any misinterpretation of the facts, I would like to state that polyvinyl chloride resins produced by a number of different companies, among which is Union Carbide, have been and are currently utilized in this process. We acknowledge with thanks the assistance given by various resin, plasticizer, and other raw material suppliers who have cooperated with us in adapting and extending the plastisol concept for the manufacture of solid propellants.

M. G. Deffries, Solid Propellant Div., Atlantic Research Corp.
Alexandria, Va.

'Well Done' for Admiral

To the Editor:

I would like to add my congratulations, along with those of so many others, on the inauguration of your new ASW department. Perhaps your readers would be interested in knowing that Admiral Harry Sanders, your consulting editor for this department, has written a superb 1900-word article on "antisubmarine warfare—" for McGraw-Hill's forthcoming Encyclopedia of Science and Technology (publication scheduled for autumn of 1960). Admiral Sanders' article is one of the very best—and certainly one of the most important—articles which I had the pleasure of editing.

K. W. Perkins
Physical Science Editor
McGraw-Hill Encyclopedia of Science and Technology
Charlottesville, Va.

Due Credit to a Source

To the Editor:

Your coverage of optical instrumentation on Project DAMP (M/R April 18, p. 22) was excellent, but I wonder why you did not credit your source. Barnes Engineering Co. is prime contractor to ARGMA for optical and infrared measurements aboard the USAS American Mariner. This fact, plus the fact that you made liberal use of the DAMP Instrumentation Manual (to which I contributed) makes me wonder why due credit was not given to Barnes as well as other possible sources.

Robert E. Buckley, Head
Field Measurement Section
Barnes Engineering Co.
Stamford, Conn.

M/R did use the Barnes manual as source material. Omission of credit was an oversight—and not intentional—Ed.

AutoLite Article Pleases

To the Editor:

We have read your article on Electric AutoLite Company (M/R, April 25) and I certainly want to congratulate you on the very fine, well written article.

George Spaulding,
Director of Research
The Electric AutoLite Company,
Toledo 1, Ohio

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This interesting and unique position offers excellent opportunities for professional advancement. The Laboratory's suburban location allows staff members to select urban, suburban or rural living. Applicants must have a B.S. or M.S. in Chemistry or Chemical Engineering in addition to one or more years of experience, preferably in the liquid propellant field. Salary commensurate with experience. For detailed information, address inquiry to:

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When crews of SAC's 1st Missile Division successfully launched the USAF ICBM Atlas from Vandenberg Air Force Base, September 9, 1959, the world became aware that the United States had brought into being a formidable retaliatory power for peace. Within four months after the first operational launch, the Air Force doubly underlined this missile's capability. On a single day, January 26, 1960, the 16th and 17th consecutive successful Atlases were fired intercontinental ranges to predetermined targets from both Atlantic and Pacific bases.

After only five years of intensive development, including concurrent research, testing and fabrication under this nation's top military priority, Atlas is extremely versatile as well as powerful. It was the Project Score satellite vehicle and is scheduled for use in Project Mercury, the Man in Space Program, and in other space exploration missions. Thus, used as a booster for space projects, Atlas provides the nation with a key capability in scientific as well as military applications.

Space Technology Laboratories provides the systems engineering and technical direction for the Atlas as well as other portions of the Air Force Ballistic Missile Program. Much of what was learned in building Atlas has helped cut the lead-time in the development of such other Air Force Ballistic Missiles as Thor, Titan and Minuteman.

Among the industrial organizations which have worked in concert in developing Atlas are such major contractors as: Convair, Division of General Dynamics Corp. for airframe, assembly and test; General Electric Co. and Burroughs Corp. for radio guidance; Arma, Division of American Bosch and Arma Corp. for inertial guidance; Rocketdyne Division of North American Aviation, Inc., for propulsion; General Electric Co. for re-entry vehicle; Acoustica Associates for propellant utilization.

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The Countdown

WASHINGTON

Budget Battle (cont.)

Odds are considered good the Senate will follow the House in voting more money—over Administration objections—for the missile-packing B-70 bomber, *Polaris* submarines and possibly more *Atlas* ICBMs. Where the Administration and Congress stand on what DOD should be spending is reflected in the following FY 1961 funding breakout (in millions):

	Administration Request	House Passed
Samos	$199.9	$233.7
Midas	106.8	117
Discoverer	45.1	55.1

NASA's Slip Shows

Timetable for the *Mercury* man-in-space program is slipping badly. The manned ballistic test aboard a *Redstone,* originally set for early this year and subsequently re-scheduled for mid-summer, is now expected to take place in late fall. Manned orbital launch is at least 15 months away.

U-2 Nevermore

Very shortly NASA will disavow itself of all future connection with U-2 spy planes. As the "cover" for the craft downed in Russia, NASA suddenly found itself in an acutely embarrassing position with neutral countries upon whom the space agency is counting for tracking sites. Some of these countries have been made suspicious of NASA's "peaceful" aims by the U-2 incident.

Cobra Decision Nears

Both the Army and the Marines will decide within the next two weeks whether to buy the West German-made *Cobra* anti-tank missile. Both are on deadline for FY 1960 procurement—if they feel they need it. The Seventh Army in Germany in an evaluation fired 80 *Cobras,* some in competition with *SS-10s,* and had only two malfunctions.

Redstone Reorganizing

A reorganization is now underway at Redstone Arsenal in anticipation of the July 1 creation of NASA's Marshall Center (for the *Saturn* project). Delmar Morris, veteran Atomic Energy Commission administrator, is being transferred to handle the paperwork of the new center being headed by Dr. Wernher von Braun.

INDUSTRY

Power Contract Due

Look for ARGMA-Huntsville to award a contract soon on a 3KW-8MW DC power supply for a big new plasma-jet test facility. The facility, which will use World War II surplus generators from a destroyer escort, will permit the measurement of radar cross-section of missile models in high-temperature, high-velocity gas stream. One obvious application would be to pinpoint incoming missiles for *Nike-Zeus.*

STL-NASA Tieup

Chances are good, Space Technology Laboratories will form closer ties with NASA—when and if it severs its connections with Air Force BMD. STL already has developed payloads for such satellites Pioneer V and Explorer VI, to NASA's satisfaction.

On Mahogany Row

A merger is in the works between General Instrument Corp. ($41 million sales in 1959) and General Transistor Corp. ($10 million sales in 1959) . . . General Precision Equipment Corp. is combing operations with its principal subsidiary, GPE Controls Inc. . . . and Hughes-Fullerton has just established a computer lab with a staff of 600 persons.

Marketing Costs Soar

With the present rugged competition, Manager Jim Bowles of Ampex's Computer Products Division says marketing costs equal or exceed all technical costs for any company trying to break into the computer field. Yet, the market and the industry are growing rapidly.

On Pad Training

More than 40 SAC missilemen are now in training at Cape Canaveral on the Martin *Titan* ICBM. For the first time, on May 27, one of them acted as test conductor for a successful R&D shot of the *Titan* which is expected to be operational at Vandenberg AFB by the end of the year.

INTERNATIONAL

Hydrofoil Gap Next?

The Soviets are boasting that the U.S. is playing around with small 100-ton ASW hydrofoil ships while they already are carrying passengers up and down the Volga on a much bigger hydrofoil called the Meteor. Moreover, a Soviet source told THE COUNTDOWN the Russians are building an even bigger one called Sputnik which also will be river-going—not ocean-going.

Canadair Gets Research Rocket

Prime for the new Canadian research rocket—*Snow Goose*—is Canadair Ltd., Montreal. The contract involves both the design and environmental testing.

Maruca Pleases French

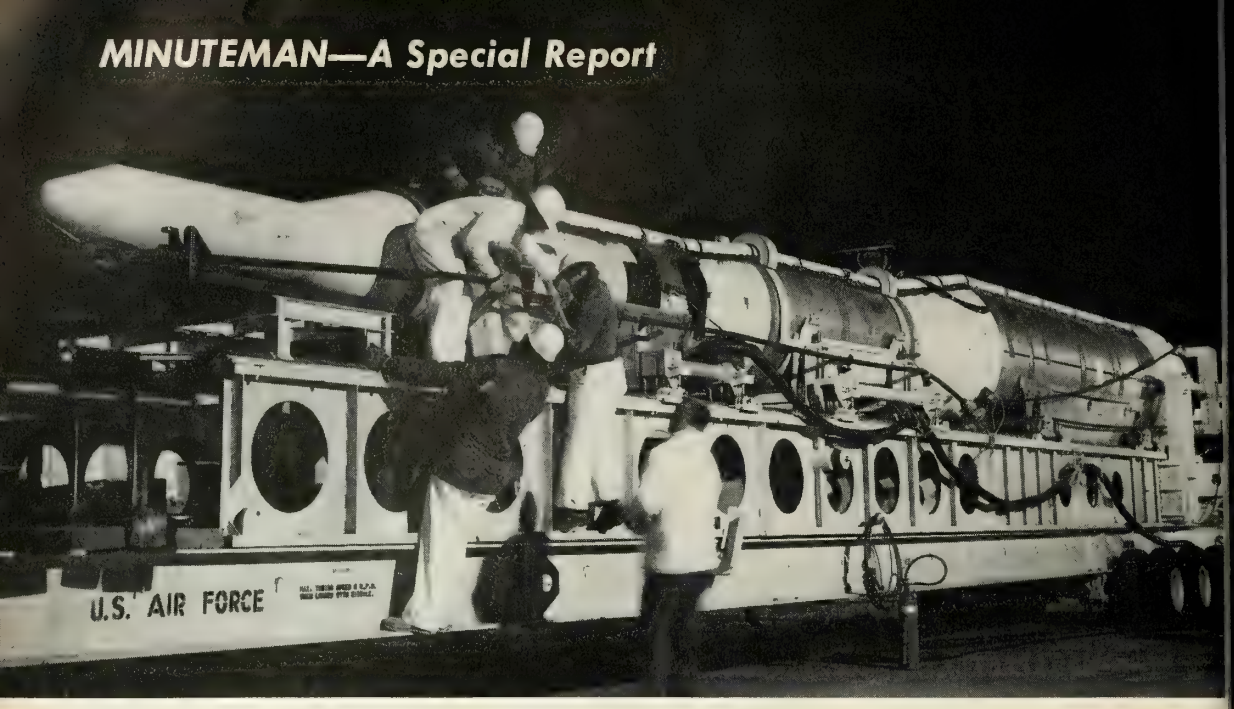
Fired from the bow of a ship, the French surface-to-air *Maruca* is reported to have hit a CT-10 target drone up to 10 miles away. The missile has four SEPR solid boosters and a nitric acid and aniline sustainer.

NATO Eyes Mauler, Redeye

Some of the NATO countries are expected to buy the Convair *Mauler* and *Redeye* battlefield missiles. Convair recently stepped up its European sales activities for missiles. There is also speculation that Thiokol will receive the propellant contract for the antimissile/aircraft *Mauler,* soon to go into production.

Man Over Instrument

I. Shevlyakov, a Moscow Planetarium official, writes in Pravda that the Soviet space program is now based on the theory that "automation will never be able to replace man completely in space."



ON EXPERIMENTAL TRAILER, operational configuration *Minuteman* is readied for silo test shot.

600 on launchers by '65

Huge Minuteman Buildup Starts

by James Baar

Air Force plans for the *Minuteman* ICBM today call for the greatest and fastest missile buildup in military history beginning in mid-1962.

Informed sources make clear that the Air Force is preparing to:

• Scatter some 450 *Minutemen* in hardened silos across the continental United States—ready to be fired in less than a minute.

• Deploy some 150 *Minutemen* on 50 missile trains that will roam more than 80,000 miles of the nation's railroad network.

All apparently can be on their launchers ready to fire by the end of 1964 at the latest—if present schedules are met.

The total number of *Minutemen* involved—some 600—equals all the *Atlas, Titan* and *Polaris* missiles for which the Administration has authorized deployment or has announced plans to authorize deployment.

The advent of *Minuteman* will tip for the first time the balance of SAC's forces in favor of missiles rather than manned bombers. The missile will be king.

Cost estimates vary widely. However, many Air Force officials do not expect the total *Minuteman* price tag to exceed $2 billion at the most.

This figure is based on an estimate of about $2.4 million for each *Minuteman* in the ground and $4.8 million for each *Minuteman* on a train.

Plans call for deploying silo-based *Minutemen* at previously unheard of speed. At the peak of the buildup, 50-missile *Minutemen* squadrons are expected to become operational at a rate of one a month.

The Air Force's *Minuteman* program, as detailed in this comprehensive report, promises to be the nation's largest missile effort in the '60s. To obtain all the information available about this undertaking, M/R editors interviewed scores of project officials at the Pentagon, the Air Force's Ballistic Missile Division and the major contractors, including Boeing Airplane Co., Thiokol Chemical Corp., Aerojet-General Corp., and American Machine & Foundry.

The buildup of missile trains will be slower, but still very rapid. At its peak, plans call for deploying as many as four or five trains a month. Each will carry three or possibly five *Minutemen*.

The first silo-based *Minutemen* are scheduled to become operational at Malmstrom AFB near Great Falls, Mont., in mid-1962. The first train-based *Minutemen* are scheduled to be operational about six months later.

• **Men at minimum**—The *Minuteman* will be the closest that man has ever come to the science fiction nightmare of pushbutton war.

Unlike all other U.S. strategic missiles, silo-based *Minutemen* will not be manned or even guarded except through remote controls.

Each of the approximately 60-ft. *Minutemen* will be deployed in simple underground shafts topped by huge concrete hatches weighing more than 10 tons. Nearby will be a locked manhole cover that will lead to a checkout console, but not to the silo itself. Each silo and checkout shaft will be situated somewhere in a two-acre site that will

be surrounded by a high steel fence.

That is all: No guards. No missilemen. No buildings.

The missile will be launched by two officers stationed in an underground launch control post miles away. Security guards located at the launch post will travel by helicopter to a *Minuteman* site if detection alarms signal that unauthorized persons have entered the area.

"That cover is built to withstand an H-bomb blast," one man closely associated with the program has said. "It won't be easy to pry open even with the help of a little dynamite."

Nor does the checkout room pose any threat to the missile. The room will contain only a checkout console for identifying trouble areas. It will not give access to the silo.

One launch control post will launch 10 of the approximately 50 missiles in each squadron. However, any one of the five launch control posts in a squadron will be capable in an emergency of launching all 50 missiles.

• **Pullman accommodations**—To date no firm decision has been made on how many missiles each train will carry. The figure varies from three to five, depending upon strategic requirements and cost. Each mobile *Minuteman* squadron will be comprised of 10 trains.

The trains will have eight or more cars: A launching car for each missile, one or two power cars, a communications car, a launch control car and several Pullmans for the missile crews.

The trains will move in apparently random patterns along nearly half of the nation's railroad network, stopping periodically at preselected sidings. Special gyrocompasses developed by Autonetics will enable the missilemen to pinpoint their position for launching their *Minutemen*. However, the missiles could be launched from any position along the right of way with less accuracy.

The Air Force is considering two plans for moving the trains from siding to siding. Under one, engines with regular trainmen would be permanently assigned to a train. Under the other, missile trains would "hitch-hike" by prearrangement: The missile train would be attached to passing passenger or freight trains.

The "hitch-hike" system would be cheaper, but it has the obvious drawback of not keeping an engine available at all times. Probably both systems will be used.

The groundwork for the deployment of *Minutemen* will begin this winter with two important events:

• The first *Minuteman* fully-powered test missile is scheduled to be

ICBM 5-Year Plan Today

ATLAS

Total squadrons	13
In soft and semi-soft sites	7
Hardened	6
Sites announced	11
(Warren AFB, Wyo., has 3 squadrons)	
Missiles per squadrons	6 in the first
	9 in each of next six
	12 in each of last six
Total missiles	132
Number operational	about 8

POLARIS

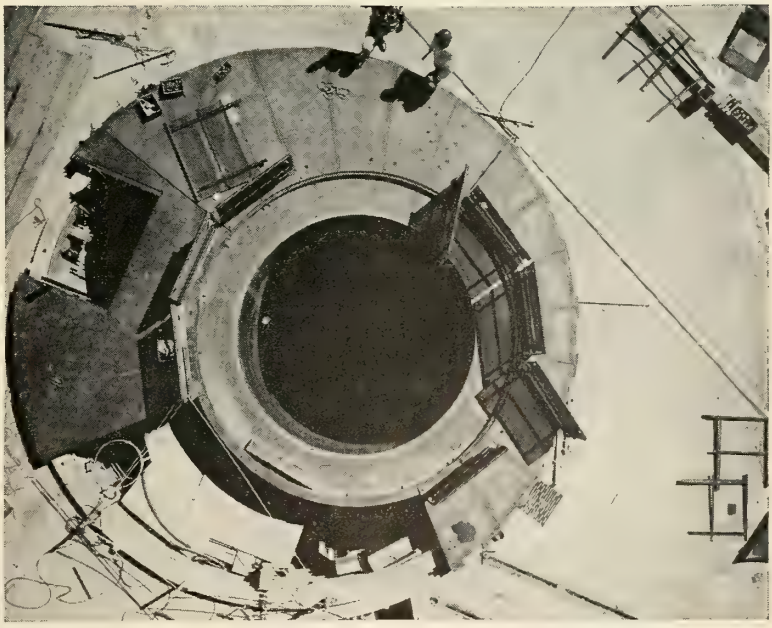
Total submarines	21
Ships built, funded or to be funded	12
Long-lead items only	9
Missiles per submarine	16
Total missiles	236
First operational	Fall 1960

TITAN

Total squadrons	14
In hardened sites	14
Sites announced	7
(Three have two squadrons each)	
Total missiles	126
Missiles per squadrons	9
Total missiles	126

MINUTEMAN

Total squadrons	about 14
In hardened sites	9
On trains	about 5
Missiles per silo-based squadron	about 50
Missiles per train-based squadron	30 to 50
Trains per squadron	10
Total missiles	about 600
First operational	Mid-1962



LOOKING INTO one of the *Minuteman* test silos at Edwards AFB from which silo development test models of the ICBM were fired in a program now completed.

launched from Cape Canaveral in December.

• The first construction contract for the first 50-missile *Minuteman* squadron of Malmstrom is scheduled to be let in January. Construction for the squadron is expected to take 15 to 18 months to complete.

Test launchings from the Cape may average as many as four a month between January and mid-1962 when the first *Minutemen* are scheduled to be deployed at Malmstrom.

Meantime, a series of six missile train tests will begin June 20 on the railroad lines around Ogden, Utah. Fourteeen railroads are taking part. Later tests will begin at Des Moines, Iowa.

The railroad tests are designed to work out communications systems and other operational matters. The test train commander will be in radio communication with Hill AFB at Ogden and the SAC Command Post at Offutt AFB, Neb. No missiles will be carried aboard the train in the initial tests.

Minuteman Statistics

Stages	3 plus warhead
Propellant	solid
Guidance	all inertial
Height	about 60 ft.
Weight	about 160,000 lbs.
Booster diameter	about 10 ft.
Range	more than 6300 statute miles
Speed	more than 15,000 mph
Payload	nuclear

The *Minuteman* program officially got under way in 1957. However, two years earlier the Air Force Ballistic Missile Division began laying the basis for the program by opening a small office for studying possible solid-propellant weapon systems.

The Air Force concept for the *Minuteman* called for several major developments along with numerous improvements that would be beyond anything that had been done before:

• The missile would be fired directly from an underground silo rather than ejected like the Navy's *Polaris* from a submarine. This has the advantages of cheapness and simplicity. But many doubted that a missile could live in the blazing environment that would be created in the silo as soon as the missile was ignited.

• The missile would use the biggest solid-propellant motors ever built.

• The missile would be steered by swiveling nozzles rather than jetavators similar to those used by *Polaris*.

• The missile would be test-launched from the beginning from Cape Canaveral.

• The first mission to be test-launched from Canaveral would be all-but-operational prototypes. Previously all large missile programs first called for launching something less than an operational prototype.

The silo launchings which began last fall were immediately successful and the number of tests was cut from 18 to seven. Time also was saved in

Much of Advanced Minuteman Testing Shifte

Major portions of the advanced testing of the Air Force's *Minuteman* ICBM have been shifted from Edwards AFB in California to the Atlantic Missile Range in Florida. Initial shipment of *Minuteman* rocket motors for checking out launch facilities have already been received at Cape Canaveral, and flight tests of the solid-propellant missile are expected to begin late this year.

Tests at AMR will include launching from both silo and railway car facilities. Meantime, Air Force personnel at Edwards will conduct tests to check out destruct systems, motor reaction to fire, and such things as bullet holes. Individual engine tests will also be done at Edwards.

The missile will be assembled at AMR in a building now under construction. This phase will differ from normal final assembly in that test instrumentation will also be installed at AMR.

• **Testing**—The Boeing plant in Seattle will do much of the systems testing for integration and compatibility; the program is currently under way. A full-scale silo will be built, as well as a rail spur. The first prototype rail command car has arrived at the Boeing plant for installation of electronics equipment.

Space performance of the *Minuteman* motors will be tested at the Arnold Engineering Development Center in Tullahoma, Tenn. Pre-Flight Rating Tests (PFRT) on the motors are also due to begin shortly.

Flight proof tests of the guidance system are secheduled in the near future at Autonetics and at Holloman AFB, N. M. Some testing of guidance components has already been carried out on rocket sleds at Holloman, and further tests are scheduled—including a test soon of a complete prototype guidance system.

Subsystems testing by contractors is increasing in tempo. Test activity at Vandenberg AFB is expected to be in high gear by the end of 1961, with a dual purpose: in addition to providing the same emergency war capability represented by the *Atlas* and *Titan* pads at Vandenberg, final system demonstration of *Minuteman* will be carried out there, culminating in actual firings both from a silo and railway car. The latter procedure will take advantage of the Southern Pacific Railroad tracks which run through the California base.

In addition to these, the Strategic Air Command will train its *Minuteman* launch crews at Vandenberg, as is now done on other large ballistic missiles.

• **Cut-grain shots cut**—One of the drastic slashes made in the test program came with the reduction of cut-grain silo test shots from 18 to eight. This was due to extreme success achieved in the launches. The primary objective of these silo launches was first to check out the silo configuration (depth, diameter, wall thickness, etc.) and the effects on the missile itself. By the end of the seventh such test, the Air Force found that it had either solved all the problems which it had expected, or had found them insignificant. The program was then terminated after the eighth test.

Before attempting the first full-scale silo shot last Sept. 15, the Air Force and Boeing conducted 5200 sub-scale tests with 1/30 and 1/20 scale models at Edwards and Seattle. These consisted of about 3800 cold flow tests and 1200 hot flow tests to determine pressures. The remaining tests were used in studies of acoustics, heat dissipation, and other parameters.

Following these low-cost studies, tests were carried out on 1/3-scale models placed in horizontal simulated silos.

As seemingly simple an item as a silo presented all sorts of theoretical problems during the program, mostly in the area of hot exhaust gases. It was widely feared that these would cause great damage to the missile, and that a "W" or "U" shaped silo would be needed to expel the hot gases. Air Force decided, however, to put a simple hole in the ground, fire the missile and see what would happen.

The result was that a simple hole in the ground proved adequate.

the achievement of early successes in the testing of various components. The overall result was that a year could be cut from the program and the operational date was moved to mid-1962.

Problem areas still remain before the first launching in December—particularly the perfection of the nozzles and the attainment of sufficient consumption of propellant. However, people associated with the program feel certain that the present schedule will be met.

Two major arguments are being put forth in support of making *Minuteman* America's major deterrent weapon in the 1960's. One is *Minuteman's* low cost. The other is its relative ability to survive a nuclear attack even when deployed in hardened fixed bases.

• **Cost trend reversed**—Since the beginning of the Missile Age, the cost of ground support equipment for missile systems has steadily increased. For the first time, the trend will be reversed with *Minuteman*.

The Air Force contends that construction and all ground support equipment for one 50-missile *Minuteman* base will cost only $20 million. The figure is astounding. Construction and ground support equipment for one nine-missile *Titan* base, for example, costs about $80 million. A *Polaris* submarine which is capable of launching 16 missiles costs about $100 million.

So far, an estimated half-billion dollars has been made available for the *Minuteman* program. The Administration has requested another $415 million for FY 1961— about $300 million for R&D and the rest for procurement.

Using Air Force figures, another $1 billion or so will be needed to complete the program and deploy the missiles in fixed sites and on the more costly trains.

• **Destruction-proof?**—The argument for the relative invulnerability of the *Minuteman* systems is based on what it would cost Russia to destroy them in a nuclear attack.

Successful random bombing of the railroad network with Soviet ICBM's would call for a Soviet striking force of 10,000 to 20,000 missiles. A successful attack on the fixed *Minuteman* sites would call for many thousands more unless the Soviets are capable of making a major advance in their guidance systems.

Finally, the Soviet problem can be made even more difficult by the building of cheap decoy *Minuteman* sites.

The conclusion of the argument is that train-based *Minutemen* are all but impossible to wipe out and silo-based *Minutemen* will put the United States in the strategically desirable position of having a deterrent weapon that is far cheaper to build than for Russia to destroy.

Nothing marks the changing composition of SAC and the Air Force so much as *Minuteman*.

Present plans call for the deploy-

o Canaveral



HOT LAUNCHING OF ***Minuteman*** **begins in the silo and the specially painted bird must fly through its own flames. (1) Artist's conception of silo; (2) Flame appears first at Edwards AFB tethered launch; (3-4) Missile fires, is yanked back.**

ment of a total of 258 *Atlases* and *Titans*. This, added to the some 600 *Minutemen* now planned, will bring SAC's total force of ICBM's to about 850—more than SAC's combined bomber fleets of B-52's and B-58's.

The *Minuteman* will be complemented with the Douglas *Sky Bolt*—the 1000-mile-range air-launched ballistic missile. These will unquestionably be deployed not only on bombers but even more likely on tankers and transports.

And, finally, the *Minuteman* program may be expanded beyond 600 missiles to a total nearer the 1200 expected last year.

Minuteman and her sister missiles —not bombers—will be SAC's major weapon.

TURN TO PAGE 39 . . .
for more of the *Minuteman* Special Report, including articles and pictures on the rail launcher, propulsion system and contracting.

Tiros Rockets Fired After 56 Days in Orbit

Two tiny rockets on the *Tiros* weather satellite have shown it is possible to ignite and fire rockets by ground command successfully after they have orbited the earth for more than 56 days.

The solid-propellant rockets, manufactured by Atlantic Research Corp., were ignited on command from Ft. Monmouth, N.J., May 27 during *Tiros'* 819th orbit, so as to increase the satellite's rate of spin.

The satellite must be kept spinning at a rate of 9 to 12 rpm to maintain stable orientation. Three pairs of the Atlantic Research rockets were installed on the satellite to maintain the rate. It was expected when the satellite was launched April 1 that the spin rockets would be fired every 20 days to overcome slowdown resulting from magnetic drag.

However, it was not until May 27 that the spin had slowed to 9.4 rpm. This would indicate that the satellite will have a useful life longer than the three months originally planned. After launching its perigee was 435 miles and its apogee was 468 miles. Now they have fallen to about 433 and 465 miles.

The spin rockets each produce 5 lbs. of thrust for 0.3 seconds. After they were fired, the spin rate was 12.85 rpm.

When the satellite was launched, somewhat larger rockets spun up the third stage to 136 rpm to maintain a stable trajectory. But when the payload was separated from the third stage, the spring mechanism reduced the rotation to the required rate.

Irvine Proposes Single Service, Top Planning Group

Lt. Gen. C. S. ("Bill") Irvine, retired, former deputy chief of staff materiel, USAF, and now a vice president of Avco Corp., last week advocated a single service "National Defense Force" as a solution to the nation's military problems.

Speaking before the Purchasing Agents Association in Los Angeles, Gen. Irvin declared that accelerated technology has completely outmoded our traditional military concepts. Science, he said, has pushed us well beyond the time when the land, sea and air mediums of the present organization represent a realistic appraisal of modern and advanced military procedures and objectives.

A National Defense Force would, he said, "provide operational and logistical flexibility so that the Secretary of this Defense Force could assign military missions to appropriate commands and know that reasonable compatibility and capability existed. It would help eliminate duplication and parochial rivalry."

It would also, Irvine declared, permit a 50% reduction of present DOD personnel and then "the 50% of the military in the Pentagon headquarters that spend their lives in frustrating coordination could then return to operations or logistics with the combat forces."

The former Air Force officer also called for closer cooperation between government and industry, championed the incentive-type contract and suggested a Defense Planning Group whose members would include top civilian and military scientific and DOD procurement officials.

• **Cost of mediocrity**—Recognizing that incentive-type contracts are frequently criticized as non-competitive, he declared:

"Such contracts have to be premised on the soundest target estimates relating to cost performance characteristics, reliability criteria and time of availability. Incentive payments should be made only when these targets are fairly surpassed.

"These estimated targets should be set up in a most ambitious manner. Then if better management or better engineering results in superior performance, better than marginal reliability, time savings or cost reductions—the incentive is earned. Cushions are for the weak at heart. And we cannot afford mediocrity, even if it comes from our own home town."

Gen. Irvine pointed out the cooperation between the Air Force Ballistic Missile Division and industry as an excellent illustration of good military-industry relationship and team effort.

• **For more brain power**—"I am suggesting here," said the General, "that we have within the defense establishment a legally constituted board, authorized by Congress and integrated within the total defense procurement setup, to plan, recommend and direct specific actions regarding weapon system research, development, procurement and production.

"Such a group would serve a dual purpose. It would provide the needed input to the Government on what industry anticipates in the way of breakthroughs or potential applications of new knowledge. In addition, it would enable the Government to use some of our top brainpower, not now being gainfully applied, to the best interests of the nation.

"The people chosen from the industrial side should not be in an active management of corporations. Rather they would be highly knowledgable men who are the recently retired senior management people and no longer associated with specific companies but with broad knowledge of our industrial and scientific activities.

"Such an approach would enable the military services in general to stay abreast of technical advancements and of major breakthroughs. On the other hand, it would enable the industrial forces to see immediate potential applications of every new discovery. The promising results of such an effort would be obvious."

—news briefs—

ROCKET STRIKE ORDERED—Soviet Defense Minister Malinovsky said he has ordered missile forces to strike any base which any surveillance plane might use to violate Russian air space. At the same time he boasted that Soviet antiaircraft rockets "are able to hit targets not only at an altitude of 20,000 meters but much higher."

SAMOS-MIDAS PADS READY—The Navy has completed the two *Samos-Midas* surveillance satellite pads costing $6 million at the Pacific Missile Range's Point Arguello. They will be used for polar orbits (see M/R, Dec. 28, '59, p. 13).

DOD Defends Incentive Contracting with Figures

Detailed evidence has been handed a Special House Armed Services Procurement Subcommittee by DOD to prove the dollar worth of incentive contracting. The information is intended to head off legislation introduced by Chairman Carl Vinson (D-Ga.) to curb the use of these contracts.

Figures given the subcommittee show "under-runs" of $219,703,000 on $6,316,528,000 worth of Air Force incentive contracts negotiated between 1952 and 1959. An under-run is the difference between the estimated production costs and the target price negotiated by DOD and the contractor. Normally savings are shared on a basis of 20% to the contractor and 80% to the government.

There were some over-runs turned up in the incentive contracts studied, but the overall average showed Air Force contractors' prices running 3.5% below the target price. The Navy figures show an average of 2.7% under-run on $2.5 billion worth of business.

G. C. Bannerman, director of DOD procurement policy, told the subcommittee that the percentages give an incomplete picture of total savings. He said savings realized when the prices fall below the legal "ceiling price"—as distinguished from the target price—do not show in the statistics.

The Air Force revealed that the Lockheed Marietta division experienced a $67,842,000 under-run on two contracts totaling $211,294,000 or 24.3% below target. Lockheed's Burbank division experienced a $2,851,000 under-run on 11 contracts worth $124,587,000, or a 2.3% under-run.

Convair, San Diego, experienced a $15,210,000, or an 11.5% under-run, on a $132,124,000 contract. Boeing Airplane Co.'s Seattle division had .9% over-run on a series of contract worth $837,120,000, but its Wichita division experienced a 6.9% under-run on 12 contracts valued at $1,417,309,000.

On a group of six contracts, Douglas Aircraft Co. had an under-run of $1,343,000 on a $6,968,000 total. A $6,457,000 under-run on a $57,432,000 contract was credited to Fairchild Engine & Airplane Corp., Hagerstown, Md.

General Electric, Evandale, O., had a $1,386,000 under-run on a $35,895,000 contract. A $9,965,000 under-run on three contracts totaling $337,959,000 was attributed to Martin Co., Baltimore. McDonnell Aircraft Corp., St. Louis, has a $3,377,000 under-run on a $100,129,000 contract.

The Air Force said North American Aviation, Los Angeles, experienced a $13,210,000 under-run on $637,649,000 worth of contracts, while its Columbus, Ohio, division had a $6,171,000 under-run on a series totaling $168,367,000.

Northrop Corp. had a $7,098,000 under-run on four contracts valued at $209,851,000. A $1,482,000 under-run on seven contracts totaling $946,665,000 was credited to Republic Aviation. Temco Aircraft Corp., Dallas, had a $383,000 under-run on a contract for $8,609,000.

UTC Gets NASA Award For Conical Solid Engine

United Technology Corp. has received a National Aeronautics and Space Administration contract for a feasibility study of a conical-shaped solid rocket engine. UTC will design, fabricate and test three experimental motors under terms of the contract. The sum involved was not disclosed.

Russian Press Denies Sputnik IV was Manned

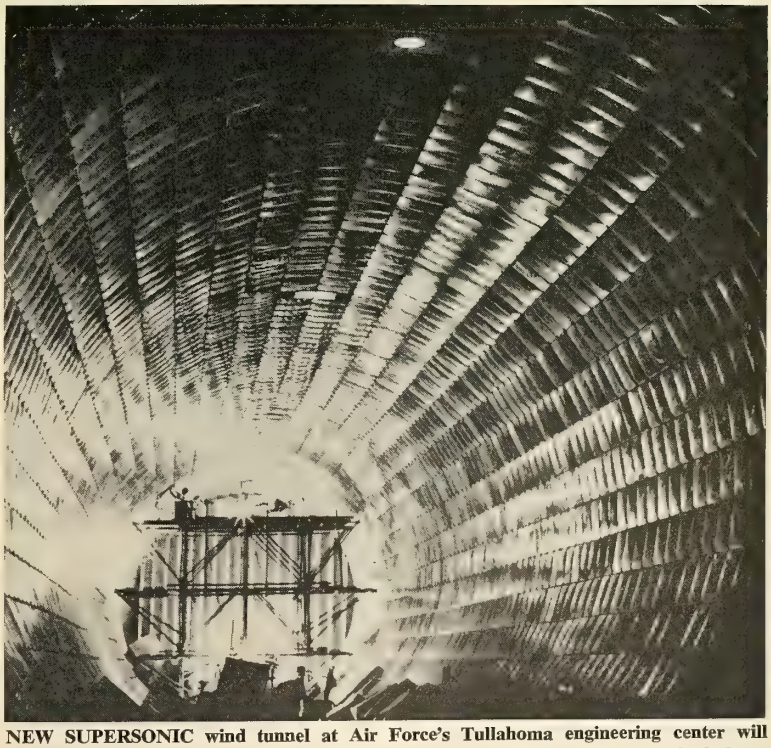
The Soviet press claimed recently that the *Sputnik IV* space ship's life support system functioned satisfactorily. But it denied that the vehicle was manned.

Prof. V. B. Parinyy of the Soviet Academy of Medical Sciences, in an article in Trud, May 17, denied rumors that the craft had a man aboard. He said no manned flights would be scheduled until there is confirmation of conclusions drawn from the *Sputnik II* experiment with the dog Laika.

A Tass wire service article appearing in Izvestiya May 21, said *Sputnik IV* produced these results, among others:

- The launching and orbiting equipment of the carrier rocket was proved to be reliable and accurate (this contradicts CIA reports that one of these boosters may have blown up at launch).
- Reliable guidance and orientation was achieved for several days.
- Necessary conditions for manned flights were maintained throughout.
- Retransmission of voice messages was noisy and greatly distorted.

Tullahoma's New Tunnel



NEW SUPERSONIC wind tunnel at Air Force's Tullahoma engineering center will create temperatures up to 650°F and noise levels to 155 decibels. Walls of 1790-ft.-long, 27-to-62-ft.-diameter tunnel were made of thousands of 24 x 24 x 2 in. stainless steel panels covered with glass fiber cloth, many of them formed in a deep-drawing process by McDowell Mfg. Co., Pittsburgh.

Saturn Vibration Not a Big Problem

First tests by ABMA damaged stand and snapped rivets on booster, but troubles are less than expected

HUNTSVILLE, ALA.—First tests of the *Saturn* booster and its static test stand show that vibration is a problem but engineers say it is not a major one.

Karl Heimburg, director of testing for the Army Ballistic Missile Agency group directing the clustered rocket, reported that the second and third tests of the eight-engine cluster shook bolts loose on the stand. Others said that some rivets were snapped on the missile itself.

Heimburg said he originally planned ned the third test May 26 for 50 seconds but cut it back to 35 seconds after inspecting damage to the stand from a 26-second test the previous week. He said the bolt holes would be changed to slots in heavily vibrating areas of the stand.

Another problem is distribution of the water used to cool the stand, Heimburg said. Even though 40,000 gallons are sprayed across the big flame deflector during each minute of testing, some spots still are not cooled enough. As evidence, Heimburg showed visitors a crazy-quilt pattern of paint on the deflector after the May 26 firing—painted spots cooled sufficiently and rusty spots needing more cooling.

No such problem was encountered in the first eight-engine test late in April, which ran 8 seconds. But the cluster was run for 26 seconds on May 17. It was then that the vibration trouble began.

Nevertheless, Heimburg declared that progress to date is encouraging. "We anticipated more trouble," he declared. "We are considerably more optimistic now."

To reduce the possibility of vibration buildup at the start of burning, the engines are ignited by twos. In the third test, the ignitions were programmed 300 milliseconds apart. The first two pairs were the interior engines. They cut off by fours, 200 milliseconds apart. The timing is controllable to a tolerance of 100 milliseconds.

• **Added assurance**—In the first test of 8 seconds, the engines were ignited in fours. It was switched to twos for the second test. They were programmed 150 milliseconds apart but the intervals averaged 100 milliseconds in the firing. To provide assurance, the interval was increased to 300 milliseconds in the third test.

Hans G. Paul, director of propulsion and mechanics for the ABMA group, which will be transferred to the National Aeronautics and Space Administration July 1, said Rocketdyne will deliver engines by midsummer for the second *Saturn,* which will be the first flight vehicle. Some work is already in progress on construction of the flight vehicle. Heimburg said the flight vehicle will be static tested at Redstone before the end of the year and flown from Cape Canaveral in 1961.

In early tests, including the 1961 flight, the individual H-1 engines will run at 165,000 lbs. thrust, making a total of 1.32 million lbs. By 1962, Paul said they will be uprated to 188,000 lbs. to bring the total to the planned 1½ million lbs.

Paul emphasized that individual engines on hand at Redstone Arsenal have already been run at 188,000 lbs. thrust. But they are being held down, Paul says, "because we want to prove that clustering will work—not that the H-1 will run at 188,000 lbs."

The improvement in the turbopumps—mainly the use of a stronger alloy—is the same as what was done to lengthen the range of *Atlas* and improve the *Thor* for space missions. However, the H-1 does not have the fiber glass wrapping around the thrust chamber that was used to lighten the *Atlas* booster. H-1 retains the steel bands used on earlier engines.

"The reason is primarily reliability," Paul said. "Each change is always a risk and the weight saving is not so important to us. The *Saturn* booster is not so weight sensitive. In upper stages, this is a different matter."

If the fiber glass wrapping develops a long history of reliability, Paul said, it is possible it will be used on later *Saturn* versions a few years from now.

The propulsion specialist declined

Rocketdyne to Power Saturn Top Stages

Rocketdyne Division of North American Aviation—the apparent low bidder—was chosen to develop the 200,000-lb.-thrust hydrogen-LOX engine that will power upper stages of later versions of the *Saturn* vehicle.

The National Aeronautics and Space Administration estimated development of the new engine under Rocketdyne's bid of $44 million will take about three years. (Two of the other major bids were Aerojet-General Corp. —$60 million and Pratt & Whitney—$80 million.) Design and qualification of the engine will take about four and one-half years.

At the same time, NASA disclosed a possible change in previously announced plans for an 800,000-lb.-thrust second stage for *Saturn.* The NASA statement said the 200K engine might be used in clusters of either two or four.

Whichever cluster is chosen for the new second stage will be inserted between the first and second stages of the *Saturn* C-1 vehicle. That vehicle consists of the eight-engine *Saturn* cluster as booster, the 80,000-lb.-thrust Douglas S-4 as second stage and a slight modification of the Convair *Centaur* as the third stage. The Pratt & Whitney LR-115 liquid hydrogen-LOX engine powers both the S-4 and the modified *Centaur,* which is designated S-5 in the *Saturn* system. There are two LR-115's in the *Centaur* and four in the S-4.

Latest NASA calculations show that the *Saturn* C-1 configuration will be capable of putting 25,000 lbs. in orbit or accelerating 9000 lbs. to escape velocity. The contract-award aannouncement said that the insertion of a 400,000-lb.-thrust second stage would increase payloads by 50% and an 800,000-lb.-thrust stage would double them.

No time schedule was announced for decision on which stage would be developed. There remains, of course, the possibility that both stages will be developed. The optimum payload with a *Saturn* booster would be realized with an 800,000-lb. second stage, a 400,000-lb. third stage and the S-4 and *Centaur* atop these to make a five-stage vehicle.

There is also a possibility that stages based on the new 200K engine will be used in *Nova,* the liquid-propelled vehicle based on the Rocketdyne F-1 engine, which is to follow *Saturn.* However, decisions on the nature of the *Nova* vehicle are several years away.

Altogether, five companies bid on the 200K contract. In addition to Rocketdyne, they were Aerojet-General, Pratt & Whitney, General Electric and Bell Aircraft.

to say what variation in thrust had been noted among the eight engines on early tests. Variations of a few hundred pounds one way or another are not important at this stage of the game, he said. The guidance allows for an error of up to 3% in the thrust of individual engines—that is, the error can be corrected by guidance if the thrust of an individual engine varies by less than 3%.

Even if an engine should fail completely after igniting, he said, almost all of the propellant will be routed to the other engines. Only the small amount needed to provide a head to the fuel pumps in the dead engine would go to waste.

• **Small starters**—Rocketdyne reported that the H-1 engines used small solid-propellant motors as starters. The start engines are produced at Rocketdyne's Solid Propulsion Operations in McGregor, Tex.

Each starter uses about 6 lbs. of a low-cost ammonium nitrate propellant, which supplies 1500 horsepower for one second. When the starter is ignited, its exhaust spins the main engine's fuel and LOX turbopumps up to 5000 rpm and simultaneously the flame ignites the converging propellant streams in a bootstrap operation.

Rocketdyne said the solid-propellant units, originally developed and tested in an experimental engine for the *Thor* missile, were later applied to the MA-3 *Atlas* engine and the H-1. They have achieved a reliability of 99.6% and have resulted in weight savings of 120 lbs. on large liquid engines, the company said.

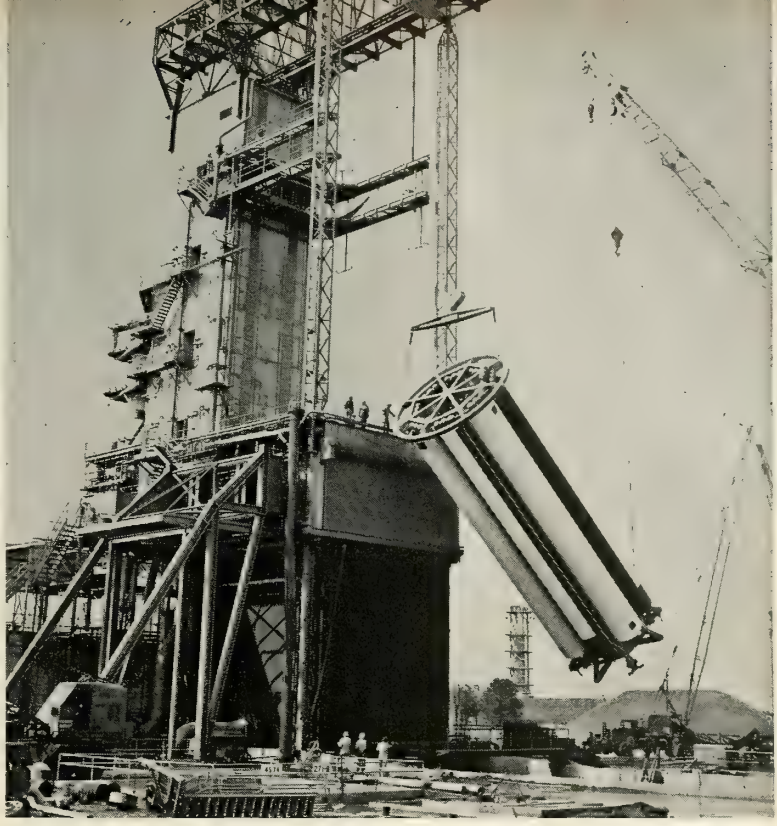
The most important changes in the H-1 engine are in the direction of simplicity, Rocketdyne said. The H-1 has less than one-tenth the number of major components that were used in engines for *Jupiter*, *Thor* and *Atlas*.

The May 26 firing was the first to which the press was admitted. About two dozen newsmen and photographers watched from a hillside 2200 feet from the old *Jupiter* test stand at Redstone, which has been modified for tests of the *Saturn* cluster.

A blown fuse in an instrument recording nitrogen purge of the LOX dome caused a 4½-minute hold less than a second before the countdown reached zero. Recheck showed the purge itself was operating properly.

A thunderstorm had drenched watchers a few minutes before but the rain stopped in time for viewing. Heimburg said the firing would have gone on regardless of the weather. The rain resumed 10 minutes after the firing, while some of the visitors were atop the tower.

Because of the low cloud ceiling, the sound volume at the observation point was greater than in the two previous tests. A volume of 126 decibels was recorded, one above the level at which medical men say discomfort normally begins for humans. Heimburg said 140 decibels is a danger level above which no one should subject himself without first taking a physical examination. The ground at the observation point vibrated more than the street above a subway train.



BIG LIFT of *Saturn* booster onto test stand at Redstone Arsenal preceded current series of static tests. Men give indication of rocket's size.

The visible flame appeared to be about 125 feet long—about 50% longer than the booster itself. The measured time was 35.16 seconds. During that time, 820 measurements were made. These included 360 of pressure, 185 of temperature, 40 of flow rate, 55 of force and strain, 60 of vibration and 120 miscellaneous.

• **New stand sought**—In another development, the NASA group at Huntsville, which on July 1 will be designated the George C. Marshall Space Flight Center, announced that bids have been requested on construction of a second *Saturn* test stand at Redstone Arsenal.

The new stand, to be known as a "dynamic test facility," will be used to check mechanical erection of the *Saturn* vehicle. It will not be used for engine firings. The new stand will allow determination of the natural bending characteristics of the vehicle, effects of cryogenic liquids when held for various lengths of time and the effect of simulated flight vibrations on the various stages.

Bending and vibration tests can be conducted when the vehicle is fully fueled to the liftoff weight of 580 tons. Other tests will include wind effects, fueling techniques, ground crew training and assembly methods. The stand will have means for carrying spilled propellants to remote holding ponds to minimize fire hazards.

The stand will include a structural steel test tower 204 ft. high containing about 600 tons of steel, a reinforced concrete control building with a floor area of 700 sq. ft., an electric elevator with a 190-ft. lift and a 75-ton stiffleg derrick with an 80-ft. boom and a 50-ft. mast.

The steel superstructure will provide lateral support for the vehicle and working platforms. The plan also calls for power, water and other utilities; and a road and hardstands. Test date will be recorded with equipment in an existing blockhouse.

Bids were requested for NASA by the Mobile District, U.S. Army Engineers, and will be opened in Mobile, Ala., June 15.

Congress Studies DOD Procurement

Three different subcommittees of Congress this last week were involved in activities affecting the procurement regulations and policies of the Defense Department. Committees and activities were:

House Small Business Subcommittee: considered a reply from G. C. Bannerman, DOD Director of Procurement Policy, to charges made by industry at recent hearings that proprietary rights are inadequately protected. Bannerman agreed that present policies need changing and proposed that proprietary data be defined as any data "not readily revealed by the product itself."

The present definition states that data is not proprietary if "it is not disclosed by inspection or analysis of the product itself" and often leads to expensive and long engineering analysis by the government just to discover if such is the case.

Special House Armed Services Subcommittee on Procurement: heard Perkins McGuire, Assistant DOD Secretary for Supply and Logistics, plead for a softening of the Vinson bill to amend present procurement laws. The new law, said McGuire, would curb incentive contracting, limit negotiated procurement and require written or oral discussions with prospective bidders.

McGuire declared incentive payments are desirable for those contractors who have demonstrated they can cut costs by skill, efficiency and ingenuity. He said all purchases should be made by formal advertising "when practicable." He thought discussions with all bidders would simply permit them to pad early bids.

Chairman Vinson agreed to consider and discuss proposed DOD substitutions in his measure.

Senate Small Business Monopoly Subcommittee: Chairman Russell B. Long (D-La.) introduced a bill which would give the U.S. exclusive rights and title to any invention developed with government research money. It would, he said, make the results of government research open to all our citizens instead of just a favored few. A waiver involving proprietary rights could be ordered, he said, when a contractor's contribution outweighed that of the government.

mergers and expansions

CUNO ENGINEERING CORP. stockholders will vote shortly on an offer for acquisition by American Machine and Foundry Co. The move has already been approved by the boards of directors of the two firms.

No changes in personnel, operations or marketing policies of Cuno are expected. The Meriden, Conn. firm manufactures a line of industrial filters used in chemical, atomic energy, aircraft and guided missile fields, in which AMF already is active. Cuno also has plants in Stafford Springs, Conn., and Windsor, Ontario, Canada.

Export and foreign manufacturing operations are conducted by the Olin-Cuno Filter Corp., jointly owned with Olin Mathieson Chemical Corp., with a subsidiary in France.

AMF's most recent acquisition is the Emhart Manufacturing Co.'s Maxim Division at Hartford, Conn., noise suppressor manufacturers.

KOLLMORGEN OPTICAL CORP. of Northampton, Mass., is merging with Inland Motor Corp. of Radford, Va., and Pearl River, N.Y.

General headquarters will be maintained by the new company, to be known as the Kollmorgen Corp., at Northampton, with divisional headquarters at Radford. Inland will be operated as a division. No change is anticipated in production facilities.

UNITED CONTROL CORP. has acquired all outstanding stock in the Electro Development Corp., both of Seattle. Electro, holding contracts for instrumentation systems in *Polaris* and *Minuteman,* will be maintained as a separate company. United Control Corp. just recently established Palomar Scientific Corp. in Palo Alto, Calif.

NEW YORK RESEARCH & DEVELOPMENT TEAM has been created by six independent technical companies in the New York area. They include an engineering-computational firm, a physical research group, a radiation and chemistry research group, a testing laboratory, and a systems research group. The team hopes to be operating as a coordinated technical team by mid-summer, according to group leader Cyrus Adler, President of the Manhattan Physical Research Group, Inc.

HAVEG INDUSTRIES, has announced plans to enter the blow molding field with the purchase of the equipment and inventory of the Blow-O-Matic Corp. of Bridgeport, Conn. President Soren Graae will join Haveg as manager of the facility, which will be known as Blow Molding Division of Haveg Industries, Inc. The existing building will be maintained.

MEKTROL LABS, INC. is undergoing a $250,000 expansion program in Alta Loma, Calif. The new facilities will enable the firm to provide eight more testing services to bring its number to 24 available services in electronic, chemical, and physical testing and analysis.

CONTROL DATA CORP.'s Computer Division has formed a Programming Research Group to increase its efforts in Automatic Programming and other related programming efforts for the Division's line of digital computers.

ULTRASONIC INDUSTRIES, INC. of Long Island has joined forces with Industrikeme A/S, of Denmark, for mutual distribution of their products in the metal finishing equipment field.

financial news

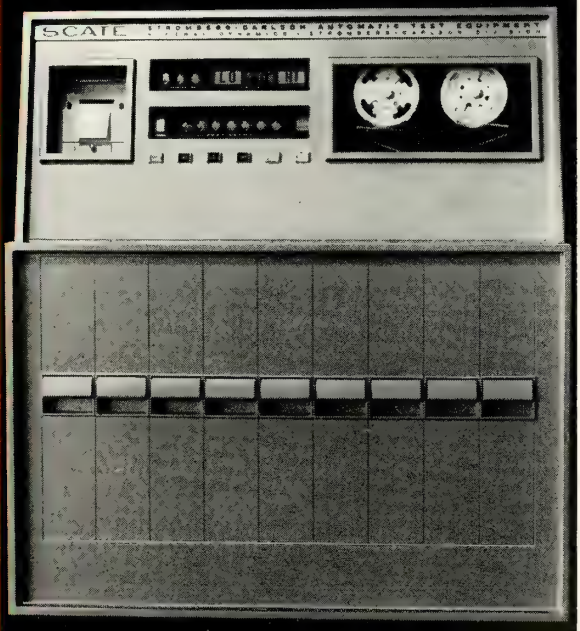
The Board of Directors of the Summers Gyroscope Company have forecasted a "reasonable" operating profit for Fiscal Year 1961 for the first time in several years.

Unaudited first quarter figures show sales at approximately $5 million and net profit at $269,608. Last year's total sales were only $7.5 million, of which some $3.6 million were under loss contracts. Over-all operating loss for the FY was held to $364,000. The company expects sales near $14 million for the year ending Jan. 31, 1961.

Summers suffered an operating loss of $4 million for the fiscal year ended Jan. 31, 1958, reduced to $992,000 for the year ended Jan. 31, 1959, and further reduced to an operating loss of $364,000 for the fiscal year ended Jan. 31, 1960.

Present backlog of orders is close to $5 million, expected to be increased by the end of June.

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Technical Countdown

ELECTRONICS

WWV Adds Time Code

Bureau of Standards has added an experimental timing code to regular WWV broadcasts to provide a standard time base for scientific observations. The 36-bit 100-pps binary code designates hour, minute, and second in universal time, and indicates WWV broadcast accuracy within one millisecond.

Batteries Fail in Space

Failure of *Pioneer V's* power supply was reported to be due to deterioration of batteries caused by leakage of gas in the hard vacuum of space.

Electrons Make the Scene

First films showing the interactions of electrons within a microwave tube will be shown at the International Tube Conference in Munich this week. The movies are part of a paper presented by Dr. Joseph Hull, manager of Litton's electron tube research lab.

Electronic Industry Becoming Giant

Electronics will be the third largest U.S. manufacturing industry by 1965, according to Harvey Riggs, president of International Electronic Research Corp. He predicts that within five years electronics would rank behind only the automobile and steel industries.

GROUND SUPPORT

Sky-spy Uses Borrowed Pad

Midas was launched from modified *Atlas* Complex 14, one of two at Canaveral modified for multistage space vehicles. Gantry heights were increased to 130 feet and towers added for upper-stage umbilicals. Later launchings will be from Point Arguello.

GSE Directory Revised

DOD has revised its directory of military agencies responsible for development of missile GSE (PB 161535—"Technical Resources Directory—Missile Ground Support Equipment No. 2"). Copies may be obtained for 50¢ from OTS, Dept. of Commerce.

3-D Radar for Navy

Navy has just awarded a $14-million contract to General Electric for production of AN/SPS-30 long-range height-finder radars. One of the longest-range radars ever developed for Navy, the new unit will provide 3-D capability for detection of missiles and high-speed aircraft.

PROPULSION

Plasma Gets Boost

An "electromagnetic plasma accelerator" developed by Litton Industries uses electromagnetic fields to make a gas electrically conductive and accelerate the plasma to extremely high velocities (250,000 mph). Method is said to eliminate problems of electrode erosion, wall friction, low efficiency, and containment associated with plasma propulsion systems.

Largest Helium Plant in Operation

Daily output of the Navy's new mobile liquid-helium plant is 45,000 standard cubic feet equivalent high-purity gas. The liquifier—largest in the world—was built by Air Reduction Inc. It is the prototype of an even larger plant to be built later.

MATERIALS

Plastic Ceramic from England

Ceramic-like resins capable of resisting temperatures of 1000°C with excellent thermal shock properties are being evaluated in England. Expected applications include missiles, high-speed aircraft, and nuclear fuel element cladding.

Micrometeorite Impact Simulated

Pyrex glass beads four milli-inches in diameter are being slammed into metal test specimens at speeds up to 31,000 fps in a series of micrometeorite impact studies at North American Aviation's Missile Division. The beads are fired from an electric gun through a vacuum at aluminum and magnesium alloy targets.

GUIDANCE AND CONTROL

Magnetic Damping Stabilizes Satellite

"De-spin" of *Transit* satellite worked even better than the project scientists hoped for. Slung counterweights dropped the initial spin to about 4 rpm and magnets in the vehicle damped the rotation to zero.

Ceramic Gyro for Missile Guidance

New miniature ceramic gas-lubricated bearing gyro is reported to be ten times more accurate than best available today. First of its kind, the Honeywell development uses super-hard aluminum oxide ceramic for critical parts (see p. 22 this issue.)

ASW ENGINEERING

Nuclear/Fuel-Cell Power for Subs

Fuel-cell development may be directed toward combination with nuclear reactor. Promise is great for use in small killer-type antisub submarines, as well as spacecraft. Increase to 48% total efficiency is believed possible with heat-output type system.

Ceramic Gyro Ten Times More Accurate

by Hal Gettings

NEW YORK—A new space-guidance gyroscope 10 times more accurate than the best production models available today is claimed by Minneapolis-Honeywell. The new development—described as "the greatest improvement in production gyros in a decade"—uses ceramics and gas-bearings to virtually eliminate drift inaccuracies caused by conventional bearings and the unstability of other critical gyro parts.

The new gyro is similar to Honeywell's MIG (miniature integrating gyroscope) except that the spin-motor, bearings, and gimbal are all made of gem-hard aluminum oxide ceramic. Its accuracy is 10 times better than the MIG.

• **Eliminates ball bearings**—The big advantage claimed by the ceramic gyro is in the elimination of ball bearings with their wear and subsequent changing drift rates. In the new unit, the ceramic shafts of the spin-motor serve as the bearings, riding in ceramic "races" lubricated by a helium-gas film 0.000025-in. thick. The gas film—virtually friction-free—is under pressure that effectively makes it stiffer than the steel ball bearings it replaces. Vibration or bearing noise is said to be decreased by a factor of 30.1. Honeywell says that the bearings have undergone thousands of starts and stops without detectible wear.

• **Ceramic in critical parts**—Use of the ceramic in other critical gyro parts—spin-motor and gimbal—was found to considerably reduce unstability and add to the accuracy of the unit. Tests in which the ceramic was subject to temperatures of from −85 to +1500°F showed dimensional stability within two-millionths of an inch.

A further advantage claimed by Honeywell is that the ceramic parts can be cleaned with acid with much better results than conventional methods such as solvents and ultrasonic scrubbing produce.

The ceramic gyro parts are roughcast in powdered form and fired to a "green" state where they can be easily worked. After a final firing at 3200°F, the material becomes almost as hard as a diamond. It is finish-ground with diamond compounds to tolerances less than 0.000003 in.

The gas bearing principle is not new, but Honeywell contends that previous application has been severely limited by wear on non-ceramic bearings caused by starting and stopping.

• **Conventional construction techniques**—Construction of the ceramic gyro follows conventional methods except for the new materials. It is a miniature integrated gyro with floated gimbal. Flotation of the gimbal—conceived by Dr. C. S. Draper of MIT—gives suspension of better than 99% of gimbal weight and reduces friction to practically zero. (Equivalent torque level has been compared to that produced by the light pressure of a flashlight shining on a playing card hinged at one end.)

Miniature gyros play a vital part in missile guidance systems. They must be supersensitive to measure extremely small angular motions and yet not respond to other outside influences such as vibration, humidity, and shock, and changes in pressure and temperature.

• **Accuracy and reliability**—Extreme accuracies have become almost a fetish among the designers and manufacturers of gyroscopes and guidance systems. Requirements are so rigid—a shift of one micro-inch in wheel position can mean the difference between success and failure of a moon probe—that even a one-micron speck of dust can ruin a gyro. "Clean rooms," ultraprecise manufacturing methods, frequent inspections, and a high number of rejects, make costs of the units fantastically high. (Examples: One little gem that can be held in one hand costs over $12,000. Over 100 precision gyros were bought for one satellite program in order to get five acceptable units.)

In addition to costs, the design of small, accurate, and reliable gyros involves many other headaches for the designer. Time, of course, is one especially significant factor.

The state of the art is being pushed to its limit in many areas and significant advances such as this use of new materials are urgently needed.

• **Unwanted torques big problem**—Two types of unwanted torques are of prime importance in gyro design. The first is a friction-torque that tends to mask off some lower-level gyroscopic torques to limit the angular-rate threshold capability of the gyro. The second is unbalance torques that come from other than gyroscopic action and are erroneously measured as angular motion.

Friction torques are greatly reduced with gimbal flotation suspension. Flotation of the gimbal weight has reduced friction to the order of a million times less than ball bearing. This improvement may be extended several orders of magnitude further by advanced developments in externally pressurized air suspension, hydrostatic fluid gimbal supports, and magnetic or electrostatic suspension.

The ceramic gas-bearing spin-



CRITICAL PARTS of first ceramic gyro are made of new gem-hard material diamond-honed to extreme tolerances. Spin-motor, gas-lubricated bearings, and gimbal are all made of the new ceramic. Motor stator is glass-encapsulated.

motor greatly improves the second category: unbalance torques.

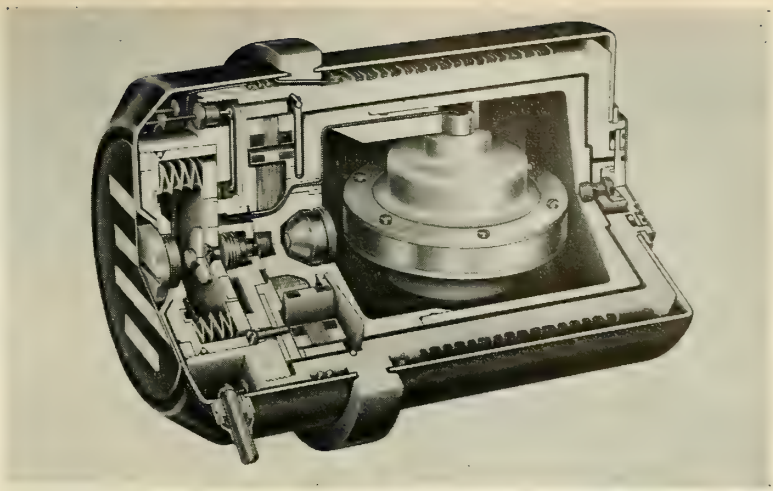
One of the most significant measurements of gyro performance is its drift uncertainty. Because the turning rate inputs to the gyro element are converted to gimbal torque, any unwanted, uncontrolled torques applied to the gimbal cause errors to be introduced in the output response.

Such unwanted torques may come from gimbal unbalance, electromagnetic reactions of pickoffs and torque generators, elastic restraint of the flex leads supplying power for the spin-motor, or from the complex responses of the gyro under vibration inputs.

There is usually a fixed amount of unwanted torque in any one gyro that is consistent and repeatable. This error can be easily balanced out by trim adjustment. Magnetic restraint and flex lead elastic restraint are typical examples of this fixed torque.

The gyro designer, however, is still left with some unwanted torques that cannot be compensated because of their inconsistency. It is these that establish the true uncertainty level of the gyro and set performance limits for gyro drift.

• **Ceramic gas-bearings offer solution**—Control of these inconsistent torques is where the ceramic gas-bearing gyro offers significant promise. According to Honeywell, it has proved to be the solution to torques resulting from movement of the ball retainers and shifts of the balls in the raceway, mechanical hysteresis effects due to material damping and ball slippage, and stress and strain of the balls under angular motions of the gyro which cause deformations that change the balance of the gyro and mechanical rectification of the vibrations set up by the ball bearings of the spin-motor.



CONSTRUCTION OF miniature gas-bearing gyro is similar to standard miniature integrating gyro. Unit is 2.75 inches long, 2.812 inches in diameter, and weighs eight ounces.

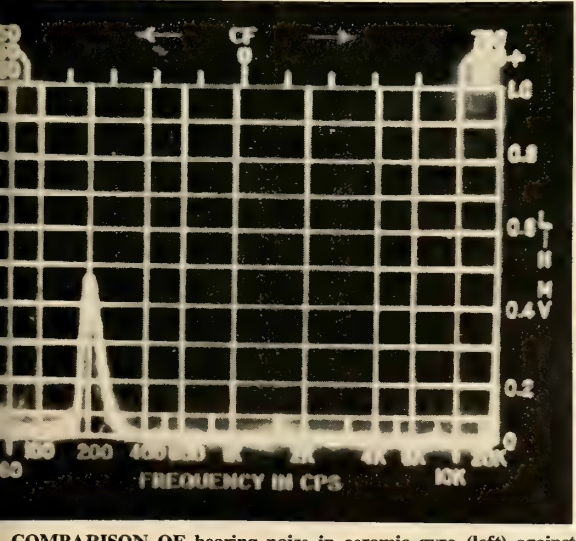
In the ceramic gas-bearing gyro the balls and retainers are eliminated, viscous damping is substituted for hysteresis damping, and deformations due to thermal expansion disappear. As mentioned earlier, vibration or bearing noise is decreased by a ratio of 30 to 1, as shown in the charts.

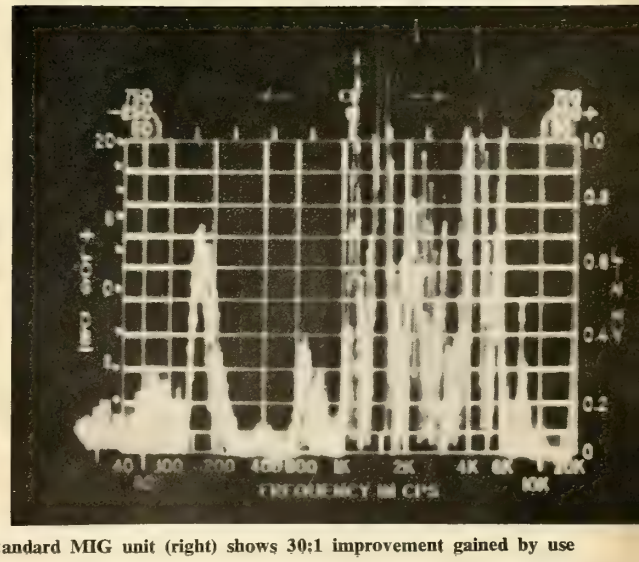
Gas—such as air or helium—has been found to be an effective bearing lubricant so long as the bearing geometry is proper. While the gas-lubricated bearing is in operation, its elements are separated by a thin film of gas. Consequently, there is no contact of the bearing elements, and wear is negligible.

Careful choice of material for the bearing is necessary to provide high reliability for a number of starts and stops. Surface finish, cleanability, hardness, and stability over time and temperature cycling are extremely important factors. It is here that the application of the new ceramic effects a major breakthrough.

Ceramics have a high modulus of elasticity and exhibit very good thermal stability and low long-term creep. These characteristics are extremely important when dimensional control and stability are prime factors.

The stability advantages of ceramics also make this material more attractive than metals for use in other parts of the gyro such as the gimbal, coil cup, and encapsulation of the spin-motor stator.





COMPARISON OF bearing noise in ceramic gyro (left) against standard MIG unit (right) shows 30:1 improvement gained by use of gas-lubricated ceramic bearings.

SOCOM to Use Solar Energy For Deep Space Communication

An optical communication system for use over interplanetary distances is well on its way toward development by Electro-Optical Systems, Inc., of Pasadena, Calif. It will use solar radiation rather than conventional radio frequency energy for transmissions.

Called SOCOM, it can be used for all forms of space communications and may, under certain conditions, be used from space station or vehicle to earth, say its developers.

The program is sponsored by the Air Force's Wright Air Development Division, ARDC, Wright-Patterson AFB, Ohio.

• **Operation**—Since solar radiation is the energy source around which the optical system is built, an accurate sun tracking mechanism is an important part of the collecting array. A radiation tracking transducer performs this function for the antenna system.

SOCOM transmitting and receiving antennas are variable orientation Cassegrainian mirror systems. These permit radiation collection from any angle. (In the Cassegrainian system, the detector is located behind the primary mirror. The receiving antenna also can employ a paraboloidal collector with the detector located at focus.)

Radiation is collected, concentrated into a narrow beam, and directed through an optical modulator for coding. Coding occurs after message input is processed and sent through a modulator-driver into the optical modulator.

Coded radiation is then directed into a second mirror system for transmission through space.

Transmitted data are collected at the receiving end by means of another mirror antenna system. The signal is concentrated on a detector at the focus of the antenna. Following detection, the signal is processed and finally read out.

The optical intensity modulation device at the transmitter has the ability to radiate away all energy absorbed from the beam, prevent overheating.

This is important to system performance because permissible power density is a function of the thermal radiation characteristics of the modulator. These characteristics also determine the maximum allowable concentration of energy in the collection system.

• **Characteristics**—EOS feels that SOCOM design characteristics offer many advantages over conventional radio frequency systems, including:

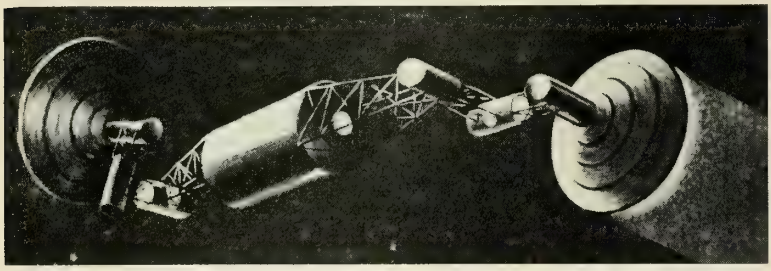
- Lower weight and power
- Higher reliability
- Longer range
- High signal-to-noise ratio
- Communications security (because of very narrow beam width)
- Invulnerability to jamming

Prototype equipment design so far indicates that an operational system could be developed weighing from 30-40 lbs. and requiring from 10-15 watts, excluding control-system power needs.

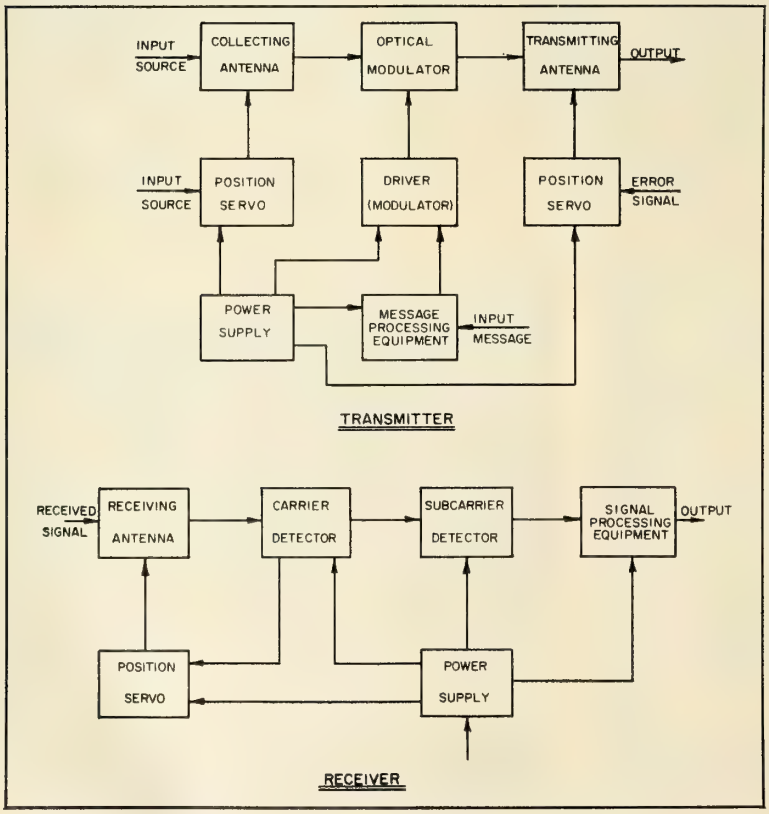
At 10^6 miles using 1-sq. meter mirrors and 10-cps bandwidths, S/N would be roughly 10 db. Using cooled receivers, EOS said, the S/N could be increased by a factor of ten.

With no limiting apertures beyond the collecting mirror, the transmitting antenna achieves a 53-db gain over an isotropic source.

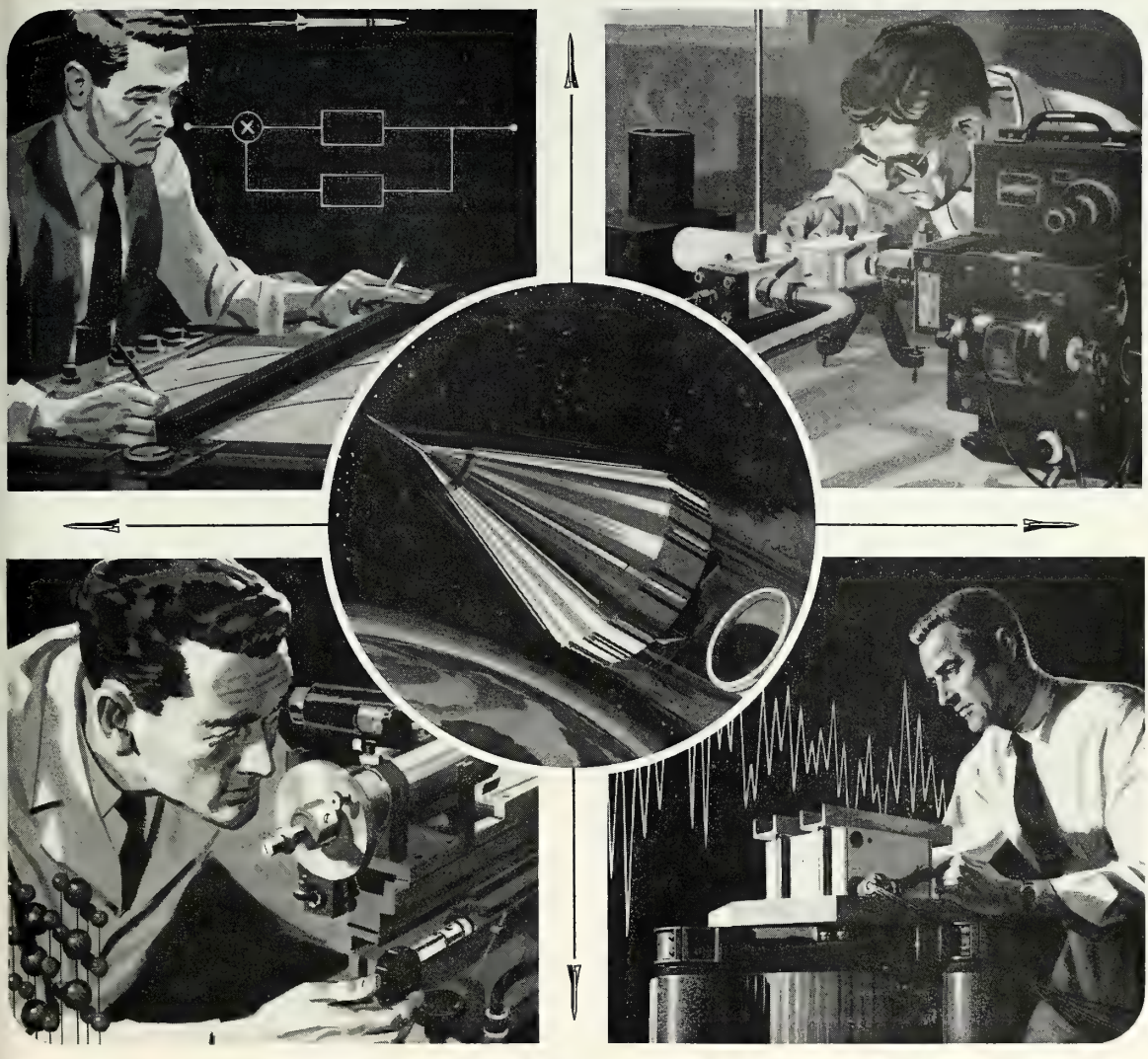
• **Testing problem**—One problem, EOS scientists point out, is realistic system testing. A laboratory environment is impractical for determining space performance. The system, which could be ready in two years, must be satellite-tested to prove out equipment.



SOCOM, solar communications system, under development by Electro-Optical Systems, Inc. for the Air Force, may be used by space vehicles and satellites to communicate over distances exceeding 10 million miles. Solar radiation is collected by mirror antenna (left), directed through modulator for message-input coding (center), and transmitted by second mirror system (right).



BLOCK DIAGRAM shows operation of transmitter and receiver systems for solar radiation communications.



TASK FOR THE FUTURE

Since its inception nearly 23 years ago, the Jet Propulsion Laboratory has given the free world its first tactical guided missile system, its first earth satellite, and its first lunar probe.

In the future, under the direction of the National Aeronautics and Space Administration, pioneering on the space frontier will advance at an accelerated rate.

The preliminary instrument explorations that have already been made only seem to define how much there is yet to be learned. During the next few years, payloads will become larger, trajectories will become more precise, and distances covered will become greater. Inspections will be made of the moon and the planets and of the vast distances of interplanetary space; hard and soft landings will be made in preparation for the time when man at last sets foot on new worlds.

In this program, the task of JPL is to gather new information for a better understanding of the World and Universe.

"We do these things because of the unquenchable curiosity of Man. The scientist is continually asking himself questions and then setting out to find the answers. In the course of getting these answers, he has provided practical benefits to man that have sometimes surprised even the scientist.

"Who can tell what we will find when we get to the planets? Who, at this present time, can predict what potential benefits to man exist in this enterprise? No one can say with any accuracy what we will find as we fly farther away from the earth, first with instruments, then with man. It seems to me that we are obligated to do these things, as human beings!"

DR. W. H. PICKERING, *Director, JPL*

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At 00h00m01s GMT, June 1, 1960, Martin logged its 557,544,000th mile of space flight



ICBM HARD BASE:

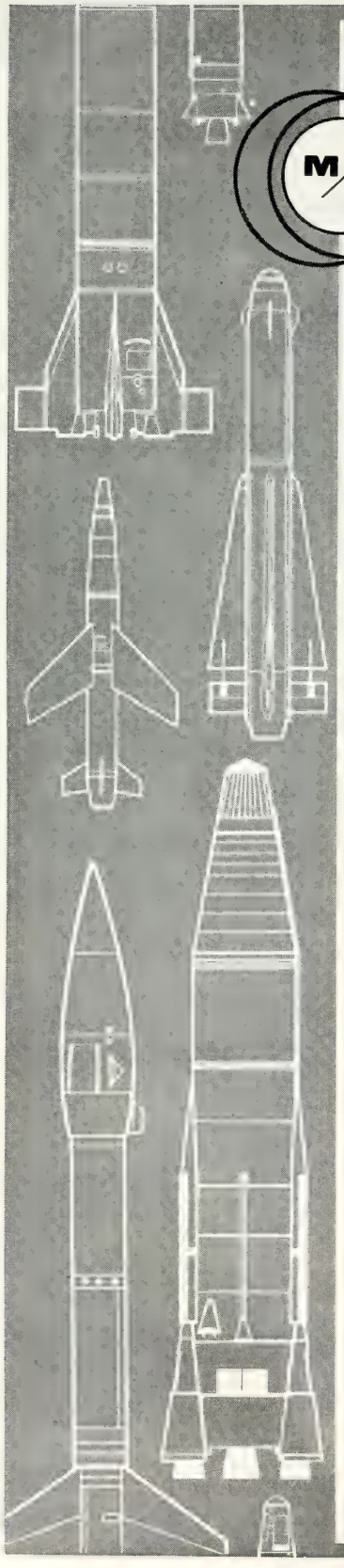
This mammoth excavation, somewhere in the United States, will soon be a "hard base"—an almost invulnerable underground launch site for the Air Force TITAN Intercontinental Ballistic Missile.

It is an important element in the United States Air Force Strategic Air Command's mission—to prevent war.

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Bases such as this cannot be built overnight. It is a credit to the foresight of our military planners that the bases will be operational concurrent with the TITAN ICBMs now in production at Martin-Denver and undergoing advanced tests at Cape Canaveral.

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THE MISSILE/SPACE WEEKLY

missiles and rockets

1001 Vermont Avenue, N.W., Washington 5, D. C.

ABL's Altair Runs Up 13-13 Record

by Jay Holmes

PINTO, W. VA.—The government last week disclosed performance details of the X248, an amazingly successful final-stage solid rocket with a mass fraction greater than a hen's egg.

The rocket—called *Altair* by the National Aeronautics and Space Administration—is produced at Allegany Ballistics Laboratory, operated for the Bureau of Naval Weapons by Hercules Powder Co. in a mountain valley near historic Cumberland, Md.

Altair, a package of 465 lbs. of double-base propellant in a glass fiber and plastic case, has given the final push to such space spectaculars as moon probe *Pioneer I*, paddlewheel *Explorer VI*, sun-circling *Pioneer V* and weather eye *Tiros I*.

Altogether, *Altair* has had 13 successes in 13 attempted altitude soundings, satellites and space probes. This doesn't include, of course, the shots in which the final stage had no chance to ignite because of failure lower down.

The rocket was one of the good things that came from the *Vanguard* program—even though it wasn't ready for any firing except the successful *Vanguard III*, which closed out the ill-starred series Sept. 18, 1959.

• **Kick for Vanguard**—Hercules joined the *Vanguard* program in April, 1956 when it was assigned the job of developing a third stage in competition with one under development by the Grand Central Rocket Co. The first produced by ABL under this program was the JATO X241, which generated vacuum thrust of 2520 lbs. for 36 seconds and had a mass ratio (propellant to gross weight ratio) of 0.85.

However, the Grand Central third stage was chosen for the first *Vanguard* firings. In February, 1958, ABL made a new design study, which produced a plan for a rocket that would give the *Vanguard* payload a 20% greater velocity kick than could the X241 and would package 23% more propellant into a container that weighed 25% less.

An important factor in the improvement was the use of a Spiralloy case. Spiralloy is a filament-wound glass fiber-reinforced epoxy resin produced by Hercules' Young Development Division. Young says the material has an ultimate strength of 130,000 psi and a density of 0.072 lb./cu. in.—which would give it a strength/weight ratio of 1,808,000 in. To perform equally well, steel would have to have strength in the neighborhood of 500,000 psi. Exclusive of nozzle, the *Altair* case weighs about 15 lbs.

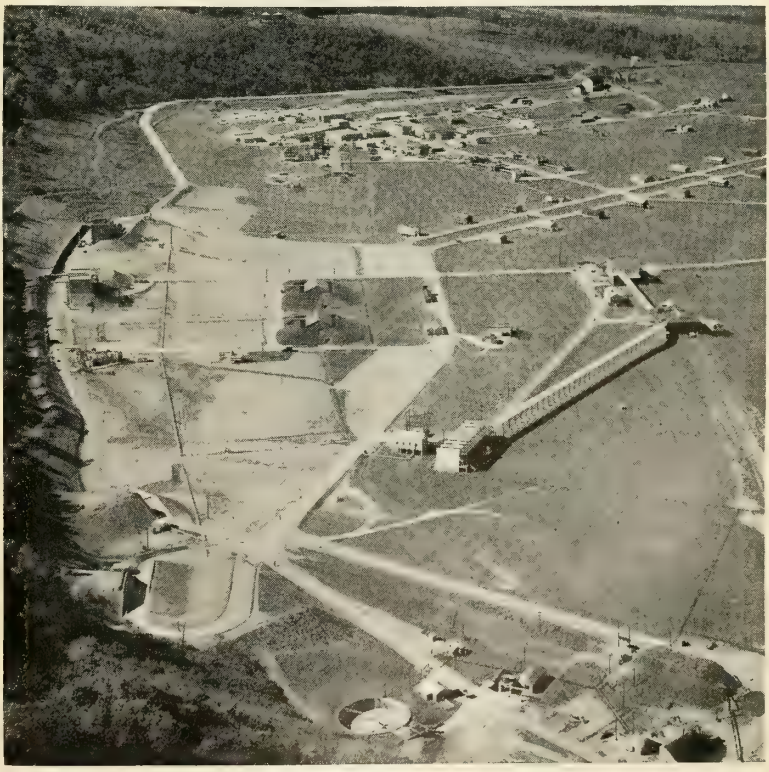
Allegany developed the new stage in nine months. Its first mission was *Pioneer I*, the moon probe attempted by the first *Thor-Able* vehicle in November 1958.

• **Description**—*Altair* has a gross weight of 507 lbs. in the X248A2 configuration used for *Vanguard III*. The gross weight varies by a few pounds from mission to mission because of the variation in attachments for connecting the rocket to the rest of the vehicle and for minor changes in the exterior chamber configuration for similar purposes. In *Vanguard III*, it generated total impulse of 116,500 lb./-seconds over 38 seconds. This amounts to an average thrust of 3070 lbs.

The motor specific (total impulse divided by gross weight) is 230 seconds. ABL scientists said this is one of the highest figures for any operational solid rocket in the U.S. Asked how the figure compared with com-

Motor Specifications

	X248A2 (Vanguard III)	X254A1 (Scout)
Initial weight (lbs.)	507	2285
Final weight (lbs.)	42	170
Mass ratio	0.92	0.93
Burning time (sec.)	38	35.6
Total impulse (lb.-sec.) ..	116,500	533,700
I_{sp} at altitude (sec.)	256	256
Motor specific (sec.) ...	230	233



GENERAL VIEW of Allegany Ballistics Laboratory operated for the Navy by Hercules Powder Co., taken from a neighboring mountain top.



WORKMEN GENTLY lower *Altair* into position atop *Thor-Able* vehicle that propelled *Explorer VI* into orbit on Aug. 7, 1959.

parable liquid rockets, they said they did not know.

Altair has a mass ratio of 0.92. Hercules spokesmen noted that the mass ratio of a hen's egg is 0.89. Since November 1958, *Altair* has been successful in four *Thor-Able* launchings, one *Vanguard,* four *Shotputs,* two *Javelins* and two *Argos.*

Altair is also the third and final stage of the *Atlas-Able* vehicle, which will make another attempt at a moon probe late this summer or early in the fall.

• **Biggest job yet**—*Altair* will begin its longest assignment later this year when the *Scout* program gets under way. Because of the relatively low cost of the all-solid *Scout,* NASA plans to bring the launch frequency of *Scout* satellites up to six a year by 1962 and continue at this rate at least through 1969. *Altair* will be the fourth and final stage of *Scout.*

The success of the *Altair* led NASA to decide to develop a scaled-up *Altair* as the *Scout* third stage. The new rocket, named *Antares,* is in a late stage of development at ABL. *Antares* packs 2115 lbs. of propellant into a case that, with nozzle, weighs 170 lbs. at burnout. The mass ratio of *Antares* is 0.93—one point higher than the *Altair* record. The motor specific is 233 seconds—three seconds higher.

The *Scout* system was tested for the first time April 18. It carried dummy second and fourth stages. The first-stage Aerojet *Algol* apparently performed successfully but something prevented *Antares* from firing. NASA officials said it is not certain what happened. Further tests are scheduled in the near future.

• **Alternate for Polaris**—Another project under way at ABL is an alternate second stage for the 1500-mile version of the *Polaris* fleet ballistic missile, which is due to become operational in early 1962. Aerojet-General is producing propulsion units for both stages of of the 1200-mile *Polaris,* which will be installed on nuclear submarines before the end of 1960.

Aerojet and Hercules are in competition for the second stage on the longer-ranged model—which must pack more kick into a package only 30 in. longer than the 1200-mile version. The 2500-mile *Polaris,* due to come along in the 1964-66 period, will be the same length as the 1962 1500-mile missile.

Neither the Navy nor Hercules would disclose any information about the ABL *Polaris* stage except that ABL is using a double-base propellant in contrast to the Aerojet polyurethane composite. However, Navy spokesmen did say the ABL stage is entirely different from the Aerojet stage—and not merely in propellant composition. This would indicate the ABL may be using a Spiralloy case for *Polaris* too. Aerojet makes its cases of steel.

• **Involved in Minuteman**—Another area where the *Altair* experience is paying off is in Hercules' work on the third stage of the *Minuteman* ICBM at its plant in Bacchus, Utah. A company spokesman said the record of success in the *Altair* and *Antares* programs has played an important part in the development work on the Air Force missile.

Hercules is also in competition with Aerojet on the *Minuteman* stage. In June 1959, the Air Force awarded a $15.3 million contract to the company for *Minuteman* R&D. Hercules said the contract represented the making definite of an earlier letter contract authorizing the company to begin work. It was not disclosed just when the work began.

Hercules is doing some of the supporting technical work at its propellant plant in Kenvil, N.J.

• **Background in bullets**—Allegany Ballistics Laboratory was an Army facility in 1942, operated by the Kelly-Springfield Co. for production of .50 calibre ammunition. In 1943, it was turned over to the Office of Scientific Research and Development in 1943 for use as a rocket development laboratory. George Washington University operated it for OSRD until December 1945.

At the close of the war, the Navy took over jurisdiction and contracted with Hercules to operate it. Hercules has operated the plant since 1945. One of the major accomplishments since then has been the development of casting double-base grain.

Despite recent developments in polyurethane and polybutadiene acrylic acid composite propellants, double-base propellants are still the most widely used solids in the U.S. arsenal. Among the missiles using double-base solids are the *Nike-Ajax, Honest John, Terrier, Talos, Snark, Rat, Weapon A* and the *Deacon* sounding rocket.

Hercules Powder Co. is generally acknowledged to be the industry leader in double-base propellant technology.

Weldless Steel Cases Now Possible

Republic's technique of overlapping seamless rings with adhesive bonding promises important advantages over welded types

by John F. Judge

MINEOLA, L. I., N.Y.—Solid rocket motor cases fabricated from steel—but without welded, riveted or bolted joints—are now possible through a development at the Missile Systems Division of Republic Aviation Corp.

Dissimilar metals can be incorporated into a single case as closures or as part of the main cylindrical body.

In addition, the process can realize the fullest strength potential of the normal fabricating metals used in such cases.

The motor case is essentially a series of overlapping seamless rings—joined by adhesive bonds. These structural bonds transmit the longitudinal loads from one ring to the next and are not affected by the hoop loads.

• **Attractive qualities**—Besides the lack of welds and their inherent problems, the patented laminated ring case has other advantages. When a vessel bursts under hydrostatic test, it is usually a joint failure due to metal yield. A damaged ring can be cut out and replaced. Further, the entire case can be assembled at the firing site with a minimum of effort and equipment. In addition, ring segments can be filled with propellant and then formed into a complete case on the firing site through adhesive bonding—doing away with the added weight of bolted flanges.

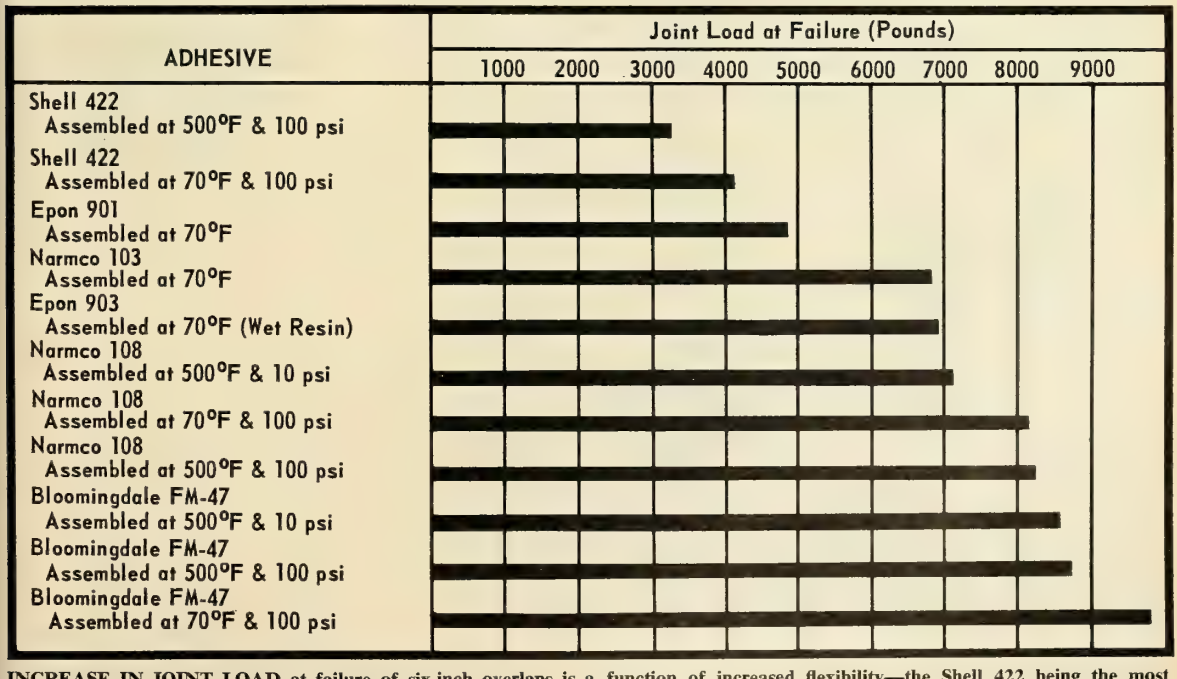
The rings used in the pressure vessel experiments were forged by the Ladish Co. from their D6A steel, and were 2 to 5% undersized in diameter. The oversize thickness ranged from 0.005 to 0.008 in. An adaptation of centerless grinding technique results in a final thickness tolerance of ±0.0005 in.

• **Aus-forming**—The ring is then run through the firm's "quench-sizing process." The ring is raised to heat treating temperatures by induction coils while mounted around an expandable mandrel. When the proper temperature is reached, the mandrel expands the ring to its final diameter and simultaneously quenches through mass contact. There is no apparent change in wall thickness although the overall length is reduced proportionately to the amount of expansion.

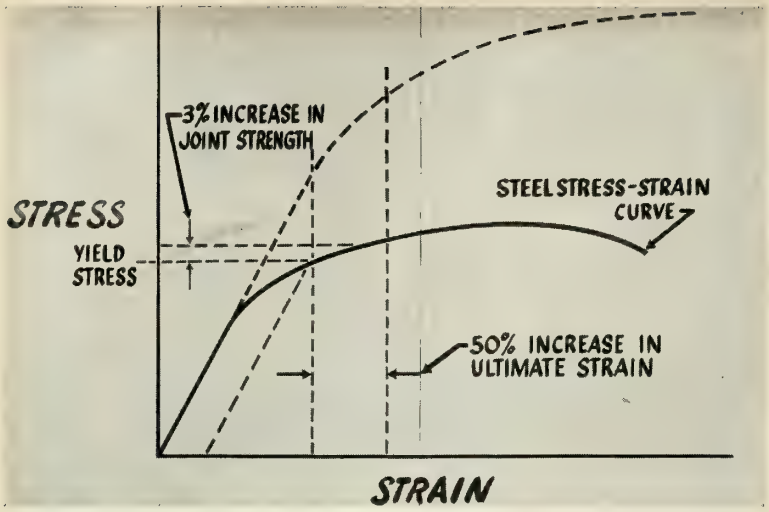
Variations in the heat-treat cycle can be made so that the work is accomplished at the exact transition temperature required for the particular metal. This aus-forming type method is almost ideally suited to realize the highest strength potential of a metal.

After quench sizing, the ring is tempered and no warpage occurs. The ring is ready for incorporation into a laminated vessel since its dimensions are now fixed.

The heart of Republic's concept is in the metal-to-metal adhesive bonding



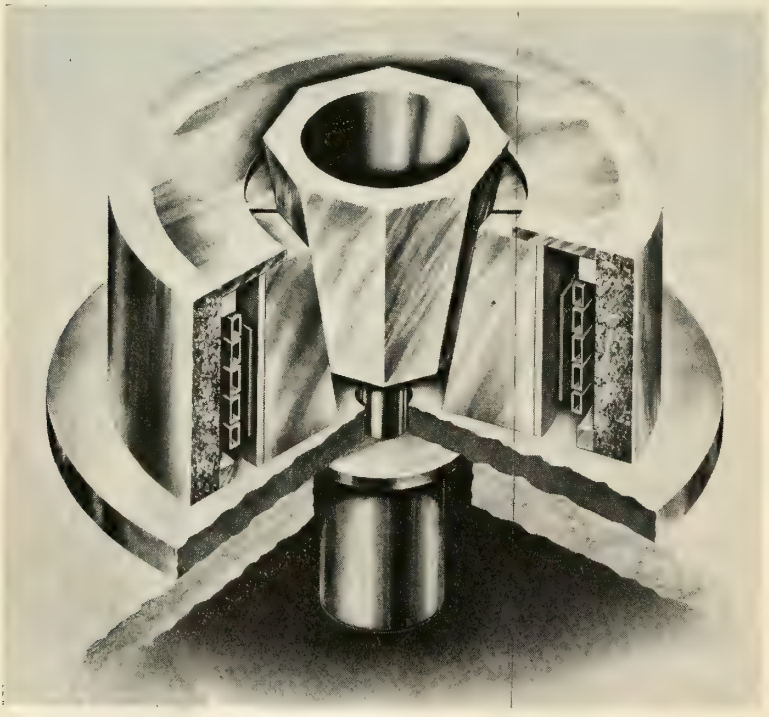
INCREASE IN JOINT LOAD at failure of six-inch overlaps is a function of increased flexibility—the Shell 422 being the most rigid and the FM-47 least rigid.



STRAIN COMPATIBILITY chart shows that, for a given joint, a large increase in the shear strain capability of the adhesive is not required to provide an adequate margin of safety. The dotted extension of the curve illustrates the compatibility of an advance in adherend materials with current adhesives.

—a relatively underdeveloped technology. Usually, a great deal of effort is directed toward reducing overlap. But MSD scientists believe the lap should be greater than 2 in. and actually use 6 in. overlap contact.

• **More flexibility**—Early investigations showed that strong adhesives were too brittle to follow the elastic deformation of the steel. The peak stresses always occurred at the ends of the joint and "walk-in" failures started at these points. Greater load carrying capabilities in the long joint were developed by using a more flexible adhesive. Increased flexibility meant a reduction in the unit strength of the adhesive but tests proved this approach to be correct. Such an adhesive was used in one series of burst tests that resulted in bond failure at a minimum of 255,000 psi and as high as 275,000 psi within the vessel.



QUENCH-SIZING APPARATUS developed by Republic for the expansion of pressure vessel ring sections. Work can be started exactly at the transition temperature of the metal and cooling commences at the same time.

Good correlation was found between laboratory lap shear tests involving flat plates and the performance of the joints in pressure vessel assemblies. The laboratory tests, being uniaxial, had somewhat lower values than the corresponding burst tests which undergo biaxial stresses. The correlation exists only when the length of lap and type and strength level of the lap shear specimens are exactly the same in both experiments. Different joint behavior will be observed with different materials, gages and moduli changes.

From the realization that high flexibility was necessary at the joint ends, Republic went on to the concept of composite adhesives. The importance of flexibility decreases as the center of the lap approaches. A composite adhesive to fit this situation involves a flexible adhesive near the joint ends, other adhesives of progressively less flexibility but higher strength are used in succession toward the center of the lap, and the order reversed past the center to the other end of the joint. In this manner, all of the adhesive can be made to perform a function while the joint is under stress. Summing up, the technique is simply "the proper marriage of adhesive and material," according to Richard Stegler, Project Manager.

The nature of the bond failure is characteristic of the effectiveness of the adhesive. Cohesive failure means that the adhesive failed within itself while maintaining its grip on both metal surfaces. Adhesive failure means simply that there was separation from the metal surfaces. The former is actually a successful failure since it is indicative of a good bond. Republic's pressure vessel successes occurred with FM-47, a dry resin manufactured by Bloomingdale Rubber Co.

This resin was applied by wrapping an impregnated scrim cloth around one lap surface and joining the rings in a proprietary process. This "dry," flexible resin also eliminated the problem of air entrapment that existed when "wet" resins were used—and insured a positive adhesive emplacement. The scrim cloth is applicable to the composite adhesive idea. The various types of adhesives can be placed along the scrim cloth prior to actual ring bonding. Visual inspection of the scrim insures an absence of adhesive voids.

A series of experiments designed to isolate the effect of flexibility on shear strength involved a number of identical lap shear specimens using the same

adhesive (Epon 901)—with varying amounts of a flexibilizing agent (Cardolite) added. Joint loads at failure increased to a maximum as the Cardolite was added and then tapered off. The joint loads were greater than if Epon 901 had been used alone. In addition, with a short (0.5 in.) lap instead of the 6 in. contact allowed in the tests, the same adhesive showed a straight line decrease in strength as the Cardolite was added.

A great deal of adhesive evaluation is currently in progress at Republic. The main task is to define which ad-



THIS PRESSURE VESSEL burst at a 255,000 to 275,000 psi stress level. Cohesive nature of the adhesive failure is visible in the lap area.

hesives are effective in the flexible-brittle range and to determine where adhesive improvements will be necessary. Theorists at MSD have evolved formulae around the sheer modulus characteristics of adhesives.

The short time heat exposure characteristic of laminated structures, in general, are excellent. In this application adhesive bond is in no danger from the burning propellant because the greater mass of fuel acts as an insulator. It is the ascent heating that causes some concern. Most adhesive temperature data are functions of 10 minutes or more since these substances are sluggish to the effect of a rise in

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temperature. If one is necessary, Republic has found that the most effective outside protective coating is "Thermolag," a product of Emerson Electric. Such a low temperature ablative (250°F) coating would lighten the case as it ablates during passage up through the atmosphere.

Studies are being made at Republic and elsewhere on flexible ceramic adhesives. This would alleviate any objections about temperatures. Another avenue of interest is in developing a dielectrically cured adhesive. Then it would be possible to use the metal overlaps as electrodes and cure the adhesive with a minimum of heat input. This insures capabilities of heating even though ring segments are loaded with propellant.

NRC Investigates Ultrafine Refractories for Navy

Refractory metals are being reduced to powders—particle diameters around one-millionth of an inch—under a $73,343 Navy contract at National Research Corp., Cambridge, Mass.

The actual process is a year old but was initially applied to the lower melting metals. Now ultrafine powders of tantalum, molybdenum and niobium are being investigated.

Besides potential uses as catalysts, the powdered refractories may be applicable in magnetic circuitry, liquid suspensions to produce non-ionic-conducting liquids and as additives to plastics to alter dielectric properties.

In the field of powder metallurgy, the powders may offer new, exact composition alloys with superior physical properties. Bureau of Weapons granted the contract.

Crossed-fields Step Up Hypersonic Tunnel Energies

Plasma stream energy in hypersonic wind tunnels is increased by 60% with little or no added contamination in a Crossed-Field Acceleration test prototype developed jointly by Allis-Chalmers Mfg. Co. and MHD Research Inc., at Newport Beach, Calif.

Crossed magnetic and electric fields further accelerate the plasma, allowing continuous operation at high temperatures and velocities. Many different conditions can be produced in the system. Specific enthalpy ranges and specific temperatures will be established through the power/gas ratio.

Current blow-down tunnels used in testing materials for use in missiles usually operate for short durations, on the order of milliseconds.

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RUM Explores Sea 4 Miles Down

The Navy recently demonstrated an experimental remote control undersea vehicle for exploring and conducting scientific studies of the ocean bottom at depths to 20,000 ft. and at speeds up to three miles per hour.

The vehicle can maneuver on grades of 60% and climb a vertical obstacle 12 in. high.

Engineering design for a fully operational vehicle, which could be built on a production basis, has been completed by Jered Industries, Hazel Park, Mich.

The future production model would also include for clearing obstacles a vertical lift appendage, essentially an underwater helicopter, designed by Hughes Aircraft's Nuclear Electronics Laboratory.

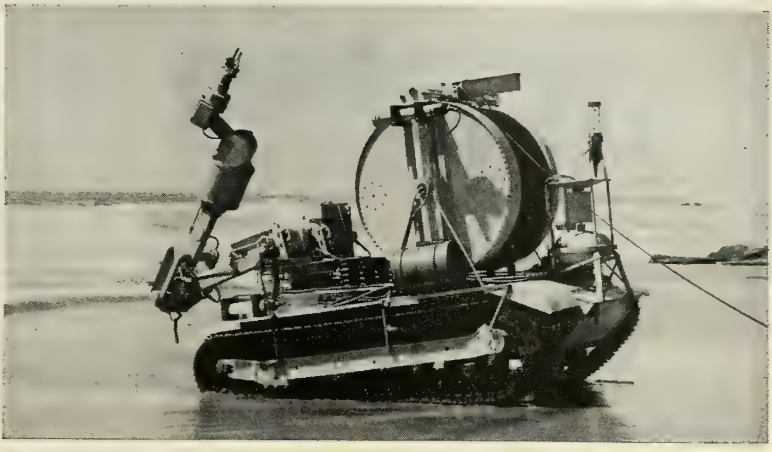
The RUM (Remote Underwater Manipulator), developed for the Office of Naval Research, was demonstrated at Scripps Institution of Oceanography, La Jolla, Calif. The vehicle is essentially a tank equipped with a long, jointed manipulator arm and hand together with specially-devised underwater television cameras which serve as the eyes of the vehicle's operator on shore.

It will observe the sea floor, collect samples and specimens and assemble and install deep bottom-mounted instrumentation.

The vehicle has the basic hull and truck assembly of an Ontos tank (an operational self-propelled rifle used by the Marine Corps.) upon which has been mounted the special manipulator arm designed and built by General Mills' Mechanical Division. The underwater television camera system was fabricated by Orbitran, Inc., Lakeside, Calif. RUM also utilizes specially adapted sonar equipment to guide its progress over the ocean bottom. Its sonar is good for 40 yards.

The vehicle is linked to a mobile van on shore by a five-mile-long coaxial cable which not only carries the television signal but also relays power for the operation of the vehicle and the cameras and mercury vapor lights as well as providing several remote control telemetering channels.

The tank's sealed hull is filled with oil to permit operation at extreme depths. Two main propulsion motors coupled through standard truck transmissions and differentials independently drive the vehicle's two tracks. These



WEIRD LOOKING RUM vehicle runs up Southern California beach after a dip to the floor of the Pacific during test evaluations.

motors are standard General Electric seven and a half horsepower series-wound 800 RPM motors which operate completely immersed in oil. Continuous control of the two motors is achieved through the use of motor-controlled Variacs in conjunction with a reversing linkage and bank of cam-driven switches.

The 11-ton tracked vehicle with the mechanical manipulator in place is capable of carrying a payload of 1000 pounds in the water. Without the manipulator the payload is increased to 2000 pounds in water. Hydraulic controls provide normal braking action. Emergency braking is automatically performed by a spring actuated friction brake.

• **Mechanical manipulator**—The boom-mounted mechanical manipulator is a modified version of the General Mills manipulator arm used in atomic laboratories adapted for underwater use. Made of stainless steel, the arm is an electromechanical device which synthesizes the motions of the human arm. It includes a two-pronged "hand" that opens and closes, a wrist that rotates in either direction, an elbow that pivots, and a shoulder that both pivots and rotates.

The hydraulic actuated boom, mounted at the rear of the vehicle, provides three additional motions—boom rotation, boom pivot, and boom flex. The boom supports the arm and enables it to reach out 15 feet in any direction. The boom also has a hook for lifting tall heavy objects, with the load capacity ranging from 170 pounds to over 5000 pounds. Both the boom and the mechanical arm are operated by toggle switches from the control van.

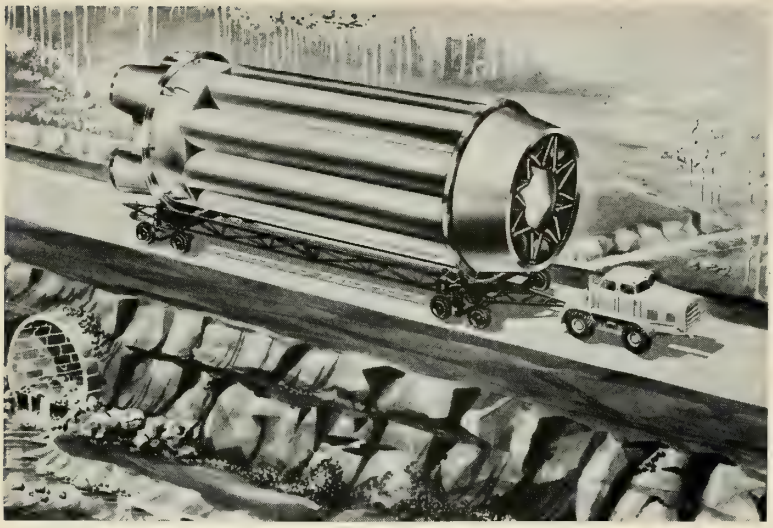
• **Television system**—Four cylindrical television cameras, each housed in half-inch steel casing capable of withstanding a depth of 36,000 feet, constitute the closed-circuit television system which enables the operator to guide the seacrawler.

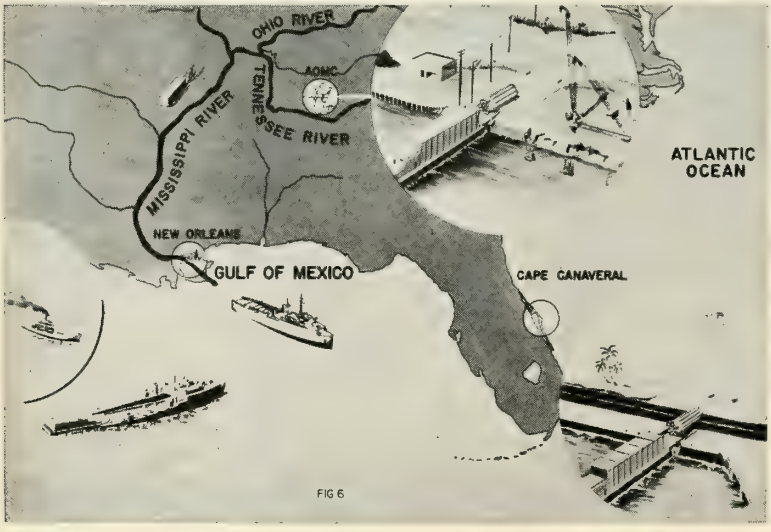
Each miniature transistorized camera is three inches in diameter and 14 inches long. A two-line, conical lucite window is sealed in front of the steel housing to protect the vidicon tube. Two TV cameras view the ground at the rear of the vehicle and two monitor the manipulator arm from the front and rear. TV is good at a maximum of 30 ft. It has 48 different switch channels for control.

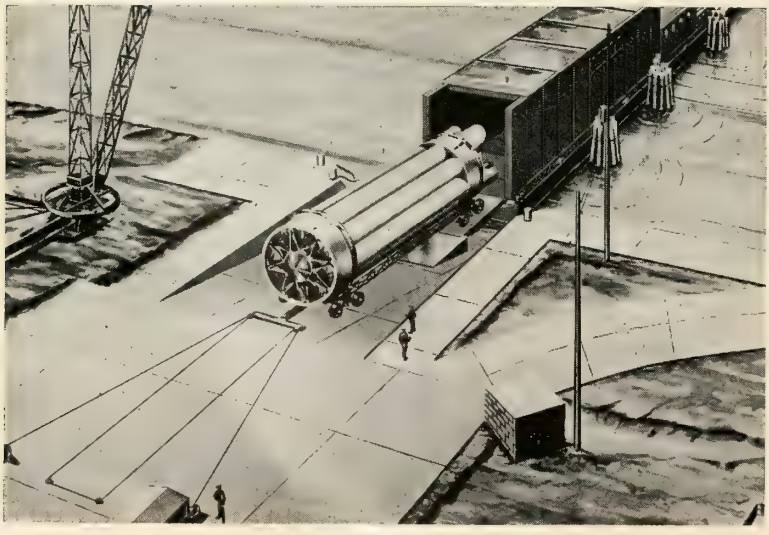
The Orbitran system can transmit two- and three-dimensional views. Through a central control unit the image of one camera can be transmitted at the rate of 15 scans per second.

A three-dimensional view can be obtained by intermittently transmitting the images of two cameras at seven and a half scans per second. Either low resolution images, resulting in a 250-line picture, or high resolution images, producing a 530-line picture, can be transmitted. The phosphorized, "long-persistence" monitor screens are fitted

(Continued on page 47)







Saturn Travel Plans: Unique, Stupendous

Moving day for the *Saturn* booster —the United State's biggest rocket— will involve a logistics problem of magnificent proportions. Too big for highway and railroad clearances, the huge clustered booster—22 ft. in diameter and 82 ft. long—will be moved from Huntsville to Cape Canaveral by a unique combination of trailer, barge, and ship carriers.

The 2200-mile trip will take from 18 to 25 days, depending on weather, availability of tugs, and other circumstances. (For comparison, the space vehicle boosted into space by the *Saturn* will take 2-3 days to travel the quarter-million miles or so to the moon.)

The assembled booster will be mounted on an eight-wheel transporter at the George C. Marshall Space Flight Center at Huntsville and towed by a tractor-tug to a nearby docking facility on the Tennessee River. Here the booster will be rolled aboard a special covered barge and towed down the Tennessee and Mississippi Rivers to the Gulf of Mexico.

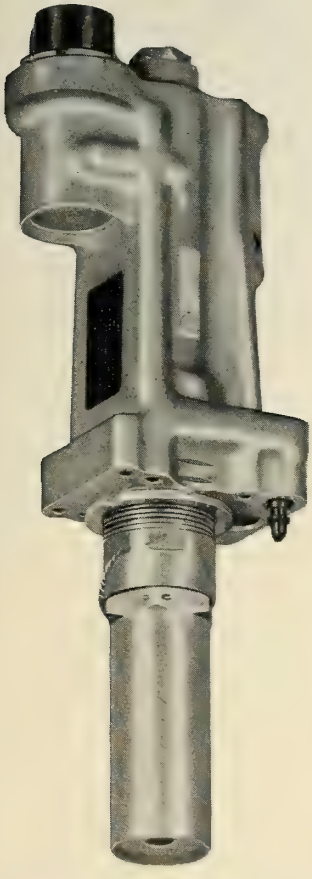
• **Off again—on again**—In the Gulf, the barge will be floated aboard an LSD (Landing Ship, Dock) which will carry it around the tip of Florida. Here it will be off-loaded and continue its journey once more under tug-tow up the inter-coastal waterway to Cape Canaveral. At the Cape, the booster will be rolled off the barge at a special docking facility and hauled to its launch area.

Both the transporter and barge are being specially built for the *Saturn*. The 180-ft. barge carries the booster in a sealed compartment that maintains closely controlled temperature and humidity. It also contains living quarters for the 10-man crew that accompanies the booster on its travels.

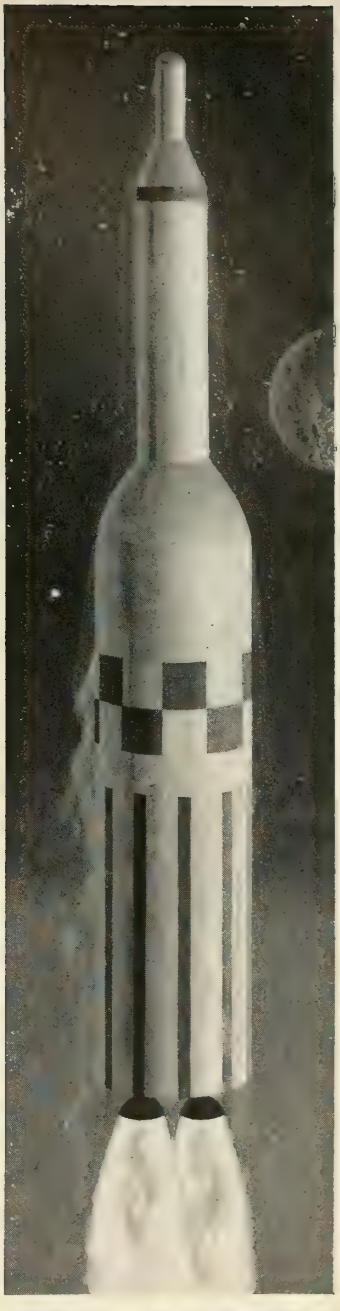
The barge is being built by Dodd Shipyards, Houston, Tex., under a $300,000 NASA contract. Delivery is scheduled for next October.

The land transporter has already been completed and used to haul the booster from the assembly area to the Huntsville static test area.

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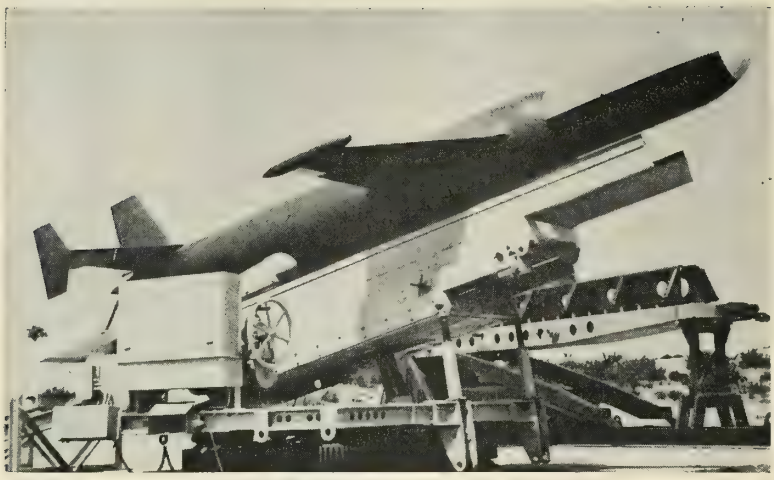
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Malafon Now in Series Production

The French Navy's ASW missile, the *Malafon*, has gone into series production by Société Industrielle d'Aviation Latecoère, the system's prime contractor.

Extensive testing and evaluation was conducted last year by the Paris firm and the French Navy at Levant Island, a small Mediterranean rocky hogback a few miles off the Riviera coast. First official fleet deliveries are planned to coincide with the formal commissioning of the French Escort Ship "La Galissonniere" which will carry the *Malafon* weapon system as standard equipment.

Basically, *Malafon* is a rocket torpedo which blasts off from a short ramp and can kill enemy submarines submerged over 10 miles away, although its maximum range has not been released.

The torpedo is three-quarters recessed into the sleeve of the carrier shell, which has aerodynamic configurations. Two solid-fuel boosters propel the missile to a precalculated height established by its firing computer.

The boosters, dropped after burnout, are fastened on swivel joints; the nozzle orifices are under a horizontal stabilizer-deflector attached to the carrier shell. The carrier's configuration includes wings, ailerons, and an elevator and trirudder tail assembly.

• **Guidance**—The missile's launching ramp is positioned and adjusted automatically by sonar computing firing equipment. The initial one-third of the flight trajectory is programed at the same time, and aerodynamic controls keep the missile at the set altitude during boosted flight. Once free from the spent rockets and deflector, an autopilot maintains the set course.

At a point about two-thirds along its flight path the missile receives radio guidance from the sonar fire control aboard ship; aerodynamic flight corrections or adjustments are made during the last approach to the target area.

The torpedo and the carrier shell are separated by explosion of the security bolt which also releases a brake-parachute from the stub rear of the carrier vehicle just under the elevators. The torpedo falls free into the target area with its own motor working, then seeks the enemy submarine through acoustical homing.

While few details have been officially released on the *Malafon* system, its warhead is believed to be of the heavy explosive type with a proximity fuze.

British Merger Brings Shifts in Top Management

LONDON—Big changes in the lineup of top missile men in the English Electric Aviation Ltd. have followed the merger of the missile and aircraft interests of The English Electric Company, Vickers and Bristol Aeroplane Company by the formation of British Aircraft Corporation.

The following changes have been made on the Board of Directors of English Electric Aviation: Viscount Caldecote, formerly Deputy Managing Director, becomes Managing Director, in which capacity he will also act as Chief Executive, Guided Weapons Division; Sir Conrad Collier retires from the position of Chief Executive, Guided Weapons Division, and also from the Board; Lord Nelson of Stafford, Sir Archibald Forbes and Sir John Woods retire from the Board.

The following are appointed new Directors of the company: L. H. Bedford, Director of Engineering, Guided Weapons Division; R. F. Creasey, Director of Engineering, Aircraft Division; Air Commodore S. Graham, Commercial Director, Aircraft Division; G. R. Jefferson, Chief Engineer, Guided Weapons Division; A. T. Slator, Manager, Guided Weapons Division.

British Space Authority Pushed by Industrialist

LONDON—The formation of a U.K. Space Research Authority, to "overlord" Britain's space research efforts, is being strongly urged in Britain by Sir Robert Renwick, a prominent industrialist and president of the Radar and Electronics Association.

Sir Robert's view is that Britain should get into this field fast, if it wishes to retain its position in aerospace technologies. He put his plan forward at the recent annual dinner of the Radar and Electronics Association in London. He said such an Authority should consist mainly of scientists and technicians led by the best business brains in the country. Its work would include the examination of feasibility studies, study of vehicles, configurations and orbits, and an examination of power plants, both present and future.

"Navigation and guidance techniques should also be studied," he said, "and training of technical personnel should be undertaken. In addition, as a first requisite, the Authority should instigate and co-ordinate plans for sending British satellites into space, using *Blue Streak* and *Black Knight* as vehicles, utilising the existing facilities at Woomera for launching and obtaining the co-operation of Jodrell Bank for tracking, observation and control when required."

Sir Robert suggested that the initial phases of such a Space Research Authority, including, say, six satellite launchings over the next three to four years, commencing with the first launching two to three years from now, could probably be undertaken within a budget of about $42 million a year over a period of several years. By this time, he thinks, the commercial advantages are certain to be so compelling that further finance would be readily available.

AF May Do Final Minuteman Assembly

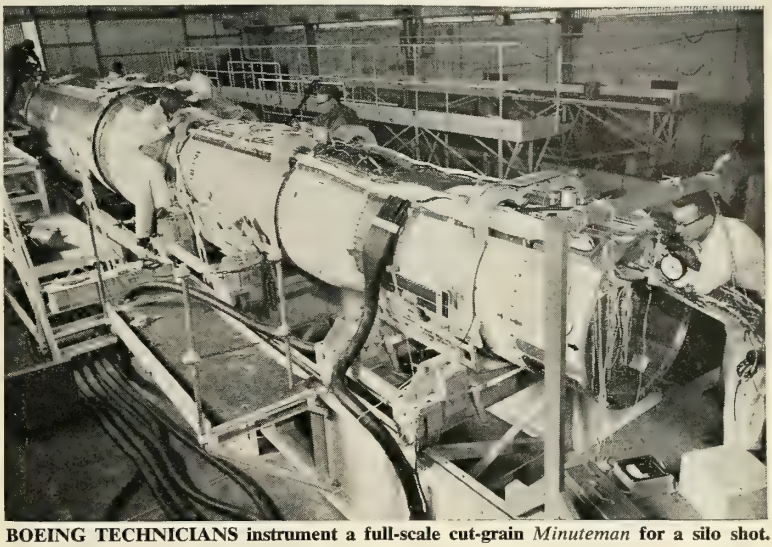
by William J. Coughlin

SEATTLE—The Air Force may take over from Boeing Airplane Co. the final assembly of the *Minuteman* missile at Hill AFB, Ogden, Utah.

Boeing at present holds the contract to operate the missile assembly facility, USAF Plant 77, where the *Minuteman* will be assembled and checked out. But sources here report Air Force has under consideration a plan to do its own final assembly on the missile.

At Air Force Ballistic Missile Division Headquarters in Inglewood, Calif., Col. S. C. Phillips, *Minuteman* Program Director, told M/R: "There is no plan at present for Air Force to take over Plant 77, although this will come up for consideration sometime later."

Final assembly, as the last production step, traditionally has been considered part of industry's job for the Air Force. Management of the *Minuteman* weapon system, however, has been considerably removed from traditional procurement policies.



BOEING TECHNICIANS instrument a full-scale cut-grain *Minuteman* for a silo shot. The success of the silo series made possible a speed-up of the program.

• **AF involvement**—The Air Force, for example, intends to carry out at Ogden its own depot maintenance and major modification program on the *Minuteman*, probably taking over for this the present Marquardt plant, which will become available due to *Bomarc* cutbacks.

Decision to use the Air Force-owned Marquardt plant is enabling a cut of some $2.9 million in construction funds for the *Minuteman* program, slated originally for a depot overhaul facility at Hill.

"This is a hazardous process in that the rocket engines have to be handled as a high fire hazard and get the same kind of treatment that is common in the munitions business," Col. Phillips said.

Under present plans, Boeing will assemble the missile at Plant 77 and put it through a very thorough final checkout for reliability and quality assurance. Major components will be shipped to Hill AFB by associate contractors—with the exception of the Avco re-entry vehicle, which will be shipped directly to operational sites in its own transporter.

Rocket engines are loaded into Boeing harnesses at the manufacturers and shipped by road in engine transporters. There is one transporter designed to carry either second- or third-stage engines while a larger transporter will carry the first-stage engine.

• **Assembly & shipment**—After arrival at the Ogden facility, the engines will be transferred to dollies, go through inspection, and then be transferred to fix storage rails.

At the in-plant missile assembly section, the engines will be mated with the guidance and control section from Autonetics, and with the skirt and two interstages built and shipped by Boeing.

The missile will be weighed and balanced, then transferred to a transporter erector at the transfer area ramp. Transportation to the operational site can be by air, road or rail, with the *Minuteman* remaining in its transporter-erector throughout. Present thinking indicates "piggyback" rail shipment is the most likely. Final step is emplacement in the silo.

• **Many hands**—Boeing's part in the *Minuteman* is a much smaller one than under traditional procurement. Air Force Ballistic Missile Division is managing the program with the Air Materiel Command's Ballistic Missile Center as a partner for procurement, logistics planning, maintenance and supply. Strategic Air Command is working out operational aspects. Systems engineering and technical direction of the program is under Space Technology Laboratories.

In addition to assembly and test of the missile, Boeing is developing the major portion of the ground support equipment, including the launch control system and ground-handling equipment. Boeing also will provide much of the test instrumentation and is responsible for the area security system.

Subcontract for the launch cars and command cars of the mobile system has been awarded to American Machine & Foundry and ACF Industries.

General Motors will provide the transporter-erector tractor and bogie-truck; Cessna Aircraft Co., the missile

Minuteman Contractors

Boeing—Assembly and testing, GSE development, test instrumentation, area security. *Space Technology Laboratories*—Systems engineering and technical direction. *Thiokol*—First-stage propulsion. *Aerojet*—Second-stage propulsion. *AMF/ACF Industries*—Launch cars and command cars. *General Motors*—Transporter-erector tractor and bogie-truck. *Cessna*—Missile container. *Bendix Corp.*—Erection system. *Avco*—Re-entry vehicle support equipment. *Autonetics Div., NAA*—GSE for integrated guidance and control system, and electromechanical activation for nozzles.

container, and Bendix Corp., the erection system.

Avco is under contract for re-entry vehicle support equipment and Autonetics will provide ground support equipment for the integrated guidance and control system, including the portion which will hold the guidance on alert. Autonetics also is developing the electromechanical activation for the nozzles on all three stages.

• **Electronics emphasized**—The *Minuteman* will be equipped with a completely transistorized all-inertial guidance system with a general purpose digital computer which will serve the dual purpose of guidance and control during flight and of assisting in monitoring the readiness status prior to launch.

Electronics, rather than propellant, will, in fact, be the governing factor in determining overhaul time of the missiles rather than propellant.

X-ray examination of the propellant will, however, be carried out during overhaul as a routine operation.

System simplicity and reliability will enable the *Minuteman* missiles to be left unattended for long periods of time in remote and isolated positions, thereby cutting maintenance costs. It is estimated that only one-tenth the number of personnel required for maintenance and support of an *Atlas* or *Titan* squadron will be needed for a *Minuteman* unit.

• **Security problems**—Boeing is at work on a mobile maintenance van which will be stationed at the squadron control center. This will be sent to the missile emplacement at regular intervals or whenever a red light in the control center lights up to indicate a malfunctioning missile.

The unusual isolation of the widely separated and unattended *Minuteman* silos raises a considerable security problem in the program; Boeing holds the contract for development of security systems. Several will be installed at each site.

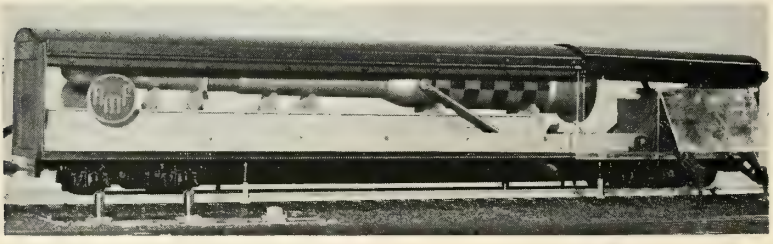
First Photo

What may be close to the operational method of transporting and launching the mobile *Minuteman* ICBM from railroad cars was demonstrated exclusively to M/R last week by American Machine & Foundry.

Using a model missile car, AMF engineers displayed a typical locating and erection sequence embodying most of the basic engineering considerations. Some modification is expected in the prototype.

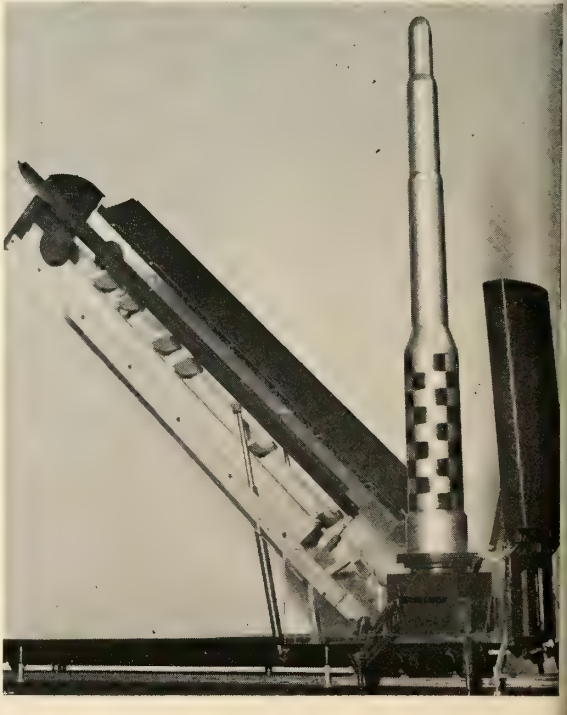
The series of four pictures demonstrates the operating sequence of setting up the mobile launch pad and erecting the missile for firing. (Metal sides of the car are represented in the model by clear plastic for demonstration.)

The first shows the car in the first stages of the launch procedure. Im-



RAIL LAUNCH sequence shows model car in transport position at left. Lower left, entire top of car is erected along with missile. Bottom photo shows erector being lowered, leaving missile on launcher. Big problem with system is to get *Minuteman* in launch position within 15-minute reaction time.





MF/ACF Rail Launch Car

mediately after stopping, stabilizing outriggers are swung out, anchored in the roadbed, and leveled to provide a stable launch pad.

The second photo shows the missile partially erected. Hydraulic rams elevate the carrying bed/erector to a vertical position, setting the missile base on the launch ring. (The erector bed will be made of lightweight aircraft-frame construction which adds only a small percentage to the total missile weight.)

After erection, the missile is unlatched from the erector which is lowered back to the car bed.

In firing position, the missile sits on its pad ready for firing from an adjacent control car (not shown). This car, which does not have to be uncoupled from the launcher, is the only other component needed for the system.

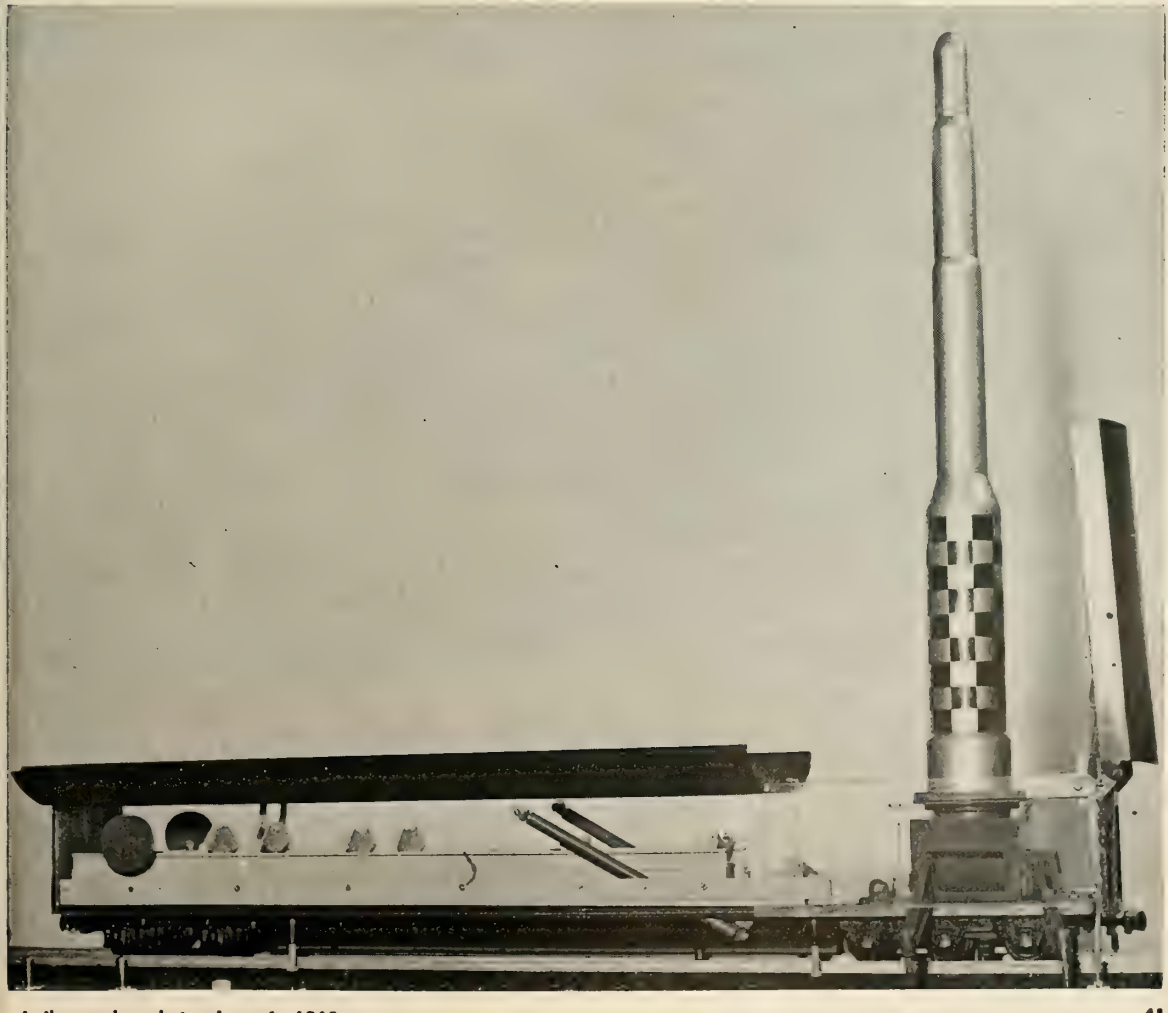
Flame deflectors at the base of the launcher deflect the booster flame to both sides of the car, equalizing the thrust forces on the car and shielding the roadbed from damage.

• **Answers due**—Major questions concerning the kind of treatment that the *Minuteman* ICBM will get as a railroad passenger will be decided within the next few weeks. Until these questions are resolved, the hardware concept of the transport and erector mechanisms must wait. Major decisions that must be made include the desired mobile operating ranges, time elements involved, and requirement for controlled environment.

Preliminary checkout of the railroad operations set up by the scheduled tests at Hill AFB is expected to shed some light on the problem. In any case, the green light for railroad hardware is not far away. Since the mobile system is scheduled to follow the hard-base system by only a few months, mid-1962 appears to be a likely target date.

Both AMF and Boeing stress the point that no radical concepts are involved in putting the *Minuteman* on the railroad. Its purely a matter of deciding the approach and building the hardware. Design and engineering are the guiding factors, with low cost and high reliability the goals.

Engineers feel that the only basic problem in the entire concept is in shielding the big bird from undue stress and strain in its travels over the nation's railroads. But this problem presents no formidable barrier. Current vibration and shock isolation techniques—applies on a bigger and different scale—will be sufficient, they feel, to protect the missile's delicate structure and instrumentation.



Last big competition . . .

Minuteman Third-Stage Award Nears

Both sides show confidence of winning; Aerojet spokesman claims development work has brought major improvements of technology

by Frank G. McGuire

SACRAMENTO, CALIF.—Award of the third-stage rocket motor contract for the *Minuteman* ICBM is expected to come very soon, resolving the last major competition being carried on in the program.

Two companies, Aerojet-General Corp. and Hercules Powder Co., are following different technical approaches to the system's design. The Hercules design has been described by the Air Force as promising "higher potential performance," but Aerojet exhibits great confidence that its design is "the obvious choice."

All three stages of the missile have now been successfully fired in full-scale tests a number of times, and flight tests are due to begin at the Atlantic Missile Range late this year. Thiokol is producing first-stage motors at its facilities near Brigham City, Utah, and Aerojet is producing the second-stage motors at its Sacramento plant.

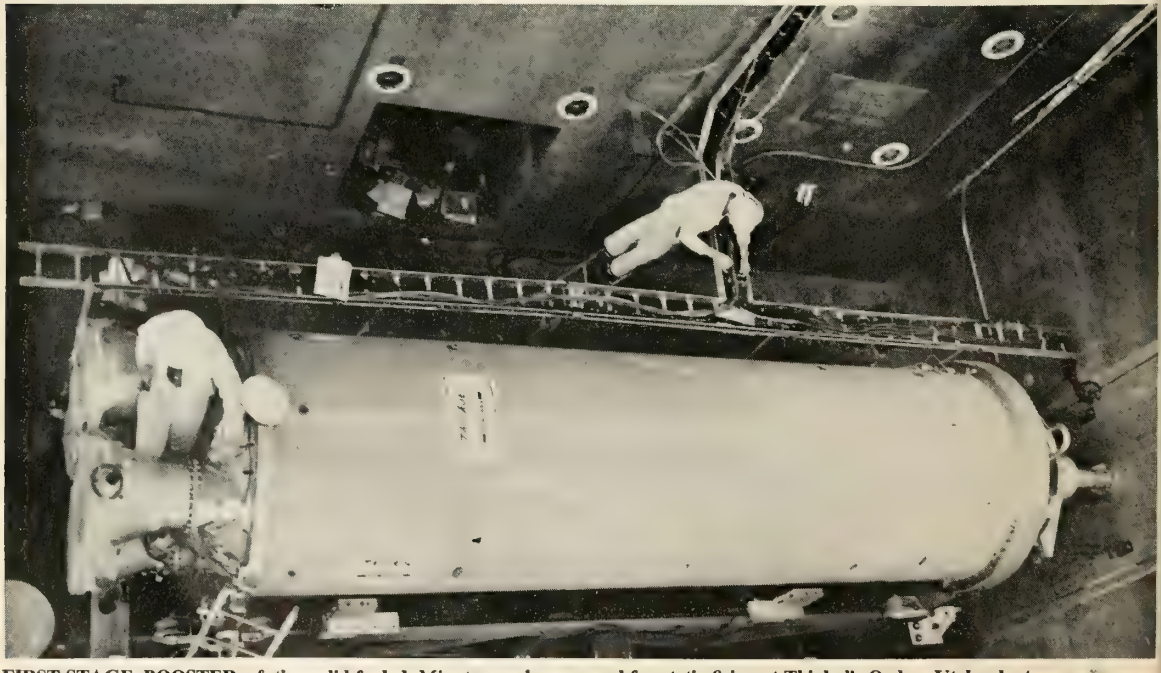
Thiokol's first stage, which burned for about 60 seconds in full-scale tests at the Utah site, uses a propellant composed of polybutadiene and acrylic acid fuel, an ammonium perchlorate oxidizer, and an aluminum additive to stifle unstable combustion. All these ingredients contribute to specific impulse.

Aerojet's second- and third-stage designs, also using an aluminum additive, are powered by a polyurethane propellant. Second-stage burning time is believed to be about 60 seconds. Aerojet says it has fired many consecutive successful tests of both stages, using flightweight hardware and thrust vector control. None of these second- and third-stage tests have experienced malfunctions. The third-stage motor casing, after static firing, can be recharged with propellant and fired again.

Col. S. C. Phillips, *Minuteman* program director for the Air Force Ballistic Missile Division, said: "Propellant problems were actually solved fairly early and we have a good solid determination of the propellant formulation. It has been fixed and proven."

Ignition of the first stage is achieved through use of a Thiokol-produced pyrogen unit, mounted in the forward end of the motor. The company points out that a high shock effect might be produced by a pyrotechnic device; hence it chose the solid-propellant pyrogen.

Second- and third-stage ignition is



FIRST-STAGE BOOSTER of the solid-fueled *Minuteman* is prepared for static firing at Thiokol's Ogden, Utah, plant.

achieved by Aerojet through use of a solid-propellant igniter containing Al-clo, a composition long standard for such applications.

• **Nozzle solved**—Major feature of the *Minuteman* propulsion control system is the use of movable nozzles for thrust vector control. All stages have now been successfully fired with the improved nozzles.

Phillips told M/R: "We're on top of the nozzle problem—we have the solution. There is no doubt that the biggest problem facing the propulsion program was the movable nozzle, particularly on the large first stage. There have now been successful firings on all three stages."

Phillips added that while some work still needed to be done to reduce nozzle weight, the high-temperature, high-gas-flow problems now are solved. He said it is a question of refinement of design and that basically the nozzle materials are "pretty well established."

The use of the movable nozzles instead of *Polaris*-type jetavators for thrust vector control results in a higher efficiency, since there is no obstacle at all in the exhaust stream. The swiveling nozzles are also somewhat lighter.

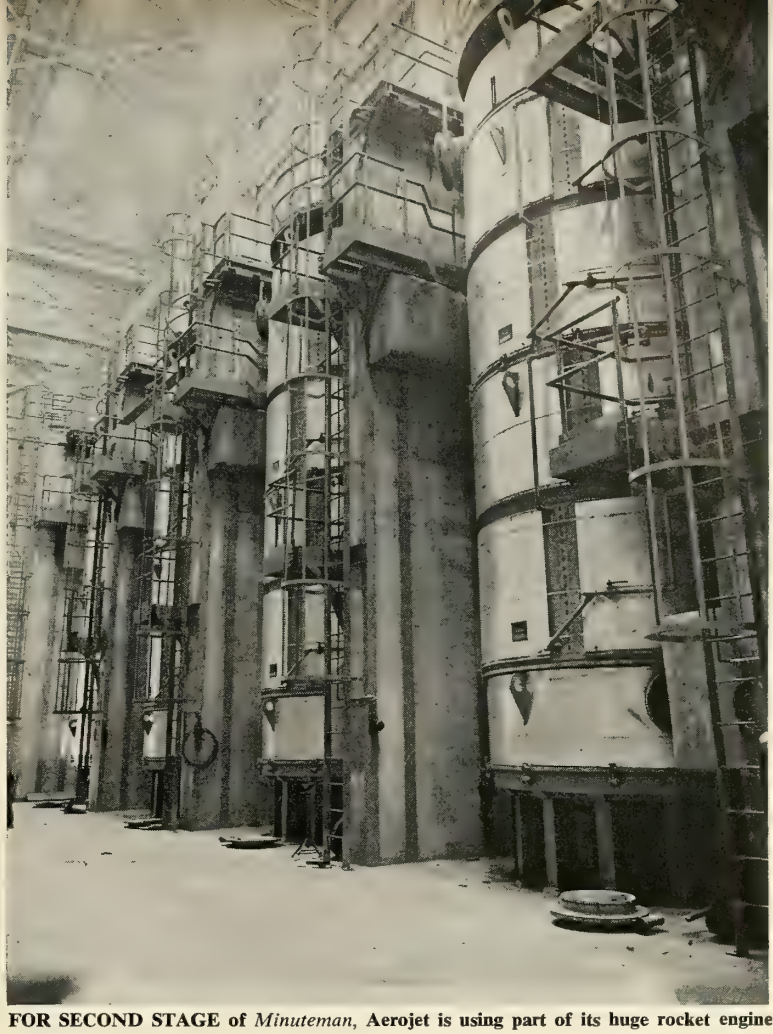
In action, two of the diagonally-opposed nozzles move in only one parallel axis, while the other two diagonally-opposed nozzles move in either of two perpendicular axes.

Erosion by unconsumed aluminum particles in the propellant was another problem, amounting to a high-temperature sandblasting of the nozzle throats and the aft bulkhead. This has also been alleviated, partly through grain re-design and partly through increased insulation. All three stages use an aluminum additive in the propellant.

• **Big advances claimed**—Two companies in the program, Boeing and Thiokol, have stated that the *Minuteman* does not constitute any spectacular leap forward in the state of current technology, (they characterized the program as "a grand exercise in reliability"), but Aerojet's D. F. Sprenger, *Minuteman* Program Manager, strongly disagrees.

"The *Minuteman* may not be as great a leap forward as *Polaris* was," he said, "but it is certainly an improvement in all three aspects of performance: specific impulse, mass fraction, and thrust vector control. In each of these areas, *Minuteman* is considerably improved over *Polaris*." Sprenger could not, however, give specific details on the improvements.

His remarks were echoed by Thiokol's Charles Hodges, who described *Minuteman* as having a better mass fraction than virtually any other solid-propellant vehicle ever built. The greatest breakthrough in *Minuteman*, however, stems from the economic advantages of the system, according to Hodges. Cost reduction through manufacturing techniques and the inherent features of the system contribute greatly to the "cost effectiveness" of the missile.



FOR SECOND STAGE of *Minuteman*, Aerojet is using part of its huge rocket engine cast and cure plant at Sacramento. Firm is competing for the third stage.

One aspect of the *Minuteman* concept, that of being able to use any of the upper stages in short-range missions independently of the first stage, has quietly passed into limbo. This idea, widely publicized at the outset of the program, has apparently slid into a grave as deep as the *Minuteman* silo itself. Whether or not it will be revived is not known.

• **Longer range coming?**—The three-stage missile now is nominally rated at a 6300-statute mile range, but there's a strong possibility that it will someday greatly exceed this.

Thrust termination, achieved in a manner similar to that of *Polaris* with its blowout ports in the forward bulkhead of the final stage, is accomplished in milliseconds, thus reducing residual thrust to an insignificant amount.

Cases for the solid-propellant motors are produced by a number of companies, including General Electric, Allison, Solar, Curtiss-Wright, Aerojet/Rheem, Avco-Lycoming and Pratt & Whitney. Nozzles are being produced by Arde Associates, Allison, Thompson Products, Bendix, and others.

Reliability of the *Minuteman* motors is extremely high, and the missile is compared to a loaded shotgun in readiness and dependability. Aerojet points out that it alone has fired well over 500 large solid-propellant motors without a failure. This includes *Polaris*, *Minuteman* and *Scout* propulsion units. In the case testing program for *Minuteman*, Aerojet says there has never been a failure of a second or third stage casing during hydrotest. These cases are fabricated by a number of methods, and a final method will be determined before full production status is achieved.

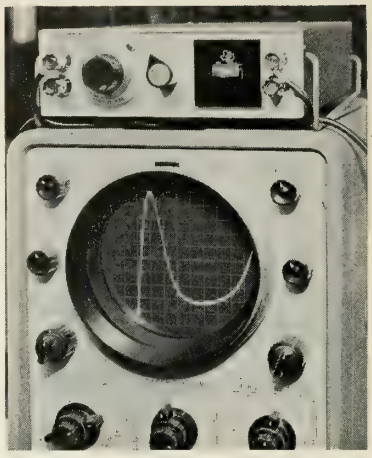
Curve Tracer for Tunnel Diodes

A Tunnel Diode Curve Tracer has been introduced by Texas Instruments, Inc.

The instrument permits the study of forward characteristics of tunnel diodes made by various manufacturers, including gallium arsenide tunnel diodes recently introduced by TI. A plug-in adapter can be changed to accommodate different package configurations. One adapter is included with original equipment; others may be purchased as required.

Any sensitive oscilloscope may be used with the Tunnel Diode Curve Tracer to create current and voltage wave forms. The TI instrument creates a sharp representation of the entire critical region of the forward characteristics curve of the tunnel diode under test rather than just a portion of that curve.

Through the use of an external decade bus shunted across the horizontal terminals, it is practical to read the



actual negative resistance of the tunnel diode at any point on the curve. This shunt can be provided as an optional feature at additional cost.

Circle No. 225 on Subscriber Service Card.

Encapsulated Rectifiers

Radio Receptor Company (Selenium Division) is manufacturing subminiature encapsulated rectifiers in center tap, bridge and doubler assemblies. All units are designed for operation in ambient temperatures from −50°C to +100°C without derating and are protected against atmospheric conditions by the plastic encapsulation. They will withstand peak surge currents up to 250 mils for 1 sec. duration and can be operated in circuits at frequencies up to 25 kc. All types are color-coded for simple identification and polarity indication. Maximum case length is .480 in. for all types, widths ranging to .480 in. max.

Circle No. 226 on Subscriber Service Card.

Versatile High Vacuums

Two high-vacuum systems, now being manufactured by Consolidated Vacuum Corp., can produce a low ultimate pressure of 2×10^{-6} mm Hg, and are ideal for use in electronics, optics, and research and development, where functional vapor deposition or general high-vacuum processes permit the use of an evacuated chamber with 14- or 18-in. diameter.

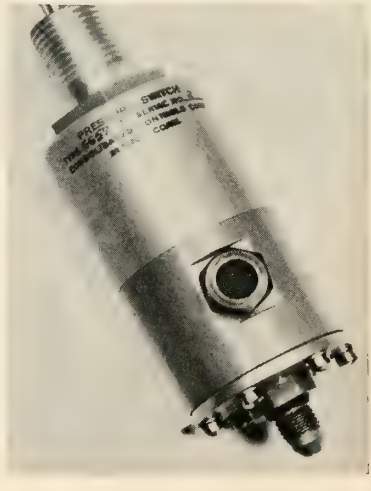
The LC1-14B system (14-in. chamber) reaches a working pressure of 5×10^{-4} mm Hg in 3 minutes with a 4-in. PMC diffusion pump and a 13-cfm mechanical roughing pump. The LC1-18B system reaches a working pressure of 1×10^{-4} mm Hg in 5 minutes with a 6-in. PMC diffusion pump and a 13-cfm mechanical roughing pump.

Circle No. 227 on Subscriber Service Card.

Precision Pressure Switches

A series of externally adjustable precision pressure switches has been introduced by Consolidated Controls Corp.

Used to convert fluid pressures into electrical "on-off" signals, the switches



are available in nine models covering the range from 2 to 3000 pounds per square-inch gauge pressures. Adjustable ranges of the various units are from 2 to 12 psig, 6 to 25 psig, 20 to 75 psig, 50 to 125 psig, 75 to 250 psig, 100 to 500 psig, 250 to 1000 psig, 500 to 2000 psig, and 750 to 3000 psig.

Changes in the actuation points are made in the field by removal of a plug and adjustment of a splined screw.

Circle No. 228 on Subscriber Service Card.

High Temp Spring Wire

A precipitation-hardening austenitic alloy, known as NS-A286, has been introduced for spring wire for 600° to 1000°F service by National-Standard Company. Costing about one-tenth as much as other, more highly alloyed exotic materials, NS-A286 experiences as little as half the percent-relaxation loss at 1000°F as comparable alloys at 850°F.

Sixteen hours at 1350°F precipitation-hardening is recommended for springs after they are coiled to increase the physical properties and to improve stability at 600 to 1000°F. Typical tensile properties for annealed 0.080-in. NS-A286 are 103,500 psi as drawn and 176,000 psi after 16 hours at 1350°F; for 15% reduction are 122,500 psi as drawn and 190,000 psi after 166 hours at 1350°F. Tensile properties for 30% reduction are 150,000 psi as drawn and 198,000 psi after 16 hours at 1350°F.

Circle No. 229 on Subscriber Service Card.

Gage Measures Height

A patented height gage is being manufactured by United States Chemical Milling Corp.

The Height Master gives accurate measurements to .0001 in. and eliminates the need for expensive gage blocks and transfer gages. Speed and ease of operation reduce inspection costs as much as 70%.

Standard and oversize gages, from 17 in. to 108 in., with a wide variety of accessories are available. Each gage is individually calibrated electronically at 70°F under controlled conditions.

Circle No. 230 on Subscriber Service Card.

Control Servo Valves

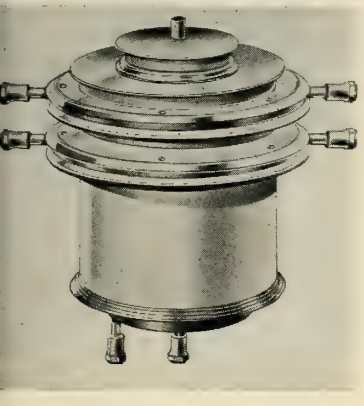
Flight Control Tandem Servo Valves and Actuators having one-piece sleeve and one-piece spool machined to reproduce identical flow characteristics in two separate hydraulic systems are

peing manufactured by Hydra-power Corp. The one-piece construction guarantees that factory set synchronization will be retained unaltered during service use. The Servo Valves with low dynamic plunger forces have true linear flow, made possible by use of rectangular orifices. These units are designed for use in 4000 psi, 275°F Systems.

Circle No. 231 on Subscriber Service Card.

Giant Switch Tube

The Central Electronic Manufacturers Division of Nuclear Corporation of America is developing a high-vacuum tetrode capable of switching approximately 44 megawatts.



The XD-32 is completely water-cooled and approximately 15 x 12 in. overall. Typical operation as a Class B modulator, .01 duty requires 7 kilowatts average power grid drive, 65 kilovolts at the anode and a heater current of 233 amperes at 6 volts. At these figures, the SC-32 has a pulse width of 25 micro-seconds.

Circle No. 232 on Subscriber Service Card.

Precision Force Gages

A series of precision mechanical force gages for measuring tension in permanent test set-up is announced by Hunter Spring Company, a division of American Machine & Metals, Inc. The Force Indicator's free-floating transmission rod, which transmits the tension load to a dial indicator, is threaded (5/16-18) at its end for mounting in test apparatus of fixtures.

The DT Series Force Indicator does not have the compression head for measuring compression forces, or the removable end attachments for measuring tension, nor the means for and holding with detachable handles which are part of Hunter's standard DM Series designed for manual measuring. Thus simplified, the Series DT Force Gage is available at a lower price.

Circle No. 233 on Subscriber Service Card.

Water-based Solder Flux

Non-resinous water-based fluxes featuring instantly soluble and non-charring residues are available from London Chemicals Co., Inc.

Known as Lonco Organo-Fluxes, they are available in four grades to provide sufficient activity for any job, while holding residues to an absolute minimum for the soldering speed required. The grade descriptions are #3355 Red for fast action and medium residue, #2133 Pink for rapid action and moderate residue, #3133 Pink for medium action and minimum residue, and #735 Blue for medium action and light residue.

Circle No. 234 on Subscriber Service Card.

Shock Overload Indicator

A device for detecting excessive shocks to delicate instruments, equipment, etc., during shipment or handling is announced by Arizona Gear and Manufacturing Co. Known as a Shock Overload Indicator, it can be mounted directly on or with fragile equipment in the same container during shipment. If the indicator is subjected to a shock exceeding its setting, a sleeve is tripped on a rod under the plastic dome, exposing a red indicator band. The action is completely mechanical—no batteries or magnets.

Circle No. 235 on Subscriber Service Card.

new literature

PHOTOMICROGRAPHY OF METALS—A 46-page data book may serve as a short course in photomicrography for metallurgists interested in reviewing the latest techniques in this field. It is illustrated with photographs, charts and graphs. Written in layman's language, the booklet contains six major sections which include detailed information on the metallographic microscope, illumination, filters in metallography, photographic materials, exposure determination, and processing and printing.

Circle No. 200 on Subscriber Service Card.

PRODUCTION CHILLING EQUIPMENT — Large-capacity production chilling equipment for stabilization of metals, stress relief of castings, dehydration of gases, expansion assembly, and many other production chilling applications is described and illustrated in a new bulletin offered by Cincinnati Sub Zero Products. Standard R, T, and V Model low-temperature chambers are designed for accurate, economical and continuous performance in large-capacity production chilling operations. The standard models are each modified to meet individual user specifications of size, type of operation, floor space, temperature range, and thermal capacity.

Circle No. 201 on Subscriber Service Card.

PREPARING FOR PATENT-HOOD —Trak Electronics Co., Div. of CGS Laboratories, Inc., announces a booklet about patents for inventors and engineers. The brochure tells what to do with your invention idea; when to talk with a patent attorney; importance of dates and a verifier; about the patent office; application handling; revising claims; claims and patents; economic importance of patents; and foreign patents.

Circle No. 202 on Subscriber Service Card.

EXPLOSIVE FORMING—A new bulletin on the Explosiform process, a method of shaping metal parts by means of explosive energy, has been issued by Propellex Chemical Division, Chromalloy Corp. The statement, Technical Bulletin No. 4, includes a list of advantages of this fabricating technique, which can shape certain materials which are difficult to fabricate by conventional means.

Circle No. 203 on Subscriber Service Card.

ELECTRONIC COMPONENTS—Standard, split bushing and precision rotary trimmer capacitors are described in a new data sheet published by the Electronic Components Department of Corning Glass Works. It says the trimmers are especially applicable to high-frequency tuned circuits. Their temperature coefficient of capacitance is 50 ± 50 ppm/°C. Operating temperature is —55°C to 125°C. Capacitances range from .3 to 12 micro-microfarads.

Circle No. 204 on Subscriber Service Card.

CLIMELT MOLYBDENUM—A non-technical, descriptive booklet on molybdenum products has been published by Climax Molybdenum Company for those executives, purchasing agents and others with a general interest in the unique combination of properties found in these materials. The 24-page booklet gives full details on the various sizes, forms, conditions of use, tolerances, weights, and methods of identification of Climelt products available for commercial use.

Circle No. 205 on Subscriber Service Card.

MOLDING CHART—A new comparative chart for compression molders and transfer molders shows the mechanical, electrical and thermal properties of all general-purpose thermoset materials comparatively. It indicates the relative position of Epoxy Molding Compounds for flexural strength, impact strength, heat distortion, dielectric strength, etc. under controlled tests.

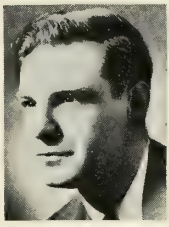
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names in the news

Presson S. Shane: Elected Vice President of Atlantic Research Corp. Responsibilities presently include the Company's Solid Propellant Division and Desomatic Products, Inc. He joined Atlantic Research in 1958 as Director of the Solid Propellant Division. Before joining AR, was employed by the McGean Chemical Company of Cleveland and E. I. DuPont Co. in various capacities.


SHANE

Robert O. Vaughan: Named Vice President of Southwestern Industrial Electronics Co. Formerly western regional manager of government operations for Dresser Industries, Inc. Prior to joining SIE was affiliated with RCA, The National Aircraft Corp., and Hoffman Laboratories.


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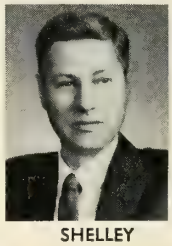
Circle No. 7 on Subscriber Service Card.

Dr. Richard W. Soshea: Appointed to technical staff research and development department, Rheem Semiconductor Corp., where he will do research on new semiconductor devices.

Harland A. Bass: Named Chief Engineer, Data Handling, Electronics and Controls Operation, Avco Corp. Previously served as Assistant Chief Engineer, Data Handling. Joined Crosley in 1940 as an engineer on military products.

Arthur Marquis: Appointed Manager-Specialty Resistor Project, Magnetic Materials Section, Metallurgical Products Department, General Electric Company. Joined GE on Engineering Test Program in 1950. Later appointed Magnet Laboratory Engineer.

Edwin F. Shelley: President of USI Robodyne, has been appointed a Group Officer and Vice-President of U.S. Industries, Inc., the parent company. He will have executive supervision over the USI Technical Center at Pompano Beach, Fla.; the USI Western Design Division at Santa Barbara, Calif.; and the USI Office of Government Programs, New York, N.Y., in addition to the USI Robodyne Division, which he has headed since 1958.


SHELLEY

Homer F. Lewis: Appointed vice president and treasurer, Transval Electronics Corp. Formerly associated with Hughes Aircraft Co.

Harry L. Wolbers: Named chief, equipment and safety research section, El Segundo Division, Douglas Aircraft Co. Succeeds **A. M. Mayo,** now assistant director, life sciences program for bioengineering, NASA.

Dr. Saul Feldman: Joined Electro-Optical Systems, Inc. as Principal Scientist, Fluid Physics Div. Prior to joining Electro-Optical Systems, was Principal Research Scientist at AVCO-Everett Research Lab., where he contributed to ICBM nose cone research.


FELDMAN

Jules Kravetz: Former director of the U.S. Army Signal Corps West Coast Research and Development Office, named Director of Government Relations, Aerolab Development Co.

Ben W. Badenoch: General Manager, Aero Hydraulics Division of Vickers Inc., elected a Vice President. Joined Vickers in 1949. Appointed Division General Manager in 1957.

John H. Richardson: Appointed vice president - marketing of Hughes Aircraft Co. He has been with the company for 12 years, and served as director of marketing since last July. Has held Hughes posts as director of military sales, assistant director of sales, manager of the Dayton, Ohio office, contracts supervisor and staff planner.


RICHARDSON

T. Phillips Morgan: Appointed director of operations, Consolidated Systems Corp. Was formerly controller of Consolidated Electrodynamics.

Murray W. Lindenthal: Formerly with The Martin Company since 1956, has been appointed to the staff of Hoover Electronics Co. He will be one of Hoover's senior electronics engineers.

Carl A. Hultberg: Formerly an engineering group leader, Bell Aircraft Corp., has joined the staff of Hoover Electronics Company as Senior Project Engineer.

Dr. Howard S. Seifert: Recently joined technical staff, United Technology Corp., named Director, Professional Development Staff.

Pacific Semiconductors, Inc. has announced three new vice presidents: **Lawrence T. Lindgren,** vice president, manufacturing; **Dr. John W. Peterson,** vice president, research and development; and **Sidney L. Spiegel,** vice president, marketing.

Joseph B. Elliott has been appointed president and general manager of the York Division of Borg-Warner Corporation. Was formerly executive vice president in charge of all engineering, manufacturing, and distribution of consumer products for Radio Corporation of America, and president of Schick, Inc. Has also been president of Teledynamics, Inc., and executive vice president of Raymond Rosen, Inc., RCA distributer.

Gustave A. Bleyle, Jr., has been named vice president in charge of engineering activities at the Santa Monica, Calif., office of Arthur D. Little, Inc. He joined the firm in 1947 and has been active in the design development and construction of liquefied gas equipment for use in missile projects and related applications.

contracts

NAVY

$9,100,000—North American Aviation, Columbus Div., for construction of a radio telescope reflector at Sugar Grove, W. Va.

$4,000,000—Stromberg-Carlson Div. of General Dynamics Corp., for special transistorized airborne radio equipment.

$2,114,886—Del Mar Engineering Laboratories, Los Angeles, for weapons training systems for Navy fighter aircraft.

$500,000—Babcock Radio Engineering, Inc., for remote guidance and control equipment.

ARMY

$20,075,000—H. B. Zachry Co., San Antonio, and **Brown and Root, Inc.,** Houston, for construction of *Atlas* launch complexes near Dyess AFB, Abilene, Tex.

$6,642,496—Chrysler Corp., for *Jupiter* repair parts and modification services (three contracts).

$4,114,000—Johnson, Drake & Piper, Inc., Downey, Calif., for construction of two *Atlas* missile launching silos at Vandenberg AFB.

$2,070,000—The Martin Co., for R&D on the *Pershing* system.

$1,869,998—Sperry Rand Corp., for production engineering on the *Sergeant* program.

$583,339—Sperry Utah Engineering Laboratory, Salt Lake City, for *Sergeant* missile repair parts.

$495,247—Hayes Aircraft Corp., Birmingham, Ala., for engineering, design, fabrication, modification, and re-work, ground services equipment (*Saturn* program).

$470,981—Brown Engineering Co., Huntsville, Ala., for engineering and manufacturing services (*Saturn* program).

$300,000—Sperry Utah Engineering Laboratory, for technical publications.

$159,789—Electro-Optical Systems, Inc., Pasadena, for R&D work in areas of exploding wires, space heat rejection systems, and stressed plate optical shutter fabrication.

$66,909—Hayes Aircraft Corp., Birmingham, Ala., for design, engineering, fabrication installation and maintenance services.

$46,200—Brown Engineering Co., Huntsville, Ala., for engineering and fabrication services.

AIR FORCE

$130,000—Space Electronics Corp., Glendale, Calif., for research, experimentation and development in long range communications using earth currents.

$85,331—Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif., for classified work on target missile flight service program.

$74,975—Hughes Aircraft Co., Culver City, Calif., for radar research.

$73,420—Consolidated Electrodynamics Corp., Pasadena, for study program aimed at increasing the percentage of useful data telemetered from satellites and space vehicles during extended flights.

$53,418—The Firestone Tire and Rubber Co., Los Angeles, for *Corporal* missile repair parts.

$44,986—Vickers Inc., Aero Hydraulics Div., Torrance, Calif., for *Nike* missile spare parts.

$39,185—Resdel Engineering Corp., Pasadena, for research and development.

$37,829—Rocket Power/Talco, Div. of Gabriel Co., Pasadena, for basic research on thermodynamics of reactions involving light metal oxides and propellant combustion gases.

$33,800—Cooper Development, Div. of Marquardt Corp., Monrovia, Calif., for loading, clustering and testing *Loki* motors.

$26,711—Motorola Inc., Scottsdale, Ariz., for destruct command receivers.

NASA

$1,758,440—Chance Vought Aircraft, Inc., Vought Astronautics Div., Dallas, for design, development, fabrication, acceptance tests for 8 vehicle launchers and ground support equipment.

$548,000—Hoffman Electronic Semiconductor Div., Los Angeles, for lunar study program to fabricate solar power panels.

$325,000—California Institute of Technology's Jet Propulsion Laboratory, for design, packaging and fabrication of a digital data handling system for transmission of information from deep space.

$303,821—Hermes Electronics Co., Cambridge, Mass., for services and materials for range programing and timing systems.

$118,000—California Institute of Technology's Jet Propulsion Laboratory, for fabrication and test of flight decoder units, ground equipment and system test consoles related to a spacecraft radio command system.

$44,800—Horne Brothers, Inc., Newport News, Va., for services and materials for new turning vanes and wind screen.

MISCELLANEOUS

$250,000—The Twin Coach Co., for production of consoles for electronic equipment used in missiles.

Lear, Inc., for design and production of a digital servo system, from **Lockheed Missile and Space Division,** amount undisclosed.

Rucker Co., Oakland, Calif., for structural test fixture for simulation of stresses encountered during the initial launching period of *Polaris* missiles, from Aerojet-General Corp., amount undisclosed.

Navy's RUM

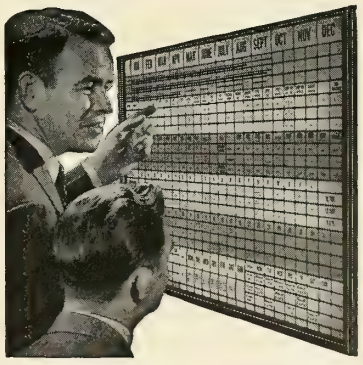
(Continued from page 35)

with orange filters to achieve a stable pattern.

• **Vertical lift appendage**—The Hughes design for the vertical lift appendage has a large three-bladed fixed-pitch 30-inch width rotor mounted on the vertical axis to the hub of a toroidal-shaped float and is attached to the vehicle through a ring mechanism interconnected by cables.

Three individual, pod-mounted, oil-immersed electric motors mounted directly on the rotor blades would provide propulsion for the rotor. Each motor, which generates 25 hp per blade, would power a 12-in., three-blade, standard marine propeller to drive the rotor blade. This combination would permit the vehicle not only to rise and descend while under water but also impart lateral movement in any direction. The normal rate of descent for the vehicle would be approximately one foot per second. During forward speed and climbing, the unit would have a speed slightly in excess of two feet per second. Guidance and operational control could be by narrow band-width radio frequency carried over the main vehicle cable.

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when and where

JUNE

Machinability Seminar, Pennsylvania State University, University Park, June 6-10.

National Society of Professional Engineers, Annual Meeting, Statler Hotel, Boston, June 8-11.

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

1960 Radio Frequency Interference Symposium, sponsored by the IRE, Shoreham Hotel, Washington, D.C., June 13-14.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 12-15.

Symposium on Molecular Structure and Spectroscopy, Dept. of Physics and Astronomy, Ohio University, Columbus, June 13-17.

1960 Cornell University Industrial Engineering Seminars, Ithaca, N.Y., June 14-17.

Special Summer Program on Fluid Power Control, Massachusetts Institute of Technology, Cambridge, June 14-24.

American Institute of Chemical Engineers, Del Prado Hotel, Mexico City, Mexico, June 19-22.

University of Connecticut, Institute for Practical Research on Operations, Storrs, June 19-25.

Atomic and Molecular Gas Beams Symposium, University of Denver, Denver, June 20-22.

ASME Applied Mechanics Conference, Pennsylvania State University, University Park, June 20-22.

Gordon Research Conference, Colby Junior College, New London, N.H., June 20-24.

Institute of Navigation, 16th Annual Meeting, Air Force Academy, Colorado Springs, June 23-25.

International Machine Tool Trades Exhibition, Brettenham House, Lancaster Place, London, W. C. 2, June 24-July 8.

Fourth National Convention on Military Electronics, sponsored by IRE PGMIL Sheraton Park, Washington, D.C., June 27-29.

JULY

Metallurgical Society of AIME Conference on The Response of Materials to High-Velocity Deformation, Estes Park, Colo., July 11 and 12.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

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editorial . . .

The Case of Mr. Hagerty and the U-2

Looking back upon some notable contradictions in the information given the public after the U-2 affair, it is very difficult to isolate the part played by the one man most responsible—James C. Hagerty, the White House press officer.

If Jim Hagerty occupied his post in the reasonably anonymous style of previous incumbents under previous Presidents, it would be possible to assume that the press officials of the other government agencies concerned were operating under the best guidance of their own official knowledge and judgment.

In this case it is a little difficult to assume that. While Hagerty doesn't make it a constant practice, he has never when he felt the occasion demanded, been reluctant to dictate policy to press officers of the State Department, the Defense Department or the National Aeronautics and Space Administration.

The question in the case of the U-2 is how much policy did Hagerty dictate? Or, conversely, how much did he fail to dictate? Can he evade the responsibility for the worst public relations fiasco the administration and the nation has suffered since—since when?

We suggest that while Congress is investigating it might like to hear from Jim Hagerty what his responsibility was in the following welter of statements given the press and the public:

The original announcement by the Air Force that the U-2 was missing on a weather flight after the pilot had radioed an oxygen failure; denial that the flight had been a military reconnaissance flight over Russia; admission that it had been; denial that such a flight had been authorized; admission that it had been; a declaration that such flights would continue; a denial of this declaration and—finally—a declaration that they would *not* continue.

In issuing the above rather remarkable sequence of statements, the press officials of the State Department and of NASA were caught in the attitude of being either fools or liars. So was the Vice President of the United States.

We do not credit Hagerty with dictating our foreign relations or in deciding when confession is good for the national soul, but we do credit him with dictating the public relations policy of the government down to small details when he thinks the occasion warrants.

In the case of the U-2, a cover plan had been devised which wouldn't hold water—yet NASA was left in the position of upholding it even while it was being abandoned; the President was placed in the position of confessing he didn't know who was running the country—a position from which he had to be extricated; the Secretary of State made the statement about the flights continuing—a statement so obviously untenable that it had to be denied; someone forgot to so inform the Vice President and he continued affirming the statement after it had been denied.

All of these events were directly or indirectly press and public relations matters and they were handled with a minimum of competence and a maximum of hysteria.

Because of the position the White House press officer has created for himself, it is difficult to separate him from the handling of the all-important public relations details of the U-2 affair. We feel that his part in the fiasco is a matter of considerable importance to the public. It would be very interesting to learn his reaction to an invitation from Congress to tell that story.

Clarke Newlon

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- ☐ DEVELOPMENT
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- ☐ SYSTEMS DESIGN
- ☐ OTHER:
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- ☐ DIGITAL COMPUTERS
- ☐ GUIDANCE DEVICES
- ☐ MICROWAVES
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- ☐ INDUSTRIAL DYNAMICS
- ☐ INFRARED
- ☐ SYSTEMS ANALYSIS
- ☐ R-F CIRCUITS
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- ☐ INSTRUMENTATION
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June 13, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY



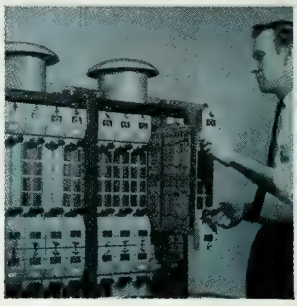
Periscope for Astronauts

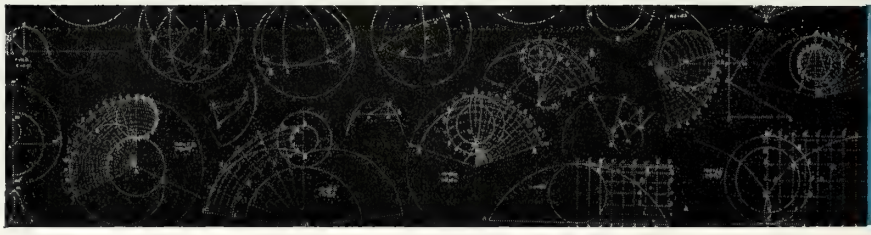
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AN AMERICAN AVIATION PUBLICATION

LIBRASCOPE COMPUTER FACILITIES

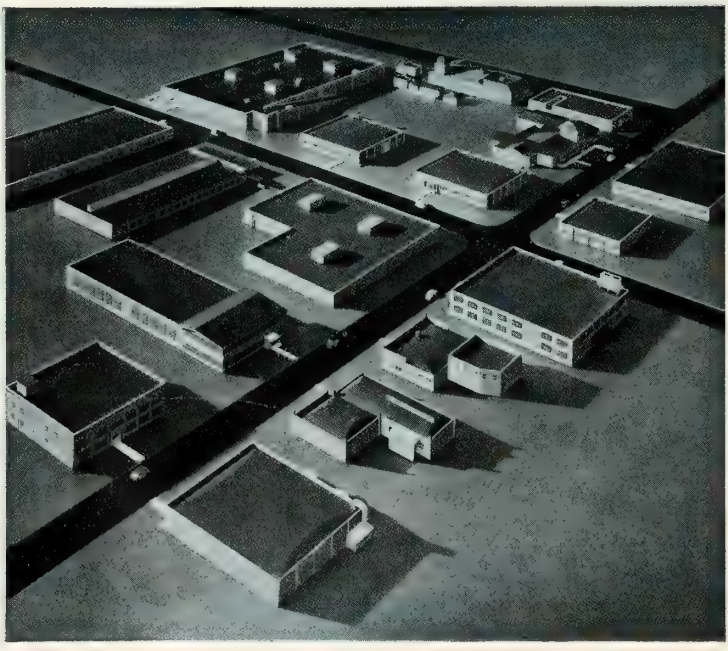
Shown below is a composite view of Librascope's facilities where a variety of computer systems are currently in different stages of design and production. Some are strategically involved with national defense...others deal with business and industrial process control. Each is uniquely designed to answer a particular need. The success of these systems illustrates the value of Librascope's engineering philosophy: A decentralized organization of specialized project teams responsible for assignments from concept to delivery...and backed up by excellent research, service, and production facilities. For your computer requirements, call on the company whose breadth of diversification in computer technology is unsurpassed. ■ Librascope Division, General Precision, Inc., 808 Western Avenue, Glendale, Calif. For career opportunities write to John Schmidt, Engineering Employment. ■



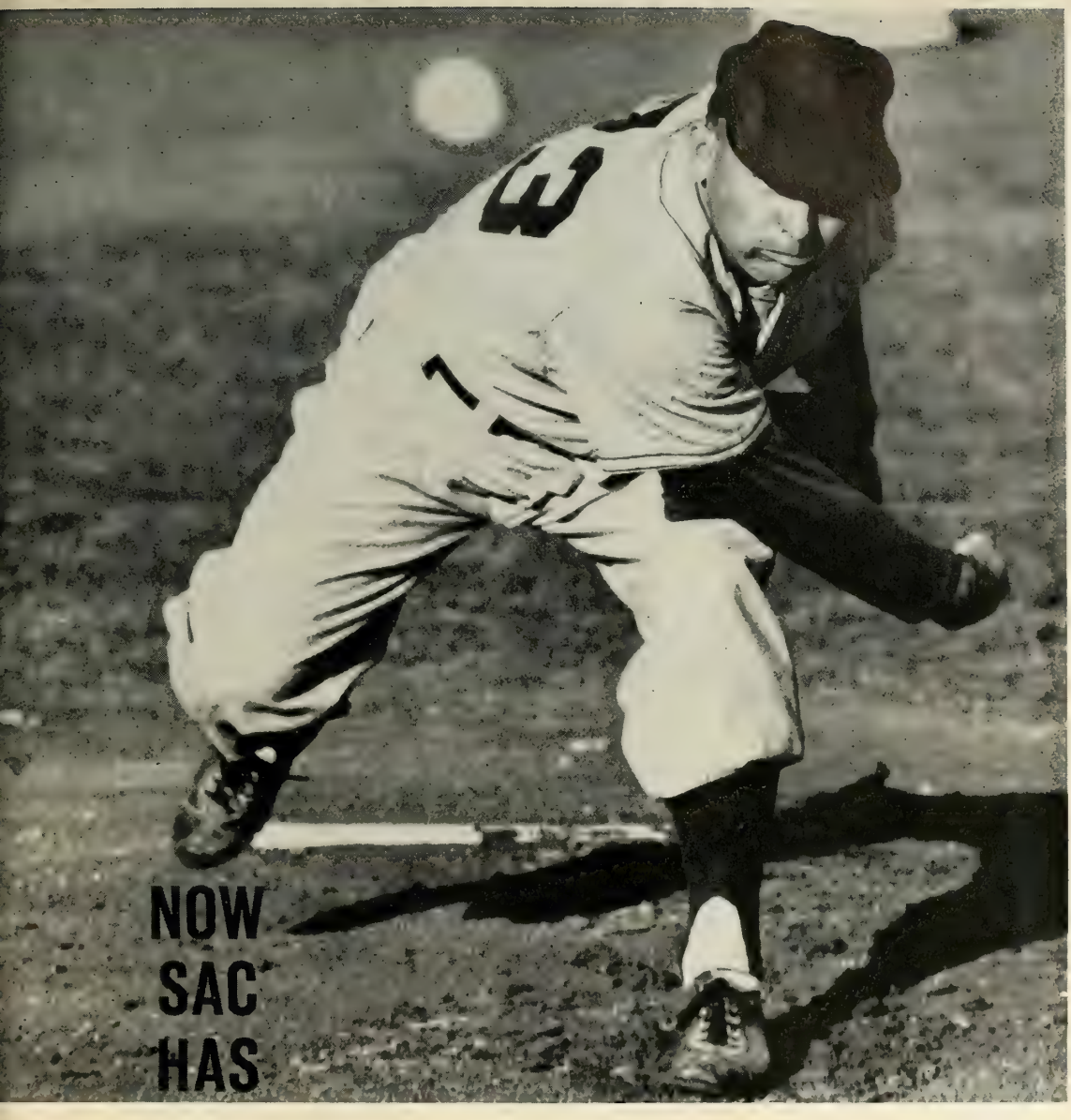




computers that pace man's expanding mind



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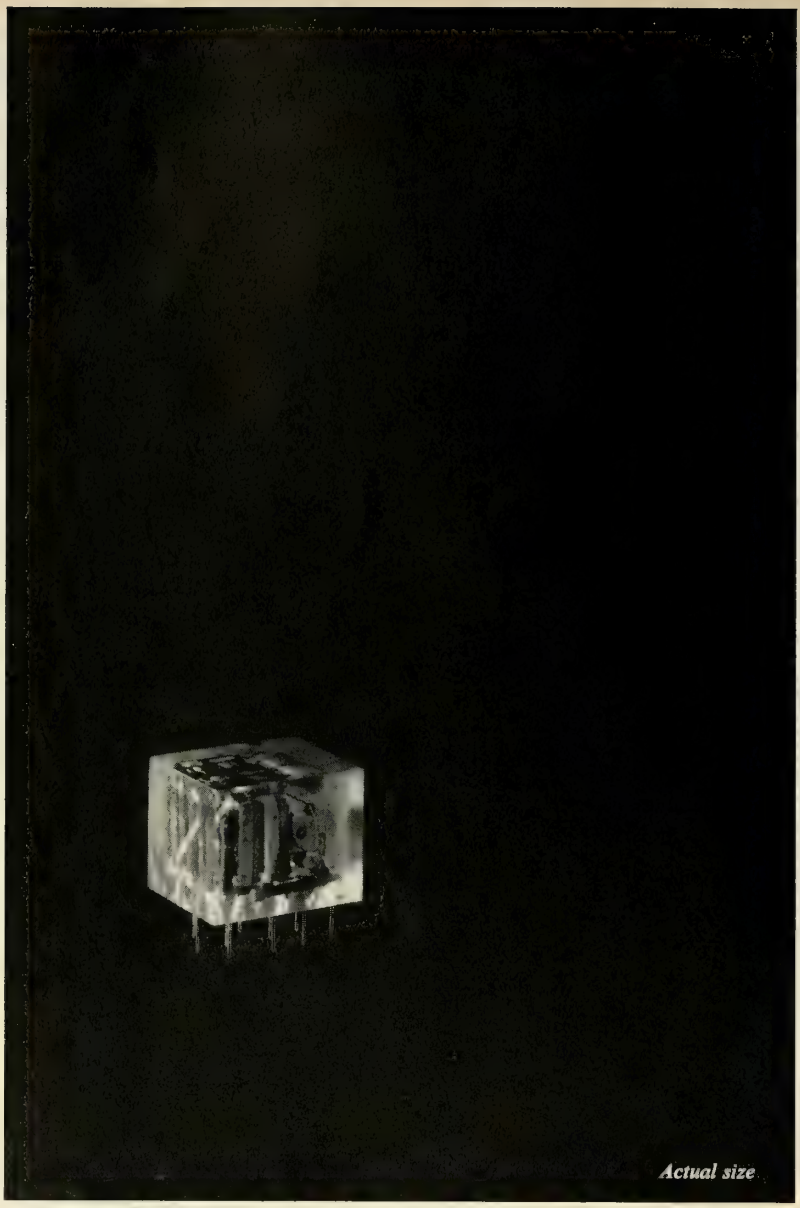
TWO STRIKES ON THE OPPOSITION

When SAC's B-52 crew steps up to the mound it can throw two deceptive curve balls before winding up to deliver the third strike. Two GAM-77 HOUND DOG air-to-surface missiles slung beneath the wings of the B-52 intercontinental bomber can quash enemy defense centers and clear a path to the main target.

Blazing into action at supersonic speeds, these GAM-77's can be used either on resistance points or on the main objective itself. Inertially guided, they can fox enemy radar by making passes at pseudo-targets before heading for the actual one. To further confuse the opposition, the jet-powered missiles can fly high or low on the way to the strike zone.

The GAM-77 HOUND DOG was designed and is in production for SAC by the Missile Division of North American Aviation.

THE MISSILE DIVISION OF
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THE MISSILE & SPACE WEEKLY

missiles and rockets

June 13, 1960 Volume 6, No. 24

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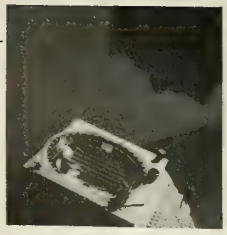
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Mercury astronaut will get man's first view from space back to earth through this periscope developed by the Perkin-Elmer Corp. *See report on p. 12.*

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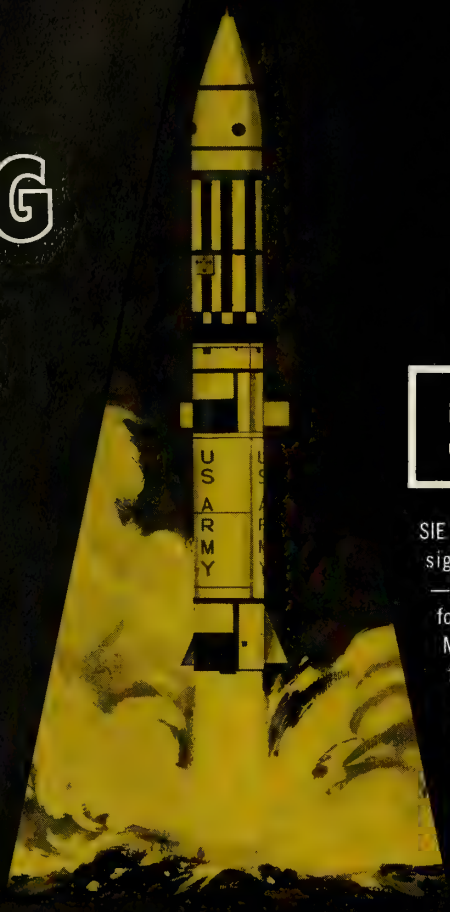
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PERSHING

AIRBORNE TELEMETRY SIGNAL CONDITIONING SYSTEMS

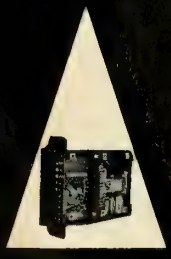


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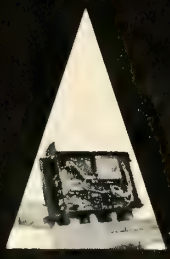
SIE

SIE provides airborne telemetry, signal conditioning systems —using solid state electronics— for the U. S. Army's new Pershing Missile, recently successfully test-fired at Cape Canaveral. SIE measurement equipment delivers unexcelled reliability under extreme airborne environmental conditions—providing the Martin Company with advanced, precise electronic missile measurement

For detailed information about SIE telemetry, signal conditioning systems, please contact LIGHT MILITARY PRODUCT MANAGER.



AC-3A
AC Amplifier



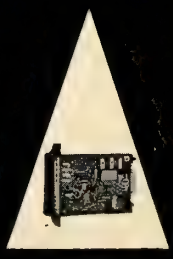
TPC-27
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reviews

THE ARDC MODEL ATMOSPHERE, 1959, R. A. Minzner, K. S. W. Champion, and H. L. Pond, USAF. Order PB 161305 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 151 pp., $2.75.

A revision of a 1956 book, this edition is based on new rocket and satellite data. A model of the earth's atmosphere up to 700 kilometers is described.

THE USE OF HIGH-ALTITUDE ROCKETS FOR SCIENTIFIC INVESTIGATIONS: AN ANNOTATED BIBLIOGRAPHY, M. Benton Technical Information Div., USNRL. Order PB 151805 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 132 pp., $2.75.

The growth and development of upper-atmosphere study by rockets is described in periodical articles and technical reports, referenced and annotated for the period from 1946 through mid-1959.

MISSILE AERODYNAMICS, Jack N. Nielson, McGraw-Hill, New York, 450 pp., $12.50.

The text's purpose is to give a "rational, unified account of the principal results of missile aerodynamics," which the author succeeds in doing through strong reliance on NACA and NASA reports and on his own experience at the former agency, where he was an aeronautical research scientist. The presentation is clear and standard, corresponding to the classical report methods set up at NACA.

The subject matter is mostly post-war material, covering bodies, wings, and tails and the interactions between them. Methods are given for determining the air flow around missiles including vortex generation. Chapters are devoted to stability derivatives for missiles, and aerodynamic controls.

PHYSICS AND MEDICINE OF THE ATMOSPHERE AND SPACE, edited by Maj. Gen. Otis O. Benson, Jr. and Dr. Hubertus Strughold, John Wiley, New York, 645 pp., $12.50.

In late 1958, the Second International Symposium on Physics and Medicine of the Atmosphere and Space was held at USAF's School of Aviation Medicine in San Antonio. Papers then given by prominent authorities in the field have been collected, edited and published in the present book.

The book seems well worth having as a succinct and technical record of the state of the art in space as related to physics and medicine. It gives most attention to the astronaut's environment in space. Radiation problems in space and laboratory simulation of ambient conditions in space are considered, together with such other topics as vehicles for space exploration, weightlessness, and escape and rescue in space.

AEROSPACE DICTIONARY, Frank Gaynor. Philosophical Library. 260 pp., $6.

Some sample definitions:

Space flight—flight in outer space.

Space propulsion—Propulsion of a space vehicle through space.

Deep space probe—A probe that penetrates deep into space.

Headward acceleration—Acceleration of the human body in the direction of the head.

Interstage section—A section of a missile that lies between stages.

THEORY OF INERTIAL GUIDANCE. Connie L. McClure. Prentice-Hall, Inc., Englewood Cliffs, N.J. 368 pp., $9.00.

Comprehensive and sound in theory, this book provides a solid approach to the fundamentals and theories of inertial guidance. It reviews the classical concepts of Newtonian dynamics and motion, and includes both past and current research on the subject to make it most timely. Classical gyro-dynamics and the preliminary theory of stabilized platforms are also covered. Six appendices and an extensive bibliography make the book a valuable reference for senior and graduate-level studies based on an undergraduate background in mathematics and elementary mechanics.

Like many of its kind, this book is afflicted with the tendency toward high-level "engineeringese" that makes it difficult reading even for its intended audience. Simplification of terms and avoidance of unnecessarily obtuse and complicated phraseology would do much to make it more readable and interesting.

THE DYNAMIC BEHAVIOR OF THERMOELECTRIC DEVICES. Paul E. Gray. Technology Press (MIT) and John Wiley & Sons, Inc., New York. 136 pp.

A Technology Press Research Monograph, this is the first published report that investigates the small-signal dynamic behavior of thermoelectric devices. Based on a study sponsored by the Air Force, it was the basis of a doctoral thesis submitted by the author.

The book considers the dynamic behavior of thermoelectric devices as a prerequisite to their control in useful applications. Since such devices are nonlinear distributed-parameter systems, it is difficult to analyze their behavior exactly. This study, therefore, is based on linear small-signal distributed-parameter models for which useful analytical results can be obtained.

FUNDAMENTAL INVESTIGATIONS OF ELECTRICAL POWER SOURCES. VOL. 2, BATTERIES, E. J. Hellund, Plasmadyne Corp. for USAF. Order PB 161262 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 97 pp., $2.25.

This volume is a survey of the performance characteristics, structure, power-weight ratios, and power-volume ratios of chemical and nuclear batteries. It also evaluates fuel cells.

Performance data on various battery types include watt hours per pound, watt hours per cubic inch and other data.

The report includes charts, graphs, illustrations and tables of comparative statistics on the performance of various cell types.

AUTOMATION AND PERSONNEL REQUIREMENTS FOR GUIDED MISSILE GROUND SUPPORT FUNCTIONS. W. B. Knowles. Order PB 151978 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 49 pp., $1.25.

The study was conducted to determine the relations between automation and personnel requirements for guided missile ground support functions.

Snark, Bomarc, and *Mace* systems were investigated regarding organization-level maintenance of electronic equipment. A maintenance system concept was developed to explain in more detail the respective roles of automatic equipment and manual operations and general outline of maintenance system factors.

CURRENT REVIEW OF THE SOVIET TECHNICAL PRESS, Order No. 60-21441 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. Published weekly. Subscription $7 for six months.

This weekly review covers Soviet articles in many fields of science and technology. Articles are not translated in their entirety, but a citation is given to the original Russian publication. OTS says the time lapse between appearance of an original article in a Russian publication and its review is no more than a few weeks and usually within a month.

BASIC ULTRASONICS, Cyrus Glickstein. John F. Rider Publisher, Inc. New York. 144 pp., $3.50 soft cover, $4.60 cloth cover.

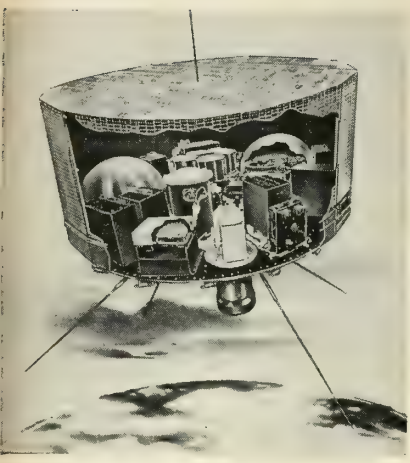
The book is divided into three major sections covering the theory of ultrasonic waves, their generation, design of equipment, applications, biological and chemical effects, cameras and instrumentation.

Review questions are contained at the end of each section and a glossary of ultrasonic terminology is included.

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TIROS I...

"mission accomplished"



By the end of its first week in orbit, TIROS I had already accomplished its basic mission as an exploratory vehicle. It had established beyond doubt that meaningful cloud-cover pictures could be obtained by a satellite, and that the complete system set up to acquire them worked.

The payload performance more than lived up to expectations, sending down thousands of valuable cloud cover pictures for study and giving man his first consistent "star's eye" view of his own planet.

TIROS was placed in an almost perfectly circular orbit. This was due to the fine engineering talents of the Douglas Aircraft Company which, in cooperation with the Aerojet-General Corporation, Bell Telephone Laboratories, and Alleghany Ballistics Laboratory, built the Thor-Able launching vehicle for the U. S. Air Force.

Developed and built by RCA Astro-Electronic Products Division under the auspices of the National Aeronautics and Space Administration and the technical direction of the U. S. Army Signal Corps, TIROS I is actually the work of many hands. Here are some of the important sub-contracted equipments which contributed to the successful functioning of TIROS.

The Beacon Transmitters broadcast a tracking signal and telemetered vehicle parameters. These transmitters and the telemetry switches were supplied by the ASCOP Division of Electro-Mechanical Research, Inc.

The Infra-Red Horizon Detector assists in the determination of the position of the satellite spin axis in space. The detector was made by Barnes Engineering Co.

The Clock and Sequencing Units which time and control the remote operation of the TV cameras were supplied by the General Time Corporation.

The TV Transmitters are 2-watt FM units which send down both the video signals and accompanying North-Indicator signals. The transmitters were manufactured by Radiation, Inc.

The Tape Recorders are the heart of the satellite's remote picture storage capability. The castings were produced and machined by Bridge Tool and Die Works, Inc. according to specification supplied by RCA.

The Power Supply of TIROS I consists of a solar-cell matrix (containing more than 9,000 cells) which is used to charge 63 Nickel-Cadmium storage batteries. The cells were made by International Rectifier Corporation. The batteries were supplied by Sonotone Corporation, and the DC power converters by Sorens Company.

Spin-Up Rockets mounted arou base perimeter of TIROS I will b when necessary, to restore the sa spin rate to the optimum value of They were made by the United Flare Corporation and Associates

This is by no means a complete tory of the payload of TIROS I. Nu other suppliers provided compone services for the satellite and the station equipment essential to the of the mission. Other items were factured entirely at RCA's Astr tronic Products Division. And it w that the complete system was d and integrated into the highly su satellite package and associated station equipment for the TIROS under the technical direction of th Army Signal Research and Devel Laboratory.



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The Countdown

WASHINGTON

Missileer Award Near

Look for the Navy to name a contractor by the end of the month for a slow-flying long-range "Missileer" aircraft to carry the *Eagle* missile. Insiders are betting Chance Vought will get the multimillion-dollar award.

In Solid Together—So Far

To anyone who cares to ask, NASA's new conical solid-propellant motor is being billed as "complementary" to the Air Force's Project 3059. United Technology Corp. has the $186,000 study contract on the conical motor and the AF plans to let a contract for the other in a few weeks. However, both Project 3059 and the NASA conical motor would involve eventual fabrication of huge solid boosters of more than one million pounds thrust. Which means—sooner or later—someone will have to decide which one will be pushed to completion, setting the stage for another interagency squabble.

Sky Bolt on Tankers

Long-range jet aircraft such as the KC-135 tanker is expected to be the principal carrier of the *Sky Bolt* air-launched ballistic missile. Britain will probably use the Vickers jet transport. Interceptors also may carry the weapon.

No Quick Solution

Navy plans to produce a cheap, shore-bombardment missile with a conventional warhead now appear to involve tougher problems than many thought. The specs call for a missile of very high accuracy, very high reliability and relatively low cost. Study contracts are in force with several firms.

More X-15 and Scout Tests

First flight of the *X-15* with a 50,000-lb.-thrust XLR99 liquid engine made by Thiokol may come any day. Initial powered flights will be in "low gear"—about half the engine's potential, but still more than twice the thrust of the present pair of engines . . . NASA is expected to make a second flight test of the *Scout* solid-propelled rocket shortly. The first shot on April 18 aborted.

Talent Pool

The dispute over duplication in space medicine seems to be solved with the Air Force assigning a top man in the field—Col. C. H. "Chuck" Roadman—to NASA's Office of Life Sciences. Roadman has been chief of human factors under the AF's deputy chief of staff for R&D.

INDUSTRY

Better Batteries for Space

Reliability of batteries for satellites is proving a nagging problem. Accordingly, a considerable R&D effort is about to get under way. The problem is particularly acute in low-altitude satellites where solar cell/battery units are subject to rapid charge-discharge cycles—once each hour or so—for long periods of time.

Big Space Chamber Wanted

The Air Force is getting ready to build an enormous space environmental chamber at the Arnold Engineering Development Center at Tullahoma, Tenn. It will be capable of testing space vehicles—booster and all. Estimated cost: more than $50 million. This chamber will be in addition to a smaller one for testing only payloads such as the *Dyna-Soar* glider and satellite vehicles, which will cost $10 million to $15 million.

Single DOD Electronic Manager

In an effort to eliminate duplicate purchasing, the Government Accounting Office is urging DOD to establish a single central agency to manage electronic supplies. GAO says such an agency should monitor the entry of all new equipment into the supply system as well as coordinate and consolidate procurement throughout the services.

14-year Safety Record

The Air Force Ballistic Missile Division reports that in 14 years of launching ballistic missiles during their development phase there have been no fatalities. And despite some industrial fatalities—the BMD doesn't say how many—"the total ballistic missile safety record is excellent."

Aerojet Wins Hybrid Rocket

Drawn-out competition for the Navy's hybrid liquid-solid-fueled rocket has ended with the award of a $580,000 contract to Aerojet-General Corp.

On Mahogany Row

Thiokol Chemical is setting up a separate nuclear space propulsion unit at Parsipanny-Troy Hills, N.J. . . . Martin Co. is now working in-house on a 10,000-15,000-lb.-thrust nuclear rocket sustainer . . . The nation's only commercial manufacturer of cyclotrons—Mevaa Corp., Santa Monica, Calif., is now a subsidiary of Hughes Aircraft . . . and High Voltage Engineering Corp. has acquired Applied Radiation Corp., Walnut Creek, Calif.

INTERNATIONAL

Government-Owned Missile Industry?

Shift to a government-owned and privately-managed guided missile industry is being recommended for Japan. The suggestion was made by a nine-man mission which inspected U.S. missile operations.

On the Way Up

Electronics production figures for 1959 show Japan taking a giant stride forward in detection and navigation equipment. In one year, the total has jumped from $7.9 million to $16 million. Output of radar alone has more than doubled.

Secret Deal Cooking?

Sources in Britain report Convair and deHavilland have concluded a missile deal. Details have been kept secret.





Pilâtre de Rozier and Marquis d'Arlandes (November 21, 1783), using a Montgolfier balloon, were the first to leave the earth to test man's physiologic reactions. This experiment was the forerunner of intensive Space Medicine studies of today.

SPACE MEDICINE

There is a relatively narrow zone above the surface of the earth in which man's physiologic mechanism can function. Hence the unrelenting search by Lockheed scientists into many aspects of Space Medicine.

Engineers already have equipped man with the vehicle for space travel. Medical researchers now are investigating many factors incident to the maintenance of space life—to make possible man's flight into the depths of space. Placing man in a wholly new environment requires knowledge far beyond our current grasp of human biology. Here are some of the problems under investigation: The determination of man's reactions; the necessity of operating in a completely closed system compatible with man's physiological requirements (oxygen and carbon dioxide content, food, barometric pressure, humidity and temperature control); explosive decompression; psycho-physiological difficulties of spatial disorientation as a result of weightlessness; toxicology of metabolites and propellants; effects of cosmic, solar and nuclear ionizing radiation and protective shielding and treatment; effects on man's circulatory system from accelerative and decelerative G forces; the establishment of a thermoneutral range for man to exist through preflight, flight and reentry; regeneration of water and food.

Exploration into unknown areas such as Space Medicine, provides endless stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum—from pure basic research to development work, in support of current projects. Space Medicine is but one phase of Lockheed's complete systems capability in missiles and satellites. To maintain this position of leadership calls for an extensive research and development program—ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space; oceanography; fuel cells; space station; space navigation; solid state electronics.

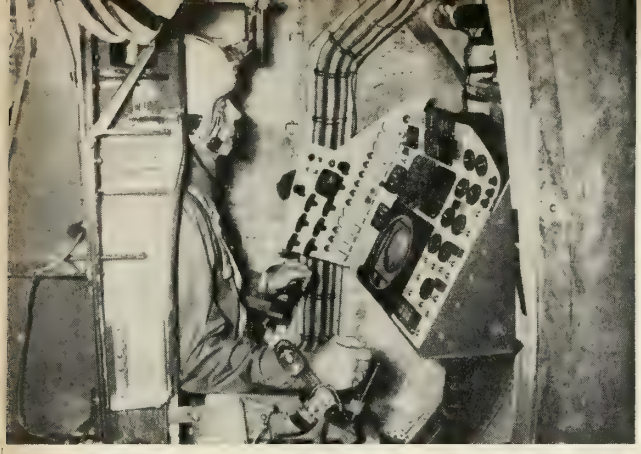
Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. F-29A, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

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MERCURY ASTRONAUT undergoes flight simulation with instrument panel in the Navy's Human Centrifuge.

Mercury Instrumentation

Pilot's Fate Depen

Engineers try to design "fail-safe" system for the man-in-space capsule, with instruments able to compensate

by Paul Means

A few hundred pounds of instruments, seven miles of electrical wiring, mechanical linkage and several clock mechanisms hold the key to survival for the first astronaut who orbits earth within a *Mercury* capsule sometime in 1961.

Design and development of these components has been one of the greatest challenges yet posed to the practitioners of the new art of space instrumentation.

The problems have mostly been solved and the instrument configuration of the capsule is now fairly firm. The remaining answers will be found when the components are flight-tested. This work has been conducted by the McDonnell Aircraft Corp.—prime contractor for the capsule—and its subcontractors, by the laboratories of NASA's Space Task Group, and by other field centers of the space agency.

Design and development of the *Mercury* capsule's instrumentation has been under way since the old National Advisory Committee for Aeronautics began wind tunnel testing of capsule configurations over two years ago. The project began in earnest with the letting of the McDonnell contract.

The problems confronting *Mercury's* instrumenters began with the size and configuration of the capsule, which were frozen by the decision to use a ballistic re-entry vehicle and an existing ICBM booster.

This meant that space available and configuration were frozen by booster and aerodynamic requirements even before the instrumentation program got under way. An added consideration was that most of the instruments had to be mounted near the blunt end of the capsule to keep the center of gravity near the base.

Within these severe limitations, the instrumentation experts were required to come up with a completely reliable system that would provide the astronaut with the atmosphere and temperature necessary for survival, keep him and his instruments in constant contact with ground stations, and provide for a fail-safe operation of the capsule's flight and its abort from orbit.

• **Environmental control system**—The primary job of keeping the astronaut alive is the responsibility of the environmental control system being developed by McDonnell and its system subcontractor, the AiResearch Manufacturing Division of the Garrett Corporation.

There are two independent systems in the *Mercury* capsule that can keep the astronaut alive for a maximum of 28 hours: the cabin circuit and the suit circuit. Both operate simultaneously but either can operate in case of failure of the other. Both systems have redundant safety features which can maintain satisfactory operation after failure of certain components. The systems are operated automatically, and can be operated semi-automatically or manually by the astronaut.

Basic functions of the environment system are: to provide metabolic oxygen, pressurization (5psi) and ventilation to the suit and cabin; to maintain selectible cabin temperature between 50° and 80° in orbit and a maximum 200° during launch and re-entry; to remove carbon dioxide and water produced by the astronaut; and to provide comfortable humidity/temperature combinations within the pressure suit.

Common supplies to both systems are the oxygen containers and the coolant tank. Eight pounds of oxygen is supplied from two spherical 7500 psi containers—enough for 26 flight hours with a consumption of 500 cc/min. and a maximum cabin leakage of 300 cc/mm. Pressure transducers supply data on the supply pressures and pressure reducers lower the primary supply pressure to 100 psi and the emergency supply pressure to 80 psi. The emergency supply is automatically actuated upon depletion of the primary supply.

The coolant tank, fitted with an elastic membrane so that oxygen forces water from the tank, supplies water to the cabin and pressure suit control system heat exchangers. Valves on the astronaut's instrument panel meter the water flow.

Electrical power is supplied as 115-volt 400 cycle a.c. current to drive system blower motors. Twenty-eight volt d.c. current is supplied to operate the various solenoid valves and system instruments.

• **Pressure suit control system**—Prior to launch, the astronaut closes his helmet face-piece and breathes 100% oxygen. Though he will later open visor and use the cabin's environmental system, anytime he chooses to close the visor the suit provides him with a complete environmental system.

The suit, a modification of the Navy's Mark IV suit developed by the B. F. Goodrich Co., has a ventilation system which admits oxygen at the chest connection, then distributes the air over the entire body and vents at the helmet connection. The pneumatic visor seal is operated by a separate high-pressure oxygen source, and can be unsealed by pushing a red button on the side of the astronaut's helmet.

The oxygen circulation within the suit picks up carbon dioxide, water vapors and body odors. The odors are removed by an activated charcoal bed, the CO_2 with lithium hydroxide, and the air is cooled in the heat exchanger. Water condensed from the oxygen is caught with a vinyl sponge which is squeezed out periodically into a condensate container.

In the event of cabin decompression a demand-type pressure suit regulator senses the loss in pressure and maintains the suit at 4.6 psi.

In the event that the normal suit pressurization systems fails, an emer-

n Seven Miles of Wiring

for any conceivable failure. Pilot himself would be only a back-up system for the instruments themselves

gency rate valve will immediately direct an oxygen flow of 0.01 lb./min. through the suit and out an exhaust port of the suit's regulator into the cabin; the pressure suit control system compressor is automatically turned off and a system shutoff valve closed.

If the suit's failure is not automatically sensed, the emergency rate valve also may be actuated manually by a control handle on the capsule instrument panel.

• **Cabin control system**—After launch, the astronaut will lift his visor and use the cabin's environmental system. A relief valve automatically controls the upper limit of cabin pressurization. The valve allows cabin pressure to follow ambient pressure up to 27,000 feet following launch. The oxygen is metered into the cabin between 10,000 and 27,000 feet, where the valve seals the cabin at 5.5 psi.

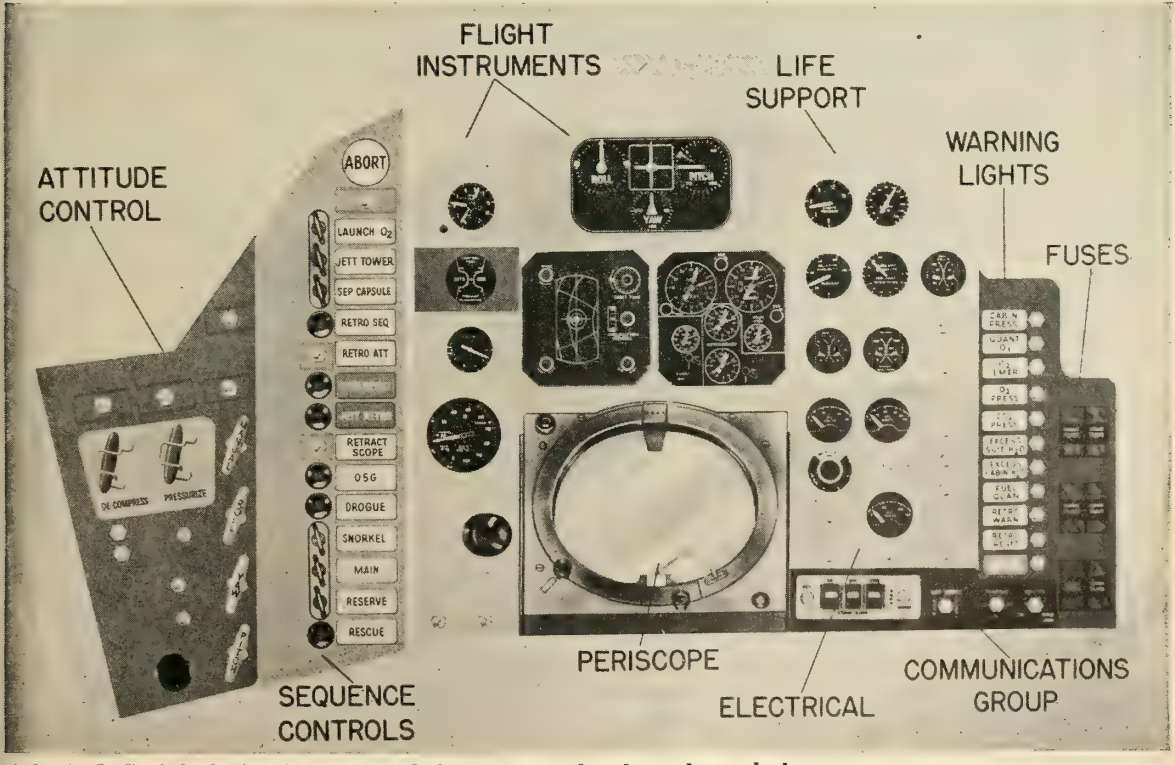
The astronaut's instrument panel also has a manual decompress lever, so that he can go back to his pressure suit's system and decompress the cabin in case of fire or buildup of toxic gasses. The regulator valve metering oxygen into the cabin shuts off during decompression when pressure has dropped below 4 psi so that cabin decompression does not deplete the oxygen supply. After decompression, another lever on the astronaut's console allows him to repressurize the cabin.

After re-entry when the capsule has dropped to 20,000 feet, snorkel inlet and outflow valves are opened by a barometric control. Simultaneously a shutoff valve in the pressure suit control system is closed and the emergency rate valve is opened. Ambient air is then drawn in through the snorkel, enriched with oxygen, forced through the pressure suit, and then exits into the cabin. The snorkel valve also has a manual backup on the sequence panel.

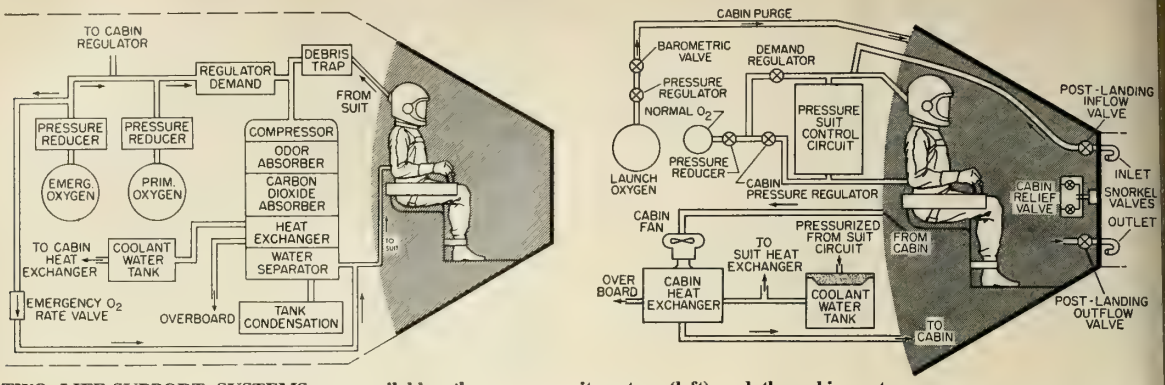
• **Controls**—The astronaut's controls for the environmental are grouped in the upper right-hand corner of the instrument panel (see cut). These give the pilot manual control over cabin pressure, temperature, relative humidity, oxygen partial pressure; primary and emergency oxygen supply pressure; and carbon dioxide partial pressure downstream of the lithium hydroxide canister in the pressure suit control system.

Warning lights are placed on the right-hand side of the console informing the astronaut when any particular facet of the environment system has failed. He then uses the instruments mentioned above to correct the situation.

Other manual controls provided on



A DRAWING of the Project *Mercury* capsule instrument panel to be used as a back-up.



TWO LIFE-SUPPORT SYSTEMS are available—the pressure suit system (left) and the cabin system.

the instrument panel to maintain the cabin's environment are the system controls located on the left side for cabin decompression and repressurization. On the flight sequence panel (left) are the launch oxygen supply and snorkel operation controls. Failure of these operations is indicated by a red light, telling the astronaut to complete the functions semi-automatically by pushing the buttons next to the lights. Successful completion of these functions is indicated by a green light.

• **Testing**—Before the astronaut ever relies on the environmental system a "black box" human simulator will be flown in the capsule. The box squirts carbon dioxide and consumes oxygen at the rate a human would.

• **Communications and power supply**—Another important segment of the capsule's instrumentation are the transmitters, receivers, and power supplies that allow constant communication with ground stations and facilitate recovery after abort.

Two-way voice links with the ground are affected by use of high-frequency and ultra-high-frequency transmitters and receivers operating simultaneously. Backing up these two systems is the UHF recovery phase transmitter/receiver operating from a separate power supply.

The UHF and HF systems weigh about 2½ lbs. each. The HF system operates at five watts and the UHF system at either one-half watt or two watts.

The HF transmitter's range depends on time of day, season of year, sun spots, etc., but should be effective for 700-1000 miles, and tests show that it could be effective to 4000 miles. The system will be flight-tested by airplane in the near future.

There are two identical command receivers and decoders through which three functions may be initiated from the ground. These are resetting the retro timer, firing the retros, and aborting the missions. Weighing about 5 lbs. each, they can also receive voice communication simultaneously with the UHF and HF links when the capsule is in range of the command transmitters. This is the only system that may not be in constant contact with the ground at all times.

There are also two telemetry links, both in the UHF band, but one at a higher frequency than the other. These, together with the capsule's tape recorder, are the prime sources of data. These transmitters weigh about one lb. each with a one lb. power supply, and use about 3.3 watts a minute each.

The *Mercury* network uses both C-band and S-band radars and consequently both C- and S-band radar beacons are carried aboard the capsule. Each weighs about 12 lbs. The C-band unit operates on 400 watts and the S-band on 1000 watts.

The recovery HF and UHF rescue voice transmitter receivers, mentioned above, weigh approximately 2½ lbs. each. The HF system operates at one watt, and the UHF at ½ or 2 watts.

As an aid to search and recovery, a combination of the SARAH and SEA-SAVE beacon is carried on the capsule and is activated after the main parachute is deployed. This system operates on the international rescue frequency of 500 kc. This system weighs 3½ pounds, and uses 7.5 watts for the UHF system and 1 watt for the HF system.

Another UHF SARAH beacon will be used on manned flights, and will have another antenna and a completely different power supply. This system weighs about 3½ lbs. and power will be in excess of 1000 watts.

While in orbit, all communication links with the exception of the radar beacons are multiplexed into a common discone antenna located in the truncated cone at the rear of the capsule.

This antenna section is jettisoned at deployment of the parachute, at which time the UHF links are transferred to a monopole antenna which is directly in back of the cylindrical portion of the capsule. Upon contact with the water, the parachute is jettisoned and an HF antenna is deployed by a helium-filled balloon.

• **Power supply**—Electrical batteries are used as the power source and alternating current is produced by solid-state inverters. There is a main battery and an isolated auxiliary battery. Also aboard is a backup standby battery which is automatically switched on in event of failure of either of the other two batteries.

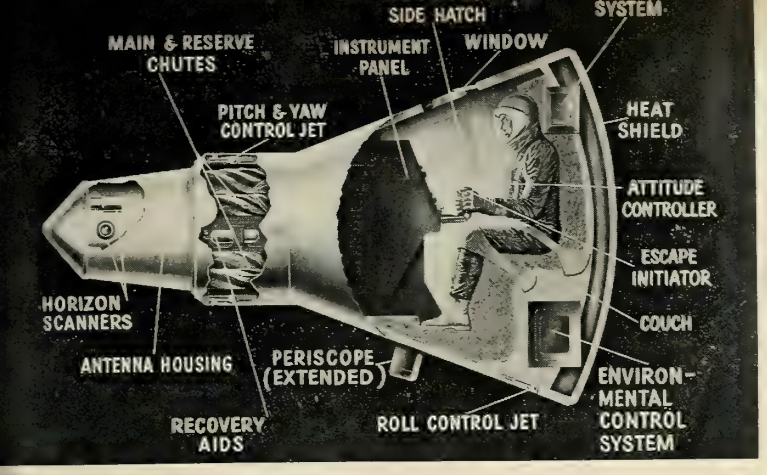
A standby inverter is also switched on in event of failure of either of the regular inverters.

Total rate of output capable by the battery systems is 1500 watt hours.

• **Control system**—If the control system functions properly, the astronaut's presence would not be needed, and his instrument panel would merely inform him when each of the sequenced events took place. The environmental control system, and its backups, have already been discussed. The important control systems direct the flight an abort of the capsule.

• **Attitude control**—Mounted in the top of the conical frustrum section are the infrared horizon scanners, whose signals are fed to the automatic control system. Capsule attitude is controlled by hydrogen peroxide reaction jets; the pitch and yaw are located in the main parachute housing, while the roll jets are located near the heat shield.

Six nozzles are used for each axis: three for positive and three for negative rotation. To conserve fuel, low-thrust jets are installed in addition to the high-thrust jets for the automatic system. The third nozzle is part of the variable thrust manually controlled system, operated by the astronaut with



his right-hand control.

The auto pilot used for automatic control consists of two attitude gyros, three rate gyros, and logic and programing circuits. During the flight, the vertical gyro is erected by the horizon scanners. Erection is programed every ten minutes. The vertical gyro is also constantly precessed in pitch to match the capsule's rotation about the earth. The directional gyro is also erected at the same time as the vertical gyro. This is accomplished by aligning the gyro axis to eliminate apparent precession due to yaw error as the capsule rotates in pitch as it circles the earth.

The thrust chambers are controlled by solenoid valves. The low H_2O_2 pitch and yaw chambers are one one-lb.-thrust units and the high-thrust chambers are 24-lb. units. For roll, six-lb. and one-lb. units are used.

The manual control system, which has another complete set of thrust chambers, is throttleable. The chambers are rated at 24 lbs. thrust for pitch and yaw and 6 lbs. of thrust for roll. Each chamber can be operated either through a solenoid valve or a mechanical valve, depending on the method by which the pilot is using his control system.

The pilot can, through his right-hand controller, command the rate of rotation in any of the three axes. Solenoid valves provide on-off control. Rate imput is obtained by an additional set of rate gyros. In the event of electrional failure, the pilot can elect to operate the same system directly through mechanical ligages using mechanical valves which are proportional. A third alternative available to the pilot is that he can control the thrust chambers of the automatic control system through electric switches on his controller, though proportional control or rate input would not be available.

During a normal mission, the automatic control system would use the damping mode (where the attitude sense is cut out) for a period of about five sec. Then the system would shift to the orientation mode while the capsule is rotated 180° in yaw and pitched up 34° into the retrorocket firing attitude.

The capsule stays in the retro attitude for five min. while range monitors determine whether the capsule is in a suitable orbit. Then the capsule is reoriented to the orbital attitude which is 14° nose up. This places the periscope axis normal to the earth.

At this point, the automatic control system is shifted to the orbit mode and remains there until it is time to fire the retros, when the control shifts back to the retro position. After the retros have fired, the system again shifts the capsule to the orientation mode, and reorients the capsule to the re-entry attitude of 1½° nose down. After entry into the atmosphere is sensed by a 1/20th-g acceleration switch, the automatic control system shifts into the damping mode where it remains until the main parachute is deployed, at which point the remaining H_2O_2 is jettisoned through the pitch and yaw thrust chambers.

• **Instrument panel**—The astronaut's console should allow him to safely complete his mission regardless of which automatic control fails to function, and even if the entire electrical system fails.

Simpler than the instrument panel in most aircraft, the controls and displays are grouped as to function. The left side (see picture) contains the controls concerned with attitude control and retros. The two large handles are used for decompression and repressurization, described earlier.

Next on the left side of the panel is the vertical sequence panel, which will indicate what functions have occurred automatically. If any of the lights come on red, it indicates a failure in the automatic sequence system, and the handle to the left is the pilot's control to actuate that particular system.

The next series of instruments indicate acceleration, quantity of control fuel remaining, rate of descent, and altitude. By watching the altimeter during descent the pilot will know when to manually deploy the parachutes if the automatic system malfunctions.

The instruments in the top center indicate capsule attitude and angular rates. With the aid of these instruments or the periscope, and the window, the pilot can orient the capsule and fire the retrorockets.

• **Periscope**—Designed by the Perkin-Elmer Corporation, the periscope will give the astronaut man's first view back to earth from space, and will provide him with visual navigational information about the satellite's flight path.

To minimize friction-causing proturbances in the capsule's outer shell, the periscope is mounted so that its objective cartridge extends and retracts through the skin of the space vehicle. The display area, on which light gathered by the objective lens passing through an optical system presents an image, is about 23 in. from the observer's nominal eye position, with an eye freedom of about one inch.

The satellite's altitude and attitude with respect to the earth and relative bearings of the sun and moon are displayed by reticle marks and associated controls.

The periscope uses a wide-angle objective lens with a field of about 180°; giving adequate coverage of the earth's horizon, which subtends an angle of roughly 151° at an altitude of 115 nautical miles.

When the earth is centered on the periscope's display, the outer part of the circular view shows the earth's horizon circle, and the center, which can be magnified by a mechanically linked power change lens, represents the end of a vertical line to the center of the earth, giving a true view with radial distortion less than 10%.

This view gives the astronaut the satellite's position relative to earth, drift, altitude, pitch, roll, true vertical, retrograde angle, and field of view of the earth sky camera.

*Editors note: Information for this article was obtained through personal interviews with Dr. Stanley White and Ralph Sawyer of NASA's Space Task Group, and from the following papers: "Manned Space Flight" by Warren J. North, head of NASA's Manned Satellites Program; "*Mercury *Capsule and its Flight Systems, by Maxime A. Faget and Robert O. Piland of NASA-Space Task Group; and "Review, Scope and Recent Results of Project* Mercury *Research and Development Program by Aleck C. Bond and Alan B. Kehlet of NASA-Space Task Group.*

FY '61 Missile Aid: $210.5 Million

The Administration plans to buy $210,511,000 worth of missiles and spare parts for its Free World allies during FY 1961.

The new military aid missile budget would bring to $780.5 million the total spent by the United States on deliveries of missiles to allied forces since July 1955.

The House released figures last week on U.S. military aid spending as:

• The Pentagon announced that Britain will buy Douglas *Sky Bolt* ALBM's when the missiles are operational—about 1965. The RAF will deploy the 1000-mile range nuclear-tipped missiles aboard their V-bombers and jet transports.

• Thirty-three members of the NATO Infrastructure Committee toured U.S. military installations and defense industries. Their primary interest was in possible purchase of Lockheed *Polarises* as an all-NATO IRBM. The NATO *Polaris* would be launched from fixed sites or mobile platforms rather than from ships.

• British defense officials also studied *Polaris* for possible use aboard British surface ships.

The newly-released House testimony shows that the United States has spent $282,068,000 to date on delivery of IRBM's to NATO nations. The FY '61 program includes another $31,900,000.

Each of the four 15-missile *Thor* squadrons deployed in Britain has cost the military assistance program $56 million. Each of the three 15-missile *Jupiter* squadrons that will be deployed in southern Europe—two in Italy, one in Turkey—will cost $77.9 million.

Total cost for all seven squadrons will be nearly $458 million. The figure does not include development costs.

Besides the IRBM's, the other three major items in the FY '61 foreign aid missile program are $53 million for Western Electric *Nikes*, $31 million for Convair *Terriers* and $31 million for Martin *Maces*.

The program also includes for the first time some funds for the new *Davy Crockett*—the short-range nuclear tipped missile that can be carried and launched by two men.

Military Aid Missile Program

Missiles	Area of destination for operational missiles	Deliveries of fiscal years 1956-60 program through June 30, 1960 (in thousands)	Fiscal Year 1961 program (in thousands)
CORPORAL	Europe, undistributed	$ 20,875	
NIKE	NATO, Far East, undistributed	159,740	53,013
HONEST JOHN	NATO	32,077	8,533
SIDEWINDER	Europe, Near East and South Asia; Far East	15,883	5,848
IRBM	NATO	282,068	31,900
TARTAR	Europe, Far East	8,700	14,871
TERRIER	Europe	2,553	31,016
SS 10-11	Near East and South Asia; Far East	3,600	
TARGET DRONES	NATO, Far East		2,388
LACROSSE	Europe		10
MACE	Europe	18,526	31,415
SERGEANT	Europe		10,010
MISSILE SPARES AND COMPONENTS	Europe, Near East and South Asia, Far East	26,017	3,780
HAWK	Far East		16,400
DAVY CROCKETT	NATO		1,327
TOTAL		**$570,039**	**$210,511**

Strikes Threaten to Spread

"Selective" strikes called by the International Machinists Union last week threatened to spread throughout the entire missile industry.

By week's end, the Machinists' partial strikes were in force at General Dynamics Convair Division's facilities at San Diego and Palmdale, Calif.; at Holloman AFB and Patrick AFB; at the Vandenberg and Cape Canaveral missile test centers; and at *Atlas* missile base construction sites at Omaha, Neb., and Cheyenne, Wyo.

The Department of Defense stated the strikes had not hampered activities at Vandenberg operational *Atlas* sites, or launch activities at Cape Canaveral —except for *Atlas* tests.

Machinists at Douglas Aircraft's Santa Monica, Calif., plant took a strike vote Wednesday, and the company's El Segundo, Calif., plant has voted by 92.7% to authorize a strike. Members of the United Auto Workers at Douglas's Plants in Long Beach, Calif., Tulsa, Okla., and Charlotte, N.C., had also authorized or were in the process of authorizing strikes.

About 10,000 machinists at Lockheed Missile and Space Division plants at Van Nuys and Sunnyvale, Calif., have said they would file the required five-day strike notice if negotiations proved fruitless.

Major areas of disagreement have to do with separation allowances (severance pay), wages and cost of living increases.

Bomarc Burns at McGuire; Radiation Not Dangerous

A nuclear-armed *Bomarc* antiaircraft missile burned up on its pad near McGuire AFB, N.J., Tuesday when its launching shelter caught fire.

Air Force authorities combed the surrounding area with Geiger counters and quickly announced that no radiation danger existed.

First reports of the mishap had caused widespread concern among the civilian population.

The *Bomarc* base's 250 personnel, uninjured by the fire, are also being checked for radiation exposure.

Air Force spokesmen said they believed that the missile's fuel system created a minor explosion in the pad shelter.

Senate Toes Pentagon Budget Line

by James Baar

The resounding collapse of the Paris Summit Conference could hardly be heard at all this last week by the Senate Defense Appropriations Subcommittee as it approved a defense money bill of about $40 billion.

The final figure expected to go to the Senate floor this week was less than a billion dollars higher than the original Administration defense request for FY 1961 and the amount passed by the House.

Even as the subcommittee acted, GOP Gov. Nelson Rockefeller of New York denounced the Eisenhower Administration and called for an immediate $3-billion increase in the defense budget. The move was an open challenge to Vice-President Nixon for the GOP presidential nomination.

Earlier, the subcommittee itself had brushed aside an urgent proposal by Sen. Stuart Symington (D-Mo.), another presidential candidate, that the defense budget be increased by $3.5 billion.

The subcommittee, in reworking the defense money bill passed by the House:

- Restored $294 million for the *Bomarc B.*
- Restored $400 million cut across the board from military procurement funds.
- Restored $293 million for a conventionally-powered aircraft carrier.
- Added $285 million for development of the B-70 Mach 3 bomber—a move that would once again elevate the B-70 to the position of a major future weapon system.

At the same time, the subcommittee cut:

- $73 million added by the House for *Minuteman, Midas, Samos* and *Discoverer.*
- $115 million added by the House for a bomber alert.
- $58 million of $100 million added by the House for ASW R&D.

The subcommittee disregarded Administration objections and approved an extra $241 million passed by the House for two more *Polaris* submarines. This puts five Polaris submarines in the bill and long lead-time items for seven more.

However, when all of the numerous adjustments were added up and subtracted, the net result was that the only major increase made by the Senate was the money for the North American B-70.

Some attempts to add more to the bill on the Senate floor were expected —particularly the cuts for *Midas* and *Samos.* However, the chances of major changes in the bill before it goes before a House-Senate Conference Committee appeared slight.

The Symington defense proposals that were put before the subcommittee called for major additions for all three services.

Symington asked for: $900 million for Air Force strategic missiles; $159 million for *Midas* and *Samos* and *Discoverer;* $800 million for Army modernization procurement; $414 million for an airborne alert; $360 million for B-70; and $241 million for *Polaris.*

The Symington proposals also included $465 million for all ASW including R&D and $160 million for expanding the size of the Army and Marine Corps. The funds would increase the Army from 870,000 to 925,000 men; the Marines from 175,000 to 200,000.

Rockefeller called for spending $3 billion more immediately on "additional and improved bombers, airborne alert, more missiles, more *Polaris* submarines, modernized equipment for our ground forces." He also urged the immediate appropriation of $500 million for a civil defense program.

"Our long-range missiles are not only inferior in number to those at Soviet disposal but also are dangerously vulnerable to Soviet attack," he said. "Our strategic bombers, though reasonably large in number, are concentrated on less than 50 bases, all clearly identified by the Soviets, every one defenseless against a direct missile hit.

"For all our reliance upon *Polaris* submarines, not one is operational now, and only two will be operational at the start of 1961. For all the dangers of local aggression, our forces for limited war are inadequate in strength and mobility."

The Senate Defense Appropriations Subcommittee and the Administration didn't see it that way.

Tucson Group Protests Titan Ring

The first sizeable protest against installation of ICBM's on U.S. soil is raising a small sandstorm around Tucson, Ariz.

A group of Tucson residents headed by Dr. James E. McDonald, professor of meteorology at the University of Arizona, is loudly protesting Air Force plans to surround the city with two squadrons of *Titans.*

McDonald's group, which calls itself the Committee Against Ringing Tucson with Titans, contends primarily that:

- The *Titans* should not be installed west of Tucson because in the event of nuclear attack on the missile sites the prevailing westerly winds would carry fallout over the Tucson area's quarter-million inhabitants.
- ICBM's can and should be placed farther from all centers of population than under present Air Force plans.

The committee has written letters of protest to top Air Force generals and government officials and late last month sent a petition with some 1100 signatures to Defense Secretary Thomas Gates.

The committee's slogan is: "'Move the Titans East."

However, it apparently doesn't want to move them too far east. A leaflet distributed by the committee in Tucson includes the statement:

"Merely shifting all Titan bases east will not deprive Tucson of any economic benefits."

Hughes Gets NASA Award For Ion Engine Development

Hughes Aircraft Co. last week won a National Aeronautics and Space Administration competition on a contract to build a small laboratory-type ion rocket engine.

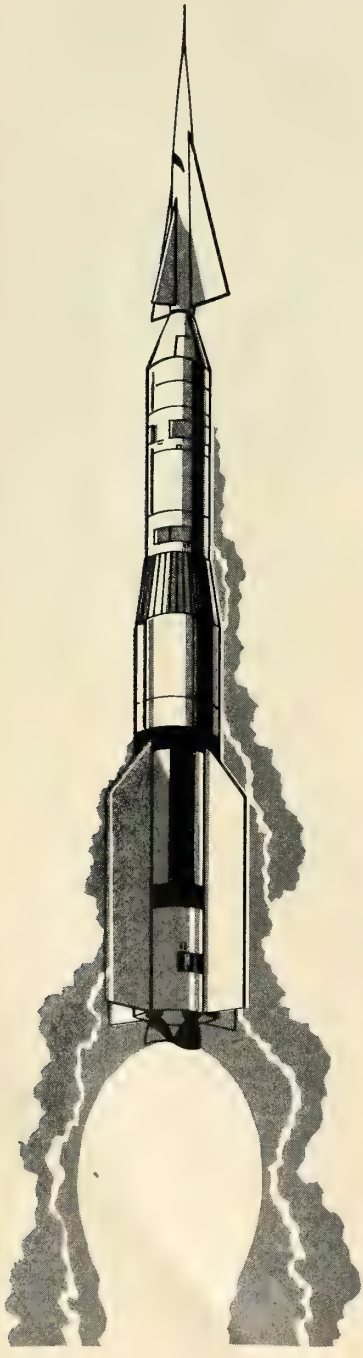
NASA, estimating cost at more than $500,000, said contract negotiations with Hughes would begin immediately. The engine, to be designed, developed and laboratory-tested in a year, will draw more than 3500 watts and generate 0.01 lb. thrust. If it proves the concept feasible, a later engine will generate 0.1 lb. thrust, drawing 30 KW —the output of a SNAP-8 nuclear powerplant.

The concept of the NASA engine is reported to be more sophisticated than that of a 0.1-lb.-thrust engine under development by Electro-Optical Systems Inc. for the Air Research and Development Command. The ARDC contract, awarded early this year, called for the construction of hardware at maximum speed under currently existing technology. Presumably, the ARDC engine also would be powered by SNAP-8.

Hughes was one of 11 bidders on the laboratory-type engine, which will be 8 in. long and about 4 in. in diameter.

required for stability . . .

Fins Likely on Titan Dyna-Soar Booster



BALTIMORE—It looks as though *Titan* will sprout fins to boost *Dyna-Soar*.

Martin Co. engineers have just about decided that the big ballistic missile needs aerodynamic control surfaces to provide stability on the upward flight through the atmosphere with a winged vehicle as payload.

The booster, according to present plans, will be the LOX-kerosene *Titan I*. If the bigger, storable-liquid-propelled *Titan II* develops as fast as proponents believe, the Air Force and contractors will take a new look at the booster system about a year from now. The decision might then be to go to *Titan II*.

Reliability is the foremost consideration in redesigning *Titan* to carry a manned vehicle, two Martin officials tolds M/R in an interview last week. Bastian (Buzz) Hello, *Dyna-Soar* program manager, and A. J. Kullas, technical director, said design would depend as much as possible on proven reliability—the principle of "Don't change what works."

This is why *Titan I* is preferred. It works. And by 1963, Martin engineers expect *Titan I* to have as good a reliability record as any missile in use. If the *Titan II* record can be forecast to be as good, a parallel development program will be proposed.

• **Questions raised**—Reliability is also the main reason for adding fins, Kullas declared. "Putting a winged vehicle aboard a ballistic missile," he said, "imposes problems of stability and control, raising questions in aerodynamics, structure and elastic response. For example, gusts of wind on launching could create a forcing function that would develop a greater load than could be handled by the control surfaces."

Although the weight of *Dyna-Soar* has not been disclosed, Martin says a *Titan I* is capable of putting 2 and ½ tons into a low orbit. Dr. Albert C. Hall, Martin vice president for engineering, has said it is possible to modify the missile to more than double the capability. Presumably, he refers to *Titan II*.

The *Dyna-Soar Titan* will be assembled and dynamic-tested in Baltimore, rather than Denver, where the ballistic missile is assembled. There will be no change in the location of manufacture of major parts, however.

At present, the fuel and LOX tanks for both stages of *Titan* are manufactured in Denver and other major parts—transition, skirt, tank splice, tail and fairing structures—are manufactured at Baltimore. The parts are shipped by rail to Denver.

For *Dyna-Soar*, Hello said, the railroads will run east instead of west. Propellant tanks will be shipped to Baltimore for fabrication. Also to be manufactured here will be the new roll, pitch and yaw fins.

• **Heavy duty**—All firings of the new booster will be at Cape Canaveral. Dynamic tests will be performed in a special building built here originally for fabricating the P6M seaplane. Green Associates Inc., Baltimore engineers-architects who designed the building, report that the base slab of the 200-ft.-square building can resist uplift of 3 million lb. on any 30x100 ft. interior area. The roof trusses are designed to take a series of concentrated loads totaling 825,000 lb. per truss on any five consecutive panel points 20 ft. apart.

The structure is 65 ft. high. Martin engineers plan to knock one section out of the roof to accommodate the *Titan* erected vertically. A superstructure will be built atop the roof opening. During the testing, the booster will be subjected to all possible loadings to simulate loading caused by flight conditions.

Martin eventually is expected to receive contracts totaling $100 million for the five-year job entailed in its share of Phase I of the big project. A mockup of the booster is to be ready a year from now. Flight testing of the modified booster is due to begin in 1963. First flights will be suborbital, essentially to prove out the vehicle.

Since the release of Air Force funds April 27 for the first phase of the job, Martin has been assembling its technical staff here. Within a few months, the engineers and scientists will number a few hundred.

◄MANNED MISSILE—Here's an M/R artist's conception of how a *Titan* carrying a *Dyna-Soar* might look with fins. Actual configurations of *Dyna-Soar* and fins have not been released.



FOR THE AIR FORCE, MSVD developed experimental 12-foot ablating ICBM re-entry vehicle, the RVX-2, largest ever to be recovered. Vehicle, with its recovery package (upper left) developed for General Electric by Cook Research Laboratories, is shown here being hauled on board ship.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in search and recovery

With each recovery of a space vehicle, scientists gain important new knowledge about the environment of space and its potential effect on man and the operation of vehicles and equipment. As more advanced vehicles are developed for space flight—some with life aboard—successful location and recovery become increasingly vital.

General Electric's Missile and Space Vehicle Department pioneered in the development of space vehicle search and recovery techniques as part of its re-entry and recovery vehicle program for the U.S. Air Force. MSVD developed and built the first payload to be recovered from space—an 18-inch data capsule ejected from an Air Force Thor re-entry vehicle on June 13, 1958. Many such data capsules have since been recovered from both Thor and Atlas flights—some carried cameras providing films from space. MSVD also developed and built the 12-foot long, one-ton re-entry vehicle shown above which the Air Force recovered on July 21, 1959—the largest to be returned to date. Today, as MSVD builds and flight tests more complex vehicles, it is continually expanding and improving its already successful search and recovery program.

Currently, this search and recovery experience is being applied to the development of such important space programs as the Air Force "Discoverer" recovery satellites and NASA's radiation research recovery vehicles (NERV).

For more information about MSVD's work in search and recovery, write to Section 160–79, General Electric Co., Missile and Space Vehicle Department, Philadelphia 4, Penna.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD

Circle No. 4 on Subscriber Service Card.

Expert Switched from AEC To Help Set Up Space Center

Morris to be Von Braun's administrative deputy; details of how ABMA will function under NASA after July 1

by Jay Holmes

HUNTSVILLE, ALA.—Veteran government administrator Delmar M. Morris has been transferred from the Atomic Energy Commission to the National Aeronautics and Space Administration to help Wernher von Braun organize the new Marshall Space Flight Center here.

Morris, until March deputy manager of the AEC's San Francisco Operations Office, has been assigned as Von Braun's deputy for administration and is organizing a staff of 1200 that will perform service functions for the 4300 technical workers now done by the Army.

The Von Braun group, which now is the Development Operations Division of the Army Ballistic Missile Agency at Redstone Arsenal, will move to NASA July 1 and become the George C. Marshall Space Flight Center. At the same time, 1200 acres of Redstone Arsenal will be turned over to NASA on a long-term, renewable, non-revocable lease.

The Army is setting up a new Research and Development Division of ABMA to replace the Von Braun group. The R&D Division will have a staff of about 350 July 1, and 1000 when fully staffed.

• **Hunting reciprocity**—Under a NASA-Army agreement, NASA will have a "hunting license" to recruit up to 815 of the needed 1200 support-type personnel from the Army at Redstone Arsenal. In turn, the Army will have a hunting license for up to 350 technical people to serve as the nucleus of the ABMA's R&D Division.

Dr. Arthur Rudolph, present *Redstone* and *Pershing* project director for ABMA, will head the new ABMA group. He will have a second "hat," however, as head of the Marshall Center Weapons Office.

The 10 laboratories of the Development Operations Division will be reduced to nine in the Marshall Center. The System Support Equipment Laboratory, which has been largely missile-oriented, will be abolished. Some of the people in the SSE Lab will go to the Army; the remainder will be distributed throughout the NASA center. A large group will join the new NASA Launch Directorate at Cape Canaveral, headed by Dr. Kurt Debus. Under the ABMA, the Debus group has been called the Missile Firing Laboratory.

Hans Heuter, head of the SSE Lab, will head a new office that will supervise the *Agena* and *Centaur* programs. *Agena* and *Centaur*, already NASA responsibility, will be supervised by the Marshall Center as part of its handling of all NASA launch vehicle development. Until now, these programs have been supervised for NASA by offices in the Air Force Ballistic Missile Division. On July 1, however, the Air Force will assign personnel in these offices directly to NASA.

• **Contract roles**—Under Morris, NASA is building up a support staff to handle such tasks as financial management, procurement, personnel, safety, supplies, plant maintenance etc. Contract administration is a difficult area, a Marshall Center spokesman said.

Under present plans, all contracts with the Army will be administered by the Army after the transfer until they come up for renewal, he said. Then NASA will do the renewing. A few major contracts, however, have already been awarded by NASA and will be administered by NASA. These include the Douglas Aircraft contract for developing a *Saturn* second stage and the contract to be negotiated with Rocketdyne for a 200,000-lb.-thrust *Saturn* engine.

Since the Marshall Center will be surrounded by Redstone Arsenal, the Army is providing exterior security. NASA will provide its own internal security. The Army will keep the satellite tracking station here; NASA will pay for its use. NASA will buy service from the Army for fire-fighting equipment and special laundry work on cleaning hazardous chemicals from clothing.

NASA will own the liquid rocket test area. The Army will own the solid rocket test area. Each will pay the owner for its use. The Army will have the right to ask the Von Braun group for technical services when needed and will pay for them. NASA will determine priority of the work.

Of the 1200 to be hired, for NASA, about 350 will be technical and the remainder support personnel. The buildup is to be completed during Fiscal 1961. It may not take that long, a spokesman said, noting that 1500 to 2000 people a year were brought here when Maj. Gen. John Medaris was building up ABMA a few years ago.

Morris, 47, is a civil engineer who has been employed by the government for 23 years. He spent seven years with the Tennessee Valley Authority, five years with the U.S. Bureau of Reclamation and nine years with the AEC, in addition to two years as a Navy Officer in World War II. A native of Champaign, Ill., he is married and has seven children.

• **Building uncertainty**—NASA has plans for extensive construction at Redstone after July 1. The 1961 budget includes $26 million for construction. The House cut $6½ million from this item, but there seems to be a good chance that the budget will be approved in full by the Senate. The fate of the building program in that case would be in the hands of a House-Senate conference committee.

The biggest item cut was $4½ million for a new headquarters building for the Marshall Center here. After July 1, the Marshall group will share headquarters facilities with ABMA. Spokesmen for both groups report that office space is at a premium in the headquarters building already. The House also cut plans for expanding the guidance and control building and the fabrication building.

Untouched were plans for constructing a second *Saturn* static test stand at a cost of $2 million. This is in addition to a plan already in the works for a dynamic test facility at Redstone, which will be used to check mechanical erection of the *Saturn* vehicle but will not be used for engine firings.

NASA Broadens Technical Information Distribution

NASA has set up a new office to expand distribution of information on its technological and research advances.

Heading up the new NASA Office of Technical Information and Educational Programs is Shelby Thompson, presently deputy director of the Atomic Energy Commission's Division of Information Services.

The new organization replaces NASA's present Technical Information Division of the Office of Business Administration. The division's head, Bertram A. Mulcahy, will be Thompson's assistant.

NASA inherited a good technical information service from the old NACA, which published a variety of technical papers, notes, and reports on its various activities. As the new organization grew, the process became overburdened.

EIA Backs Widening of Wage Law

Electronic Industries Association is strongly supporting a bill now before Congress to extend the minimum wage law to all industries affected by the Walsh-Healey and Davis-Bacon Acts.

EIA Executive Vice President James D. Secrest has disclosed that the Association has filed a statement with the Subcommittee on Labor Standards of the House Committee on Education and Labor in favor of a bill (HR 12170) introduced by Rep. Edgar W. Hiestand (R-Calif.). The statement cites "inconsistency in the basic public policy" between the minimum wage provisions contained in the two Acts and the Fair Labor Standards Act.

The EIA listed four reasons for its support of the Hiestand amendment:

- The Walsh-Healey Act stifles the growth of small business concerns and impairs their ability to secure Government business.
- The Walsh-Healey Act produces inflation and contributes to increased Government costs.
- Economic reasons for the enactment of the act no longer exist and can no longer be justified.
- The Act disrupts the economy of smaller industrial communities and increases unemployment in surplus labor areas.

The EIA reasons that since small firms have a lower wage scale than larger companies, they often elect to drop out of the government market rather than revise their wage structures in order to compete for government business. Thus, the statement declares, there is "little doubt" that the law favors large companies over small firms in obtaining government contracts.

Application of the Walsh-Healey Act and Davis-Bacon Acts not only raises wages to levels paid by large firms in industrial regions without due regard to local economic conditions and to the financial problems of small business, but it results in increased Government procurement costs and added taxpayer burden, the Association said.

Economic disruption is inevitable, the association feels, under existing conditions. It points out that industry faces conflicting minimum wage laws—issuing on one hand from Congress under the Fair Labor Standard Act, on the other from the Secretary of Labor.

EIA urged that the Heistand amendment be either incorporated into whatever wage legislation may be enacted this session, or passed separately.

mergers and expansions

GENERAL MILLS has added two electronic components companies to its missiles and electronics group, bringing its employe total to 3600 and its annual sales forecast to $40 million for missile/space and related business.

The Daven Company, Livingston, N.J. and Laible Manufacturing Co., Manchester, N.H. have been acquired by the company from owner Lewis Newman. Both businesses will retain their own names and continue at their present locations, but expansion of both plants is anticipated. Daven will operate as a wholly-owned subsidiary and Laible will become a division of The Daven Co.

General Mills vice president R. A. Wilson will serve as president of The Daven Co., with Newman acting as vice president and assistant to the president. Other officers of the Daven Co. will be: Edward L. Grayson, vice president-Marketing; Frederick A. Schaner, vice president-Engineering; Albert M. Steinbach, vice president and plant manager at Livingston, N.J.; Bernard J. Perry, vice president and plant manager at Manchester, N.H.

The second building, a 160,000 sq. ft. office and engineering laboratory will consolidate operations currently being conducted at several sites in the Syracuse area. Some expansion in the Department's applied research and development efforts will result. No substantial employment increase in the Heavy Military Electronics Department is expected.

GENERAL ELECTRIC CO.'s Heavy Military Electronics Dept. plans to lease two new buildings to be constructed in Geddes, N.Y. A 300,000 sq. ft. production plant will house defense work currently being done at other facilities, in turn providing room for expansion by the Company's Semi-Conductor Products Dept.

SYLVANIA ELECTRIC PRODUCTS INC.'s Special Tube Operations has become part of Sylvania Electronic Tubes in a realignment designed to intensify research, development and manufacturing efforts.

ELECTRO-TEC CORP. has acquired the business of Lambros Precious Metals Co., of New York City. The 25-year-old supplier to industry and jewel businesses will be operated through the company's recently-established subsidiary, Precimet Laboratories, Inc.

HORKEY-MOORE ASSOCIATES Plastics Division has moved into a 6000 sq. ft. building adjacent to the firm's main plant in Torrance, Calif.

HALLICRAFTERS CO. has purchased 30 acres in Northwestern Industrial Park, Rolling Meadows, Illinois for a 100,000 sq. ft. research facility. The company's 500-person electronic R&D staff will be moved to the plant. Production facilities for military work and commercial products are also expected to be expanded at Hallicrafters' 5th Avenue (Chicago) plant.

BAUSCH & LOMB OPTICAL CO., will change its name to Bausch & Lomb Inc., effective July 1. Founded in 1853 for the manufacture of eyewear frames and lenses, the company has moved into radiation measurement and electronics areas combining optics and electronics. Earlier this year the company formed a separate Military Products Division.

ATLANTIC RESEARCH CORP. has acquired Northeastern Engineering, Inc., of Manchester, N.H., engaged in development, engineering and manufacture of electronic equipment including a high-precision digital frequency counter, medical instrumentation, and heavy switchgear.

MARQUARDT CORP. has established a Special Projects Laboratory to develop security devices and systems for governmental and commercial application. Located near Washington, D.C. in Rockville, Md., the laboratory will be directed by Oleg C. Enikeieff, former Washington representative for the Propeller Division of Curtiss-Wright Corp.

AERONCA MANUFACTURING CORP. has purchased The United Welding Company of Middletown, Ohio, a former division of Baldwin-Lima-Hamilton Corp. Aeronca merged with Buensod-Stacey, Inc. of New York in March.

BENDIX CORP. has set up two complete facilities at Teterboro, N.J., and South Bend, Ind., to develop, manufacture and sell support equipment for missiles and military and commercial aircraft.



The Lunar Space Station project at Martin is one of astonishing magnitude, for it coordinates practically all areas of scientific thought into one common objective: *sustaining life in outer space.* If you have the scientific or engineering talent required to aid in the fulfillment of this objective, we urge you to write immediately to N. M. Pagan, Dir. of Tech. & Scientific Staffing, The Martin Company, (Dept. 9A), P. O. Box 179, Denver 1, Colo.

MARTIN
DENVER

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Technical Countdown

ELECTRONICS

Space Vehicle APU Underway

The Air Force finally has announced the month-old award of a solar mechanical engine study contract to Sundstrand's Turbo Div., Pacoima, Calif. The $350,000 feasibility study is for design of a 15-kw generator for space vehicles. High-temperature working fluids for the Rankine-cycle conversion system and materials for solar concentrators (mirrors) are important phases of this study. System weight will approach 1000 lbs.

Higher Power for Detection

Cornell Aero Lab is now building a 50-megawatt peak-power radar transmitter—the world's most powerful. Development would have application in long-range detection and tracking of ICBM's.

Transducer Needed

School of Aviation Medicine at Brooks AFB, San Antonio, Tex., would welcome a sensor that would yield blood pressure readings of a subject continuously and relatively directly. Implanting a device in the subject would be a last resort because the sensor eventually would be used on man.

Earth's Rotation Measured

Guidance engineers at American Bosch-Arma Corp. using Arma inertial guidance system have obtained first such measurement of earth's rotation. A large precision centrifuge containing parts of the guidance package was spun first in the same direction as the earth's rotation and then in the opposite direction. An accelerometer was then used to sense the rate effect of the earth.

Acoustical Research Expanding

Watch for increase in reports on military acoustical research programs. Ling-Altec's Dr. Hilliard in California has been studying direct relation of sound intensity to rocket thrust and fuel consumption, among his many classified programs. Also, Stromberg-Carlson just delivered a unique high-intensity acoustical system to Wright-Patterson AFB for its Aerospace Medical Div. A total of 480 speakers are used in system to provide undistorted sound through full 11-octave range of normal audibility.

Cheaper Guidance Due

An advanced self-contained guidance subsystem, reported to be extremely reliable yet low in cost, is being developed by Chance Vought for the Air Force. Application is classified, but original development was for C-U's *SLAM,* nuclear-ramjet weapon system.

PROPULSION

Seller's Market

Liquid hydrogen capacity on the West Coast, even with the Linde Co. plant opening at Torrance, Calif., this summer, is far less than will be required now that Rocketdyne is developing the 200K *Saturn* upper-stage engine. The Linde plant also must meet liquid hydrogen demands for engines in Convair's *Centaur,* Douglas' *Saturn* upper stage (S-4), the *Rover* nuclear rocket, and several smaller users.

New Falcon Propellant Fired

A new high-impulse propellant for the *Falcon* air-to-air missile has been developed and successfully fired at temperatures ranging from —85° to +300°F, Thiokol reports. The new hydrocarbon propellant was developed at its Elkton, Md., plant under a contract with ARDC. Firing was in an operational-type motor with a highly stressed grain configuration. Similar motors were fired successfully after cycling from —65° to +200°F.

Electron/Ion Generator Promising

The German firm of Siemens-Schuckertwerke AG, Erlangen, has developed an electron and ion generator for accelerators with possible space-propulsion application. The generator reportedly supplies current up to about seven amps and ion currents up to about one amp during continuous operation. For ion currents, hydrogen is fed into generator. Suited also for pulse operation, emission currents could be increased considerably beyond the above figures.

MATERIALS

Honeycombing to Improve

Grumman's huge (50-sq.-ft.) new vacuum furnace will be used for production-scale brazing of the honeycomb structures in the Bendix *Eagle* air-to-air missile. Not only does the vacuum process do the job at less cost, but the brazing atmosphere is considered better than from an inert gas.

Another Materials Barrier

The dilemma persists for weight-conscious designers of *Saturn* upper stages. The problem is what material to use for liquid hydrogen tanks. Aluminum alloys currently considered gain in tensile strength when temperature falls to roughly 20°K, but increase in brittleness. Structural support will be necessary to protect the tanks against vibration.

ASW ENGINEERING

Kitchen-size Trainer

Republic Aviation is building an advanced pre-production model of a high-speed atomic-submarine simulator for the sub school at New London. It features a special scoring panel which automatically records the trainee's reaction-time to an ordered maneuver and to equipment failure.

More About Fuel Cells

Most exciting possibility reported lately is a fuel cell which would use conventional petroleum products and air as fuels. The general scheme—and several companies have such cells in early stages of development—is to use catalysts in the electrodes to separate hydrogen from the hydrocarbons and use oxygen as the other fuel. Cells have been demonstrated with efficiencies exceeding 35% at low temp. and up to 75% at higher temps. The problem is to keep them operating at high output levels for long periods without having impurities poison the catalysts, and thus reduce efficiency.

PMR System Guards Against Missile

by Charles D. LaFond

One chance in several millions might be the odds for a wayward ICBM, launched from the Pacific Missile Range, to impact somewhere in the State of Hawaii.

To make certain that such an unscheduled and unwanted flight cannot occur today, tomorrow, or ever, the Navy's Impact Prediction System was created. Operated under contract since 1959 by Land-Air, Inc., a subsidiary of California Eastern Aviation, Inc., the system is a real-time computer application providing an accurate visual display of missile trajectory.

Designed as an aid to the Range Safety Officer, impact prediction involves the process of continually estimating impact-point coordinates based on present position. Essentially, the system consists of a twelve-man crew, IBM 709 (8K type) and six plotting boards at the Naval Missile Facility, Pt. Arguello. Back-up is provided by another Land-Air group at Pt. Mugu, using a larger 709 computer facility.

System input is derived from two similar instrumentation radars, AN/-FPS-16. One is a modified system capable of maintaining a radial track to a distance more than double that of the other radar. Each provides slant-range, azimuth, and elevation data in serial format, binary digital coded.

To further strengthen the impact prediction system, a new PMR microwave data link is under construction. This will feed real-time data to both the Arguello and Mugu computer groups from three sites (six radars) plus COTAR (Correlation Tracking and Ranging system, built by Cubic Corp.) outputs from several widely separated sites.

• **Input system**—Each radar outputs slant range, azimuth, and elevation in a serial format coded in binary. This output, plus PMR range time, is recorded on tape for postflight analysis.

The same output, less range time but with a shift line and an end-of-word indication, is supplied to a Collins TE-206 Kineplex transmitter. The transmitter uses the digital information to phase-shift four audio tones which are combined into a composite audio signal. This composite is then transmitted over land line from the radars to the computer site a few miles away.

In the computer room at the Range Operations Building, a Kineplex receiver accepts the composite signal and converts it into a serial digital form. This is passed to a Cubic DH-12 Data Handler where it is stored and converted to the parallel format acceptable to a data synchronizer.

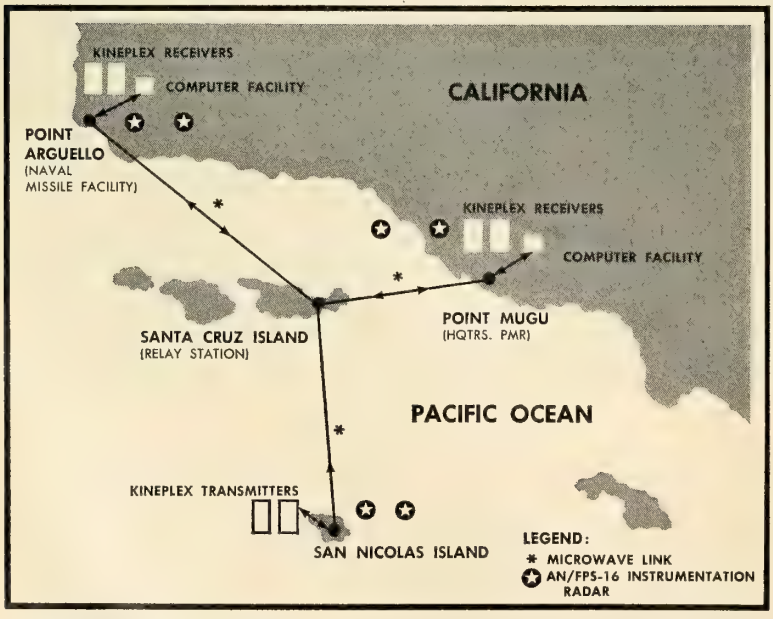
• **Programing**—The prediction of missile impact follows from straightforward mathematical reasoning. Errors due to mathematical flaws are trivial compared to those introduced by the total system. (The math portion of this subject is dealt with in "Derivation of the Equations for Impact Prediction" prepared by Mr. D. B. Alexander and published by Land-Air in late 1958.)

The actual programing of the problem was not begun until late spring when it was rushed through under a crash program by J. W. Brookshire, of Land-Air, with the cooperation of Bruce Glass and the counsel of Dr. H. H. Germond, both of the Atlantic Missile Range.

The initial programing effort had the benefit of quite loose specifications. The only output requirement was information to drive three plotting boards, two displaying the prediction and the other, present position. Computing the latter was a necessary step in arriving at the predicted point and not an extra requirement. Never in its earliest and most unrefined state did the one-tenth-second output frequency threaten machine speed and capacity.

Subsequent output requirements and provision for new microwave link and additional inputs have changed all of this, however, and now the program is getting tight. So tight in fact, that instead of outputting a prediction based on both radar and Cotar, the output will be one or the other.

The program for impact prediction is thought of as four logical function routines: the input, standardization, prediction computation, and the output routines. These depend upon elementary function sub-routines for



IMPACT PREDICTION computer centers currently providing data for Pacific Missile Range safety offices are shown. A new microwave data link from San Nicolas Island will significantly strengthen prediction capabilities.

Gone Astray

sine, cosine, arc tangent, and square root.

• **Input routine**—The input routine maintains a controlling counter in an index register which recycles after 64 counts. It initiates the program at the count of zero in this register, and recycles on the next count after 63. The counter increases one count per 0.1 second, which is the rate of the data sample input.

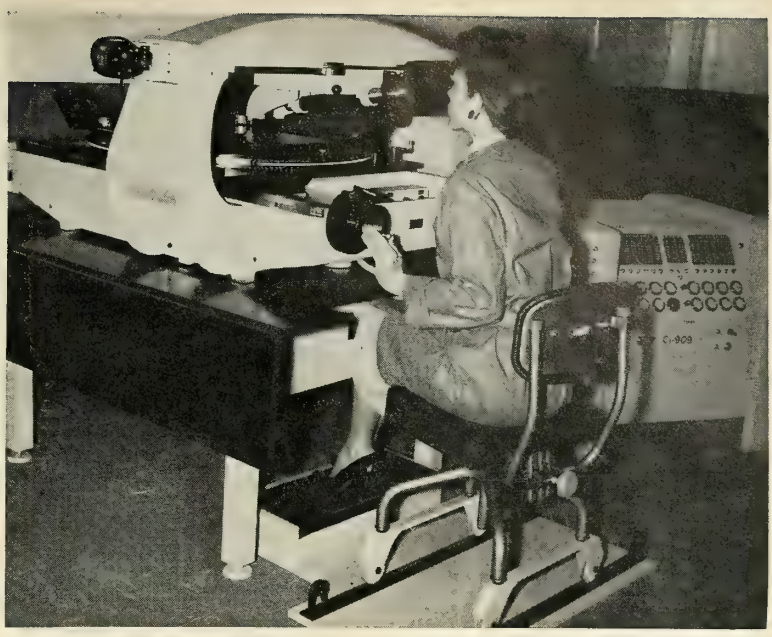
The routine encounters the data sample at the Data Synchronizer and places it in a table. This is in the form of 3 binary-coded 21-bit words representing elevation and azimuth angles and slant range.

The first sample of data received will start the table when the counter reads zero. The next sample will be placed in the table vs. the count of 1. The sixty-fifth sample will enter the table opposite the count of zero on the counter. This can be thought of as occupying the position of, or replacing, the first sample which was stored vs. zero.

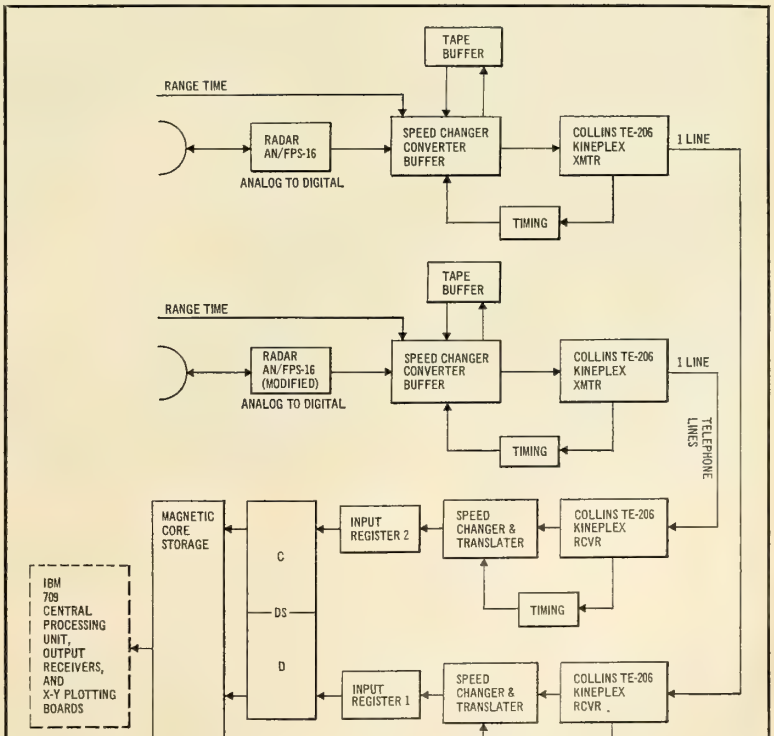
If any word is missing from the input, the program will store zeros in each of the three word positions for that count. The input routine is such that it will make three attempts to receive a sample before it accepts the missing data alternative. The count will continue, however, so that the data can be tabled properly when input resumes. Simultaneously with supplying input, this routine writes the raw data on magnetic tape for use in post-operation computations, and as a permanent record.

The input routine in use today is the tight spot (mentioned earlier) for expansion of the input system. Working against only two radars it is able to perform quite an elaborate edit operation. It uses the trend of points through time as a basis for its acceptance or rejection of a sample.

This consumes 0.01 seconds per input source, but is permissible since time is abundant. At this rate, however, as input sources are increased, editing alone could consume all the computation time. The routine to be put in service, when needed, therefore is modified to make its choice on the basis of instantaneous agreement among input from multiple sources,



ADDITIONAL INPUT is provided by many optical tracking stations, particularly during early thrust phase of an ICBM. Here, a large-bed Mann comparator permits rapid measuring of film to resolution of 1 micron. Output is fed to Telecorder (right), stored in digital form, then transferred to IBM summary punched cards.



POINT ARGUELLO impact prediction input system currently in use is shown in block diagram. As many as six plotting boards as well as one or more strip or pen recorders can be tied into output display.



Effective deployment of tactical missiles and their supporting troops and equipment calls, today, for full *off-road mobility*. In this concept, FMC offers long and versatile experience, having since 1941 designed and built more types of military-standardized tracked vehicles than any other company in America.

In recent years FMC has pioneered many developments in missile launchers, and in light-weight aluminum-armored vehicles that can be airborne and parachute-dropped, ready for extended cross country operations. We provide full mobility for missile transporters and launchers, GSE, radar and communications equipment, field hospitals, troop transport and other equipment. The use of standard military components in vehicles cuts R&D costs and eases logistics problems in the field.

When the question is mobility, FMC has the answer—from original concept through production delivery.



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casting out obviously bad points as they are revealed by a least squares fit.

• **Standardization routine**—This routine receives the values for slant range, azimuth, and elevation from all good inputs passed to it by the input routine. Three earlier samples from each input source are used for simple edit of each respective input sample. The elevation value, in addition to this edit treatment, also receives a refraction correction.

The next operation is conversion of the polar coordinates to X, Y, and Z referred to the radar. This is followed by a transformation to geocentric coordinates. These coordinates are now expressed in feet and are in the fixed point system.

The final operation of the routine is the conversion of these values to floating point arithmetic. A data sample is generated in this manner from each of the inputs. These are placed in separate tables with the output from the routine determined by a built-in selection process, but this process is only semiautomatic.

Prior to the operation, a particular input is selected as the primary source and the others are ranked behind it. Criteria for this ranking are determined partly from the equipment performance during the preoperational checkout.

The program will try to live with the input designated as primary so long as the values are continuous and survive the wild-point edit. Console sense lights and switches are tested by the program in such a manner that the operator can override the program and change input selection manually.

The routine will accommodate the anticipated number of additional inputs and will accept any input which appears in the established format. Output from the COTARs will be received as a set of direction cosines and require a routine to convert these functions to the necessary rectangular coordinates before the data can be tabled along with the radar data.

• **Impact point computation**—The standardization routine supplies 31 consecutive samples each of X, Y, and Z in a geocentric rotating coordinate system, with the Z-axis coincident with the polar axis. The routine for computing impact continues by fitting a curve through each of the 31 values of these coordinates. Then components of velocity are obtained from the curve. X, Y, Z, and time completely define the position of the body at any time.

The remainder of the routine computes the position where the orbit intersects the earth's surface. The computation proceeds by assuming the earth's rotation temporarily halted at the time corresponding to each new data point. In this frozen coordinate system an impact point and the time of flight to this point is computed. The earth is then rotated the amount that it would have turned during this time of flight to output geocentric latitude and longitude of the impact point.

No attempt is made to include the effects of drag, or of the earth's oblateness on the gravity field, since the benefits from such a consideration would be marginal. System refinements are inevitable, however, such that ignorance of these effects ultimately will be intolerable. Day-to-day experience is stockpiling empirical data which will enable adjustment for drag effects.

Completed studies produced a method for end-point smoothing to replace the present simpler midpoint smoothing method and, in so doing, to eliminate a substantial time lag in the system.

• **Output routine**—The output routine receives the geocentric longitude and latitude and converts this information to plotter counts. This is done at such scales that it can be displayed on each of two plotting boards. One board covers the close-in ranges, and the other, the more remote points—including the splash areas.

The routine also reaches into storage for the geocentric present position coordinates placed there by the standardization routine. These are converted to plotter counts for display on the third plotting board.

• **Slope fields**—A set of three slope-field plotting board charts are prepared for each planned trajectory, one each for the planes X-Y, X-H, and Y-H. These are families of curves so drawn that when the present position is plotted the progress of points in relation to the curves will identify a potentially dangerous operation.

Coordinates in the launch-pad tangent-plane system for input to these plotting boards are obtained by tapping the standardization routine.

• **Accuracy**—The Navy feels the program is reliable and probably accurate beyond need. This accuracy exists in spite of deletions in the underlying mathematics. Besides failing to deal with atmospheric interference on re-entry, the program also assumes the earth to be a sphere. The treatment of radar refraction leaves room for improvement. Still, the performance of the system to date indicates complete adequacy for its intended purpose.

There is a tendency to want to use it as a measuring instrument—and it has correlated well with other range instrumentations when circumstances have permitted a comparison.

Air-to-Air Tow Target Built

A supersonic, high-altitude tow target system newly developed by Del Mar Engineering Laboratories, Los Angeles, for Century Series fighters and high-Mach carrier aircraft has been revealed by company vice president Neil Lamont.

He says the system provides an economical means for high-speed aircraft to practice interception and the firing of air-to-air missiles. The 9-ft., lightweight target stores externally on supersonic interceptors and furnishes the radar reflectivity and infrared characteristics of a multi-jet bomber.

Constructed of molded fiber sections and Fiberglas fins, the target is one component in the RADOP (radar/optical) system which features a probe nose, the Mach 1.5 target itself, and a combination reel-launcher. The probe nose provides stability during towed flight.

Since the target is reeled in or out on a wire tow line, launching and recovery can be made by the mother aircraft while airborne, eliminating need for "rescuing" targets after their use.



DEL MAR'S supersonic tow target, 9-feet long, features stabilizing nose probe, passive radar reflector giving 360° coverage, and a reel launcher that allows tow lengths to more than six miles.

Nuclear Engines Offer Good Stability

by Frank G. McGuire

LOS ANGELES—Theoretical work by Massachusetts Institute of Technology scientists shows stability and control of nuclear rocket engines in the one-million-pound-thrust class will not present serious problems.

In studies conducted for Pratt & Whitney Aircraft, MIT found nuclear rockets to be relatively stable and capable of rapid thrust level variation from 10% to full thrust in seconds. Work was reported by A. H. Stenning and H. P. Smith, of MIT to the American Rocket Society.

Using an analog computer during the P&W-funded research program, MIT investigated a system utilizing a bleed turbine pump drive, subjecting the theoretical powerplant to numerous variables. Rapid controlled starts were simulated, using a pressure controller on the turbine valve and a temperature controller on the reactor control rods.

Since thrust and temperature are essentially interdependent in nuclear rockets, requirements for control of these parameters will be stringent.

In its investigation, MIT chose the simplest possible model of the theoretical system under study, consistent with reasonable engineering accuracy. It avoided over-elaborate analysis, which might have obscured the significant results of the computer study. Conversely, it guarded against over-simplification by varying major parameters over a wide range, to determine where small changes can have large effects on system operation.

Of two possible systems, MIT chose the bleed turbine pump for study, rather than the alternate system using a topping turbine. In these arrangements, a small amount of liquid hydrogen propellant is bled off from the reactor and expanded down to atmospheric pressure in the turbine (bleed turbine pump method), or all of the propellant may be passed through the turbine after receiving some pre-heat in the cooling jacket and reflector, returning then to the main core heat transfer channels (topping method).

• **Varying temperatures**—Control of thrust and temperature in nuclear rockets is usually achieved by varying

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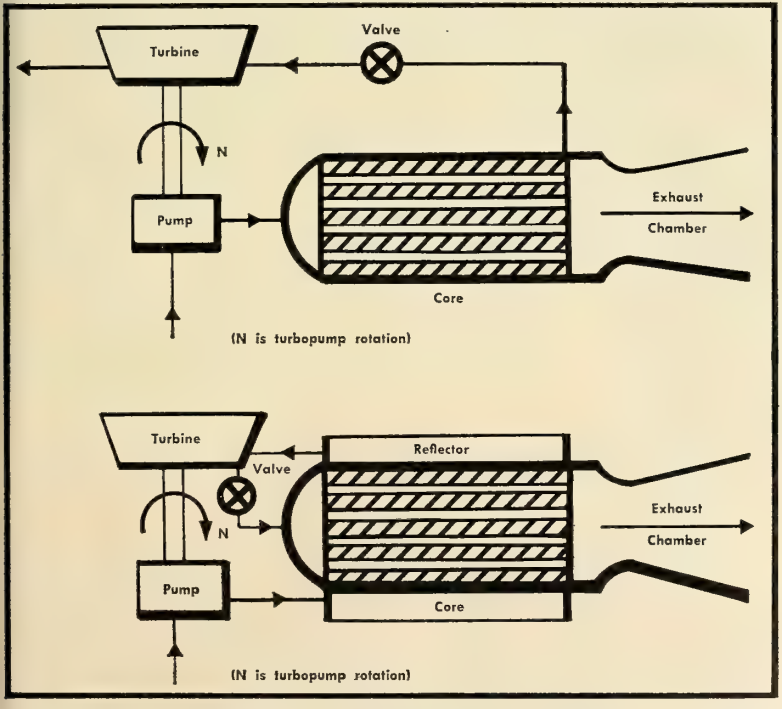


FIG. 1A (top)—Nuclear Rocket with Bleed Turbine. Turbopump is driven by a gas turbine fed with hot propellant. A small quantity of the propellant may be bled off the reactor and expanded down to atmospheric pressure in the turbine.

FIG. 1B—Nuclear Rocket with Topping Turbine. All of the propellant may pass through the turbine after receiving some pre-heat in the cooling jacket and reflector, and then return to the main core heat transfer channels. MIT study dealt mostly with the bleed turbine shown in Fig. 1A, but calculations showed that stability criteria for the two systems were similar.

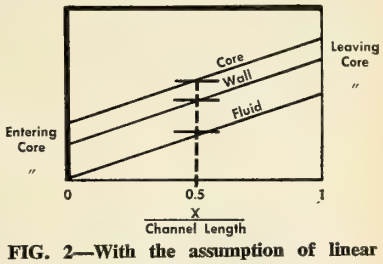


FIG. 2—With the assumption of linear axial temperature rise and constant properties, the temperature distribution along a heat transfer channel is shown here. If the thermal lag time of the propellant is much smaller than the thermal lag of the core, this expression may also be used in unsteady flow. The propellant thermal delay time is equal to the time the propellant spends in the core (milliseconds) and the thermal lag of the core is on the order of 0.5 sec., so that the propellant lag time can safely be neglected. For a cryogenic fluid, stagnation temperature leaving the core is much greater than the stagnation temperature entering the core.

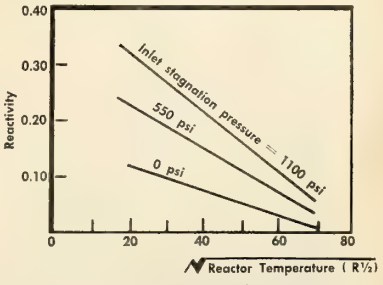


FIG. 3—Reactivity versus inlet stagnation pressure and reactor temperature for a typical nuclear rocket reactor with 30% hydrogen volume.


NASA / Little Jo
UNITED STATES
UNITED STATES

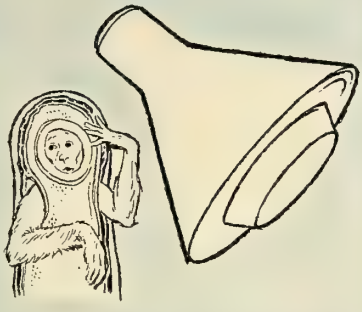
Consistently successful flight performance in Project Mercury confirms unsurpassed reliability of THIOKOL solid rocket motors.

Time after time, NASA's workhorse, Little Joe, has soared into space, checking out the workability of materials, propulsion and escape systems, and reaction of research animals to the environment of space flight.

Pollux, Recruit, Castor—solid rocket motors from THIOKOL's Elkton and Redstone Divisions—have unfailingly provided the thrust and power for Little Joe in its developmental flights.

THIOKOL's record of propulsion reliability in the spatial program is long and brilliant, reaching back to the X-17 which flew successfully in 96% of its launches, and to earlier research vehicles.

In NASA's Little Joe series, THIOKOL booster motors in various configurations have developed up to 250,000 lbs. thrust, today's ICBM class. Smaller THIOKOL rockets have been used to free escape capsule from booster.



Little Joe has carried this research and development capsule and research animals to varying altitudes to obtain engineering and medical data prior to launching man into orbit with subsequent safe recovery. The reliable THIOKOL solid rocket motors used in these missions are virtually off-the-shelf items and are available to other research groups.

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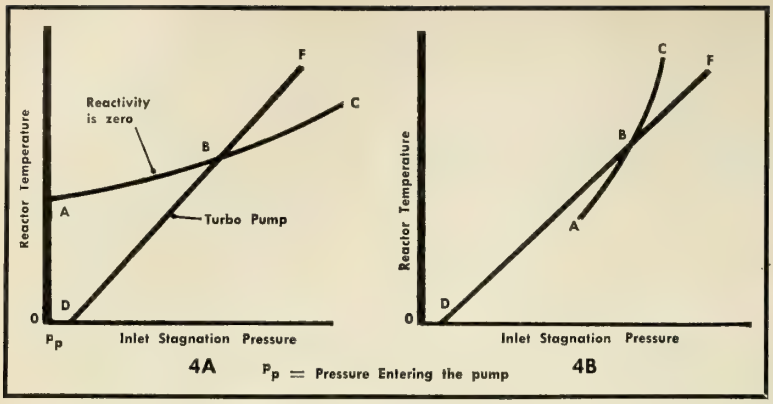
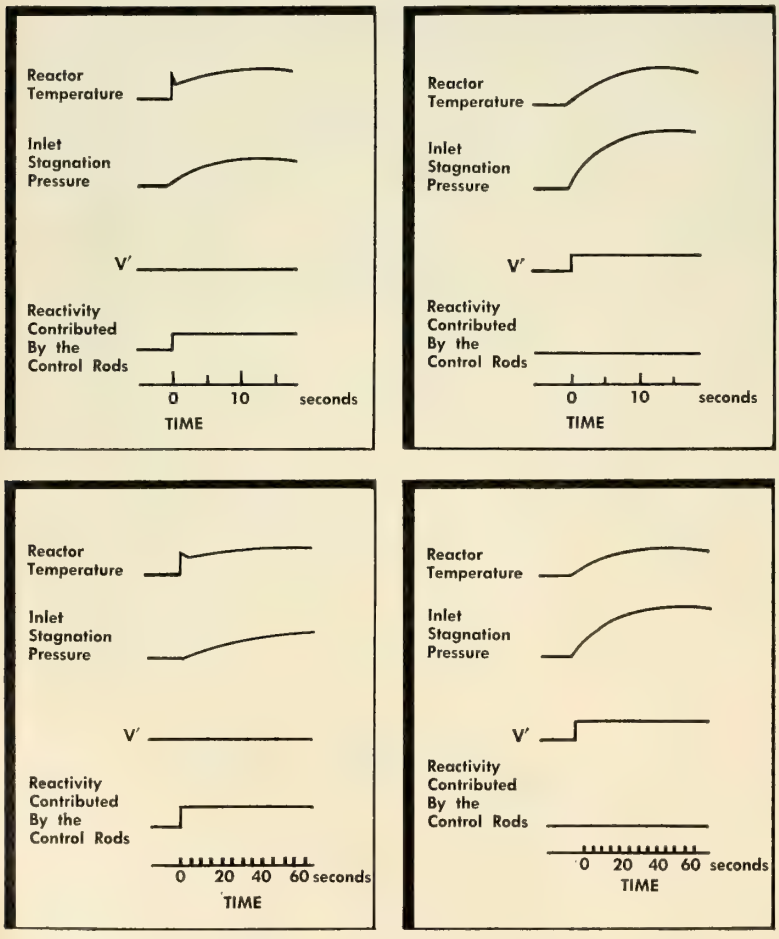


FIG. 4A—Physical significance of the stability criterion can be seen in this chart of the steady-state equilibrium operation of the system. On the chart, reactor temperature is plotted against inlet stagnation pressure, assuming steady reactor operation (reactivity zero). Values may be computed for reactivity contributed by control rods and represented as the line ABC. The equilibrium operating condition is the point of intersection B. Above the line ABC, the reactor is subcritical, and below the line ABC it is supercritical. This is a stable configuration because an increase in turbine inlet temperature drives the pressure up toward F. The operating point shifts into the subcritical region and the reactor power drops to restore the operating point to B.

FIG. 4B—This is an unstable configuration, because an increase in turbine inlet temperature drives the operating point from B towards F, into the supercritical area, and the reactor power increases further. The requirement for stability is therefore that the slope of DBF be greater than the slope of ABC at B.



(NOTE:) $V' = \frac{(p03/p02)}{(p03/p02)d}$ where p03 is the stagnation pressure entering the turbine

p02 is the stagnation pressure leaving the core

and d is the design value.

FIGS. 5 & 6—The response of the pressure and temperature to step changes in valve position and control rod reactivity are shown here for a rocket in the 10^5 pounds thrust class. In Fig. 5, the response in small steps to control rod reactivity and the V′ parameter is shown for initial conditions: average temperature of the reactor—1; inlet stagnation pressure—1. In Fig. 6, the initial conditions are: average reactor temperature—0.39; inlet stagnation pressure—0.1. The response is slower than the design point here, but the system is still very stable.

Continued from p. 29

chamber pressure and reactor core temperatures. Reactor control rods are a standard method of altering core temp., and turbine valves can act upon the pressure in the thrust chamber.

Cross coupling exists between these control elements, since a movement of the control rods results in changes in the turbine inlet temperature and core mass flow, therefore alteration in pump delivery pressure and thrust. On the other hand, changes in core inlet pressure alter the reactivity through the propellant density coefficient of reactivity, resulting in a change of core temperature.

Transient heat transfer from the core to the wall was handled by considering the core as a lumped system. Since MIT was interested mainly in the average core temperatures (which govern reactivity), there was no point in using a distributed parameter representation unless an equally sophisticated model for reactivity change was included in calculations.

Turbine control of the system is achieved through valve regulation of the turbine inlet pressure. The valve pressure ratio (stagnation pressure entering the turbine/stagnation pressure leaving the core) depends only on the valve setting.

• **Open loop stability**—With linearized equations, using the standard techniques of stability analysis, MIT found the open loop system stable and well damped, given certain provisions. The open loop stability depends on the sign of the temperature coefficient of

reactivity of the empty reactor and is independent of the propellant density coefficient of reactivity.

Stability is insured by a negative temperature coefficient; if the temperature coefficient is positive, however, the system will be statically unstable. In this divergent condition, it will not return to equilibrium when disturbed. Hence indications are that the density coefficient of reactivity has no effect on the stability of the system, within the accuracy of MIT's approximations.

Fortunately, says MIT, the empty reactor will probably always have a negative temperature coefficient, although this may be a small value. Calculations have shown that the stability criteria applying to the bleed turbine pump drive also hold true for the topping turbine system.

• **Performance**—Using U^{235} fuel, and assuming a rocket of 1,000,000 lbs. thrust, the MIT scientists plotted response times of pressure and temperatures in the system. Controlled starts were conducted from a nominal idling condition of 10% of inlet pressure at the core and the average reactor temperature at 0.39.

These starts were simulated with a combined proportional plus integral controller with a delay on the turbine valve, and an integral controller with a delay on the reactor control rods.

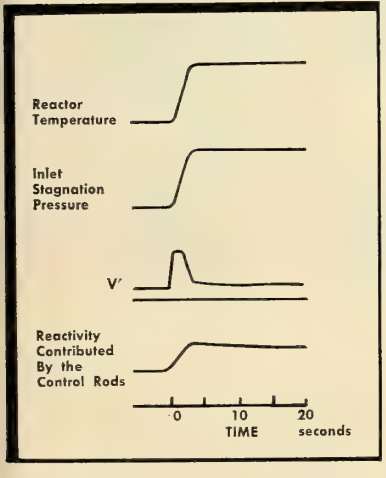


FIG. 7—Temperature and pressure response are shown for a fast start from idling conditions. Design conditions are attained in 3.5 seconds. The maximum rate of change of control rod reactivity is 0.013 per second. The turbine valve parameter V′ reaches a maximum value of 3, requiring a pressure ratio across the turbine valve of 0.33 at the design point to give a large margin for acceleration. This rapid response time is paid for in the necessity to incorporate a large turbine into the system, as well as loss of some specific impulse.

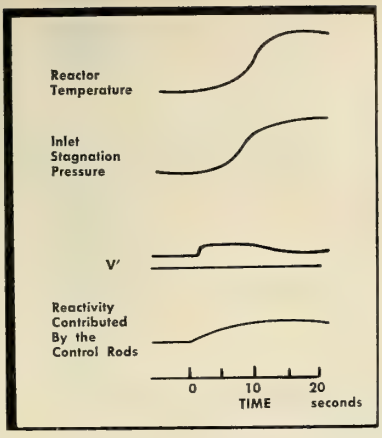


FIG. 8—With maximum pressure ratio of 0.75 across the turbine valve at the design point so that the maximum possible value of V′ is 1.33, the time from idling to full thrust is increased to 15 seconds, with corresponding thrust and temperature history shown here.

The controller actuation delay accounted for the time required to change the valve position and accelerate the control rods. This was about 0.2 sec. The gain on the temperature controller is limited primarily by the speed of actuation which is feasible, and in some cases by the requirement that the system be stable in event of failure of the turbine valve controller.

Another requirement limits the inlet controller gain to a value well above the feasible actuation rate. With values of temperature control gain satisfying these conditions, the pressure controller gains may be adjusted to give the most rapid response with no thrust overshoot.

In some cases, extremely rapid response (3.5 seconds) was achieved. Maximum rate of change of control rod reactivity in these cases was 0.013 per sec. The turbine valve parameter V′ (see Figs. 5 and 6) reached a maximum value of three, requiring a pressure ratio across the turbine valve of 0.33 at the design point to give a large margin for acceleration. (Illustrated in Fig. 7)

The penalty paid for such rapid response in the system is a greatly oversized turbine and some loss in specific impulse.

Designing for a pressure ratio of 0.75 across the turbine valve at the design point so that the maximum possible value of V′ is 1.33, and reducing the pressure controller gains until this value of V′ is reached but not exceeded during startup, the time from idling to full thrust is increased to 15 seconds. (Illustrated in Fig. 8)

Ford to Deliver 9 Scout Vehicles to AF in 1960

Ford Motor Co. will deliver nine *Scout* launching vehicles to the Air Force this year under its contract announced last month.

The Air Force has given the vehicle the official name Hyper-Environmental Test System 609A. *Scout* is a name given by the National Aeronautics and Space Administration. There have been reports that the Air Force is considering naming its version *Astron*.

The Aeronutronic Division of Ford will be system engineer and payload and test contractor for the Air Force system. Chance Vought will provide the vehicle frame and launcher and Minneapolis-Honeywell will provide guidance.

The solid-propelled satellite-launching vehicle consists of four stages: an Aerojet-General Senior as first stage, a Thiokol XM-33 as second stage, an Allegany Ballistics Laboratory (Hercules Powder Co.) X-254 as third stage and an ABL X-248 as fourth stage. However, in the Air Force version, both three and four-stage vehicles will be used, with each vehicle tailored to the requirements of an individual launch test.

First flights of the 609A rockets will be from Cape Canaveral before the end of the year, a Ford spokesman said. NASA plans to fire the first *Scout* from Wallops Island, Va., some time this summer.

J-2 Is Rocketdyne Name For 200K Saturn Engine

Rocketdyne Division of North American Aviation said last week it has given the designation J-2 to the liquid hydrogen-LOX, 200,000-lb.-thrust engine it will develop for upper stages of the *Saturn* vehicle. NASA announced May 31 that it would negotiate a $44-million contract with Rocketdyne to develop the engine.

Air Force Lays Out $20 Million for UDMH

Multi-million-pound quantities of unsymmetrical dimethylhydrazine will be supplied to the Air Force under a series of contracts totaling over $20 million, awarded to Food Machinery and Chemical Corp last week.

In a joint venture with National Distillers and Chemical Corp., FMC will produce Dimazine (R) in expanded facilities at Baltimore.

The storable, high-energy rocket fuel is the only synthetic propellant in use today, according to FMC spokesmen.



AC Seeks and Solves the Significant—AC has earned an enviable reputation for scientific accomplishment with national defense projects such as AChiever inertial guidance systems. But AC is not limiting its goal to leadership in the international technological race. Utilizing scientific "fallout," AC is also increasing its development of significant new commercial products. / This, too, is AC QUESTMANSHIP: the scientific quest for new ideas, methods, components and systems . . . to promote AC's many projects in guidance, navigation, control, detection and communication. / In the commercial field, AC is already producing communications systems, automotive controls and fuel controls for gas turbine engines. Some day they may even add such advanced projects as systems controls for "ground effect vehicles." According to Mr. B. H. Schwarze, AC Director of Commercial Engineering, "the proper application of scientific 'fallout' to commercial products leads to diversified career opportunities." / You may qualify for our specially selected staff . . . if you have a B.S., M.S. or Ph.D. in the electronics, scientific, electrical or mechanical fields, plus related experience. If you are a "seeker and solver," write the Director of Scientific and Professional Employment, Mr. Robert Allen, Oak Creek Plant, 7929 So. Howell Ave., Milwaukee, Wisc.

GUIDANCE / NAVIGATION / CONTROL / DETECTION / COMMUNICATIONS / AC SPARK PLUG *The Electronics Division of General Motors*

NASA Backs Segmented Conical Motor

The National Aeronautics and Space Administration reported last week that United Technology Corp. will receive $186,000 over a six-to-nine month period on its contract to demonstrate the feasibility of a segmented, conical-shaped solid-propellant motor.

The contract, awarded late in May and announced last week (M/R, June 6, p. 15) was the first government contract won by the new United Aircraft Corp. subsidiary.

The study calls for the design, fabrication and testing of three experimental motors to prove the concept. Neither NASA nor UTC would disclose any details of the size of the experimental motors. However, it is understood they will be in the neighborhood of 15,000 lbs. thrust.

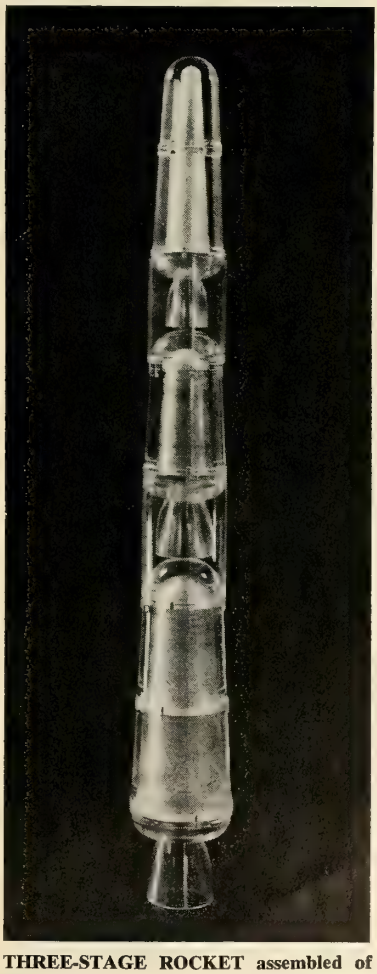
NASA spokesmen said UTC was selected for the negotiated contract because the company had filed for a patent on an interesting new concept in solid rocketry. A company spokesman said the patent application, still pending, describes as unique the conical shape and the method of joining segments together. The application did not claim that UTC originated the principle of segmenting solid rockets, the spokesman said.

Willem Schaafsma, manager of UTC's solid rocket branch, said the use of truncated cone-shaped segments makes possible economical development and manufacture of solid motors of very large size. He said such an approach would permit substantial savings in the cost of developing a motor of a million lbs. thrust. UTC is one of six industry bidders on an Air Force proposal, Project 3059, for a feasibility study on the development of a solid motor of 100 million pound-seconds total impulse.

Both NASA and Air Force spokesmen said that the NASA study is completely independent of Project 3059 and that it had been coordinated with the Air Force on the working level. Air Force spokesmen said that the Project 3059 contract is expected to be awarded soon. The amount of money involved will be several times that in the NASA contract.

• **Why conical?**—Schaafsma said the purpose of the conical shape is to eliminate erosive burning in long solid rockets. The propellant grain thickness (web thickness) is the same for the length of the conical rocket. The gas flow channel in the interior is cone-shaped with the narrower end at the head of the rocket.

Thus the flow area increases—and tends to slow the gas—as it rushes toward the rear of the rocket and out the nozzle. Otherwise, the burning would increase in rate as the rocket burned from the inside out and the burning area increased. This increase in burning area is not a major problem in small and medium-sized solid rockets. But it assumes major proportions in very large rockets such as contemplated in Project 3059.



THREE-STAGE ROCKET assembled of conical segments is shown with cases and connecting fairings transparent for demonstration.

By the elimination of erosive burning in conical segments, Schaafsma added, it becomes easier to predict the ballistic performance of the motor and testing can be reduced.

The conical shape also offers the advantage of simplified grain design. Since the web thickness constant along the entire motor length, adding conical segments to increase the total impulse does not require redesign of the grain, the UTC official explained.

He also listed as advantages the reduction of aerodynamic drag because of the tapered overall shape, reduction in structural weight and the impossibility of making improper field assembly, because of the differing cross sections of the segment ends.

• **White elephant?**—Schaafsma declared that UTC investigated and discarded as impractical the approach of on-site loading of very large rockets. He said the process is not feasible "because once the giant was loaded and an internal defect developed, it would become the biggest white elephant in the world. You couldn't move it and you wouldn't dare launch it for fear it would blow up."

UTC said hardware for its segmented rockets will be fabricated by Pratt & Whitney Aircraft, another division of United Aircraft. The propellant will be cast at UTC's new facilities under construction at Sunnyvale and San Jose, Calif.

Each of the three motors to be delivered will have at least three segments. The feasibility study calls for only static tests of the rockets. No flight tests are contemplated. If the feasibility proves successful, a UTC spokesman said, a proposal then will be made to NASA for development of larger hardware designed for flight.

UTC said it has already built and tested a scale model one 2000th the size proposed under the NASA study. The rocket segments will be built in standard sizes so that any number of them can be put together depending on mission requirements.

All stages of a vehicle would be made of the same basic components. The lowest stage would have the most components, the next stage a smaller number and the top stage the fewest.

Mahon Tells of Struggle to Push ASW

Special interview with key Congressman who outlines why he feels Navy has fought pressure to emphasize the effort under single manager

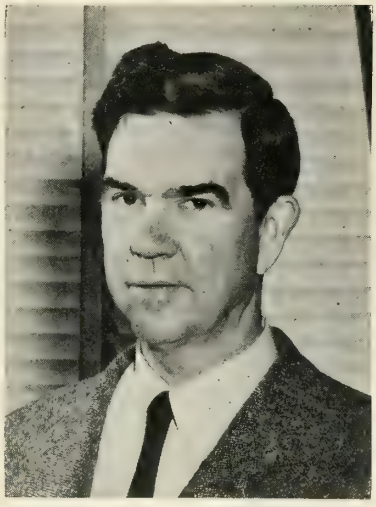
The Senate this week cut extra funds voted by the House for acceleration of lagging antisubmarine warfare research and development. House had voted $100 million but Senate's Military Appropriations Subcommittee chopped off $58 million. M/R takes you behind the scenes in this interview with the man who has one of the biggest jobs in Congress.

Q. You have stated that the Navy has failed to push undersea warfare programs with sufficient vigor. Why has the Navy so failed?

A. The Navy is not a body of men with but a single concept of military requirements. It is divided into factions or schools of thought as are all large organizations. The Navy was dominated prior to World War II by the advocates of the battleship. The dominant faction in the Navy today is made up of the proponents of Naval aviation. This Naval aviation requirement has attained such dominance that the President's budget for Fiscal Year 1961 proposed the procurement of more new aircraft for the Navy than for the Air Force. The factions within a service must contend with each other for funds and the most powerful group will tend to have more of its programs approved for funding than will the groups with less power or influence on top policy-makers.

Under these conditions, the Navy has chosen to emphasize the attack carrier with its supporting task forces, rather than antisubmarine warfare. The proponents of attack carrier forces are able men of strong conviction and earnest purposes, and we should have attack carrier forces, but it is an error to emphasize these forces to the detriment of those forces needed to face up adequately to the vast fleet of Soviet submarines which challenge our supremacy of the seas. Inability to cope adequately with this submarine threat could be decisive.

I make no pretense of being an expert in this field, but a man does not have to be very expert to understand that the Soviet submarine threat is tremendous, not only to our fleet and



Rep. George H. Mahon (D-Tex.)
Chairman of the House Military Appropriations Subcommittee

shipping, but in its missile-carrying configuration, to the cities and military installations within the continental United States. The Germans almost swept our shipping from the seas in World War II beginning in the early days of the war with a nucleus of only 48 submarines. It has been predicted by a high-ranking admiral in a position to know that before too many years have passed, it is likely that all submarines can be used to launch missiles.

The attack carrier does not have a major role as an antisubmarine weapon. Of course, it might perform the function of bombing enemy submarine bases, but land-based aircraft would probably have to be used in many of such strikes, as they were in World War II. Attack carriers are vulnerable to submarine attack and must be guarded by many ships and aircraft which seek to screen them from this threat. Our attack carrier forces would be significantly benefited by improvements in antisubmarine warfare capabilities.

The House Committee on Appropriations, without denying the importance and validity of requirements for carrier forces, has tried to bring to the forefront the urgent need for greater emphasis on antisubmarine warfare capability. This effort has met with strong resistance. It would almost seem that there are those who hope the submarine threat will just go away, but the submarine threat gets increasingly worse year by year and it will not just go away. Last year, Admiral Burke, Chief of Naval Operations, said, "We need to improve our capability to combat submarines. Since World War II, the submarine has progressed faster than the antisubmarine warfare capability to combat it."

Q. You have commended management of the *Polaris* fleet ballistic missile program and have emphasized that such a single manager system must be provided for the ASW effort. Do you expect opposition to this from certain quarters of the Navy? If so, why? How hard will you be willing to push for such a system?

A. In the report accompanying the Defense Appropriation bill this year, we made a recommendation for the application of the *Polaris* type of single manager system to the ASW problem. It should be readily understood that this does not apply to the operational aspects of the problem, although such a single manager would have to work very closely with the operational Navy. We are primarily interested in a single manager for research and development of weapons, equipment and the like, which will be adequate to do the ASW job.

Of course, the Navy has established a position called ASW Readiness Executive, directly under the Chief of Naval Operations. The two officers that have been assigned to this position are superior naval officers, but they have been able to exercise little or no actual authority to get things done. This is typical of the scatter-shot operation for antisubmarine warfare which the Navy has always had. The Navy would not, of course, want to change it. Resistance to change is traditional, especially in the Armed Services. It seems pretty simple to a layman that we should have a dynamic figure who spends his days and nights working as the director of

ASW. The problem is how to detect, identify, and destroy the enemy submarine.

This is no simple, easy job with solutions readily available. In almost every aspect of the ASW problem, we are literally pushing forward the boundaries of basic research. Technically and strategically, it is at least as demanding—if not more so—than nuclear propulsion or the *Polaris* program. When the Navy faced these problems, it went directly to an all-out single manager concept under Admiral Rickover and Admiral Raborn, needless to say with admirable results. Somebody must be given similar responsibility and authority to get this job done. The Chief of Naval Operations is a man of great ability but his time is so consumed with the multitudinous problems of operating the Navy, he cannot spend 16 hours a day devising ways to detect, identify, and destroy enemy submarines. That which is everybody's job tends to become nobody's job. If specific responsibility and authority are fixed in a director of a project and his reputation is at stake and he gets the credit for success and the blame for failure, the chance for real progress is enhanced.

Q. During this session of Congress, do you see the Navy's plans for another carrier, conventional or nuclear-powered, absolutely curtailed? How do you feel about eliminating the carrier? Why?

A. I have supported the elimination from the current budget of the conventional carrier. The House bill eliminated the $293 million in the budget for the conventional carrier. I had hoped that we could complete and test the construction of the nuclear-powered aircraft carrier Enterprise before determining what the next step should be with respect to further carrier construction.

Q. In the same vein, do you consider the nuclear-powered attack submarine as more valuable to ASW work than a carrier, and most surface ships?

A. I assume that in your question you have reference to the ASW-type carrier. There is considerable difference of opinion as to which type of vessel is the most effective in antisubmarine warfare work. Some Navy experts say that the nuclear-powered attack submarine will be the most effective warship in antisubmarine warfare. Our present antisubmarine warfare forces are built around aircraft carriers. It should be made perfectly clear that the carriers engaged in antisubmarine warfare are not the same type as the one proposed in the budget for Fiscal 1961. It is very doubtful that a direct comparison can or should be made between the attack submarine and the carrier for antisubmarine warfare work. Undoubtedly, both will be needed for this type of warfare for a long time to come. Not too much is known about how effective surface ships of any type will be against the deep-diving nuclear-powered submarine in actual war. Strangely enough, the use of the submarine as an ASW weapon system is a relatively new concept. We need much more study in these areas, but certainly such study should be made by experts primarily concerned with solving the problems, and not by people primarily concerned with supporting a particular point of view.

Q. What must be done to give the Navy more capability to kill submarines?

A. The answer must be found in research and development. A lukewarm, uncoordinated effort will not get the job done. The job must be tackled with confidence and determination and with the utmost of leadership and coordination. It is generally agreed that we can kill submarines, at the ranges at which they can be detected, with presently available weapons. As detection devices improve, and as Soviet antisubmarine submarine capabilities increase, new weapons, such as the *Subroc* rocket-torpedo, will be required. The nuclear-powered submarine, because of its performance under water and the depths to which it can go and remain, still performing at high speed, makes the kill possibility much more difficult with present-day weapons, except the atomic depth charge. It is possible that the deep diving high-performance nuclear submarine might be able to escape even an atomic depth charge because of the time required for such a charge to get down to sufficient depth to reach the submarine. What is needed is a weapon which will operate at great depths and with sufficient speed to make evasion most difficult. Rocket-type propulsion under water may provide a part of the answer.

Q. Your Committee has added $321,000,000 more to the 1961 Navy Appropriation portion of ASW. Do you consider this adequate? The Navy will be authorized to spend approximately $1.865 billion for ASW procurement, RDT&E in Fiscal Year 1961. Could you give an estimate of the percentage increase for FY 1962 and the next five-year period?

A. Money cannot buy back lost time or purchase knowledge not yet gained. The Committee added $321,000,000 to the Defense Appropriation bill for antisubmarine work, of which $100,000,000 is for research and development. This research money, when added to the approximately $180,000,000 which the budget contained for research and development is about all that can reasonably be expended. The other $221,000,000 is for attack submarines and destroyer escorts. Undoubtedly, much more could have been added in this latter category because many of our warships engaged in ASW are becoming over-aged. Very likely much more will need to be done in future years in the way of replacing these vessels. However, this should be done when we know more about the problem. What increases there may be in future years will depend on technical developments.

Q. It is well recognized that the missile/space industry sprang up virtually overnight because funding and priorities were given and American industry was called upon to provide the talent. Do you see a like emphasis in ASW and do you think American industry is being called upon by the Navy to do as much as it can?

A. It is doubtful that there will be a rapid growth, comparable to the missile/space industry, devoted exclusively to antisubmarine warfare. Unless, of course, the Russians undertake a mammoth program in the area of fleet ballistic missile development, such as our *Polaris* system. There should be considerable growth in our programs however, over the next few years, particularly in the fields of exploration and research. American industry has not contributed materially to our efforts in the antisubmarine warfare field in the past. The National Security Industrial Association has, however, formed an Antisubmarine Advisory Committee which, in April of this year, submitted its first report to the Navy. There are other indications in the business community that industry is tending to offer the assistance that is so greatly desired. There is no question but that industry can make valuable contribution—whole new concepts of such functions as tracking, identification, and classification need to be developed, explored, tested, and when proven, produced for use.

I should say, nevertheless, that our antisubmarine warfare efforts are not likely to have the same relative priority as our strategic missile programs. Antisubmarine warfare is a defensive operation. Strategic missiles relate to a build-up of our vital offensive capability. We must avoid developing a "Maginot Line" defensive concept.

Ways Sought to Ease Ordeal of Space

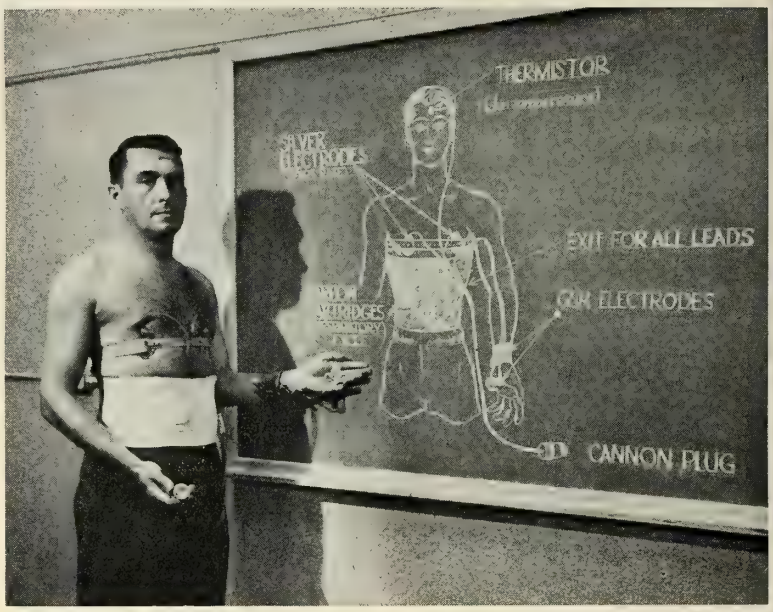
by William Beller

SAN ANTONIO—An astronaut en route through space for an extended period will have mental problems due to weightlessness, loneliness, or literally being bored to death, agreed aerospace medical experts at a recent meeting at the School of Aviation Medicine, USAF Aerospace Medical Center.

They said one way to solve his problems is to surround the traveler with more of the earth's environment such as artificial gravity, conversation with friends, and a full day's work.

A minority report filed by several of the experts questioned whether it might not be wiser to change man, making him more adaptable to space conditions as they are. If he is sufficiently changed, then not only will he be complacent but also specifications for the spacecraft's artificial environment could be greatly relaxed.

They suggested that man might be altered by radically lowering his body temperature, by conditioning and hypnosis, and by using drugs administered through a closed loop servo system tied to the space environment.



HARNESS AND SENSORS are worn by subject at Air Force space medicine school to measure his reactions to conditions of stress.

• **Astronaut selection**—Giving a close-to-first-hand report on experiences the first astronaut will be facing, Lt. Col. David Simons, SAM's chief of bioastronautics, contrasted his observations during a 32-hour balloon flight which reached an altitude of 101,000 ft., with a 30-hour simulated flight in a space chamber. He reported that he experienced hallucinations during the chamber run but not during the actual flight. Why this was so, Simons would not say without more tests. However, he surmised that space and time distortions might play an important role in hallucination forming.

Of high interest to the aerospace experts was Simons' statement that his "defense mechanism" for his Manhigh II balloon flight was his thorough familiarity with the Manhigh system. Further, he was totally concerned with "How can the job be done?" and not at all with "Can it be done?"

The Manhigh II pilot also made the following observations:

After 24 hours' continuous duty either in the chamber or during his flight, there was a definite decrease in his performance.

He experienced a deep sense of frustration early in the chamber run because he was not kept busy enough.

During the day, while he was making and reporting scientific observations, he resented interruptions from the ground crew. However, during the night, when he was threatened by environmental conditions outside the capsule, he welcomed every radio contact. These experiences contrasted with Simons' attitude during his chamber flight when he had no strong feelings one way or the other about communications with the outside world.

• **Weightlessness**—Dr. Hubertus Strughold, SAM's professor of space medicine, took pains to point out what he called a popular misconception about weightlessness. Observing that the orbiting of a vehicle around the earth is often described as a constant falling, he said that some people believe that this would produce in an astronaut the nightmare of a sensation of endless falling.

"If we consider the function of the otolith organ (vibrating substance in inner ear) we must come to the conclusion that this is not so," he pointed out. "The astronaut will have the sensation of falling perhaps for only a few seconds when he enters the gravity-free state. Thereafter this sensation should cease because the otoliths have attained a new equilibrium."

Going deeper into the probable problems of weightlessness to the astronaut, Bryce Hartman, chief of SAM's neuropsychiatry branch, emphasized that the astronaut's real difficulty would be his ability to readjust to a one-g state on his return trip. The investigator felt that the physiological effects, for instance those of circulation, digestion and muscular function, of returning to normal gravity environment would involve major disturbances. Yet it is exactly at this point, upon reentry, that the astronaut would be in most danger.

To dramatize his warning, Hartman told of one subject who for seven days had been in a water tank, a means to simulate a quasi-weightless state. Slowly the subject began losing his ability to perform tasks that previously had been easy for him. Most dramatic of all was when the subject was brought back to his normal one-g state. Then

even tasks that he could have performed in the tank were difficult if not impossible for him to do. Hartman observed that, "If these results are valid, we have been dangerously complacent about the effectiveness of man in space flight."

To the astronaut's advantage is that the energy he would use to do a given piece of work in the weightless condition would be less than that used in a one-g system. If it can be said that consequently the astronaut will suffer less fatigue then, Hartman reasoned, "It means that an astronaut will be able to perform steady work for considerably longer periods without deterious effects."

• **Sensory deprivation**—By reducing an individual's ability to sense a stimulation, investigators reported, they brought on a range of responses including hallucinations in "normal" subjects and marked changes in the body scheme in several mental patients. If the responses of the mental patients were included as the limiting condition of a normal tendency, then these studies could also pertain to an astronaut in a spacecraft. He would be deprived of a sense of weight, perhaps of sight, and—perhaps at times—of sound.

Speaking further about reducing the sensations that could get through to a person, D. Ewen Cameron, McGill University professor of psychiatry, said that one of his working assumptions is that all humans want to keep and extend their control over all matters that affect them. "Where this control is interfered with, as, for instance, in loss of control over body equilibrium, in disorientation, in amnesia, in organic brain disease, or where the individual is forced to operate in a dangerous situation without adequate means of control, anxiety constantly appears."

• **Astronaut a monitor**—Hartman considered the astronaut as part of a man-machine system. He saw space flight as merely an extension of military aviation, and the military aviator not as a pilot but rather as an operator of complex systems. In effect, said Hartman, the astronaut will be a monitor.

"While monitoring, he will be required to continuously diagnose the state of the system. When this state deviates from the desired one, he will be required to respond. If a new mode of operation is indicated, he will give the appropriate command to the system. If a malfunction or deviation from a specified mode occurs, he will give corrective commands."

From this analysis, Hartman derived the general characteristics of the tasks performed by the astronaut as follows:

• They are multivariate. The op-



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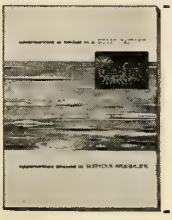
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erator is required to perform a large number of different functions.

• They involve a complex combination of skillful responses requiring precision and simple discrete responses such as throwing a switch.

• There is an increasing requirement for detection of signals, interpretation of the information contained in these signals, and making decisions about alternate modes of system operation.

• The rate of performance is variable, and involves intermittent responding and controlling interspersed with periods of monitoring.

• The sequences of responses is highly variable, for the requirements placed upon the operator are based upon minor deviations and major failures of automatic and semi-automatic machine processes which are basically unpredictable.

• **Altered day length**—In an attempt to increase man's efficiency and alertness, experimenters have recently tried altering the 24-hour cycle that man usually lives by. This cycle is reflected in a person's body-temperature curve. It is absent at birth and is individually established and maintained by being made to follow the customary routine of family and community.

Under emergency conditions, almost everyone has lived on a shortened or extended day for a brief period. To look into this question scientifically, the aeromedical experts tried to make their subjects adjust to cycles different than the 24-hour one, and with success. Subjects have thrived on cycles of 18, 21 and 28 hours. Such cycles, or rhythms, could be more easily followed off the earth and during space flight, and a particular rhythm might be of strong advantage to the mission. Certainly, the 28-hour cycle would have helped Simons during Manhigh II.

Nathaniel Kleitman, professor of physiology at the University of Chicago, said that in a reasonably long cycle—one greater than 24 hours but not too greatly extended—the longer the cycle the greater the body temperature range. "This means that one can expect to reach a greater degree of alertness and heightened performance on the one hand, and a more complete relaxation, perhaps better sleep, on the other."

• **Sensory overloading**—In critical situations, the astronaut may suddenly find himself overloaded with things to look at and things to do. As a result, he might be unable to process everything adequately, and a serious breakdown in performance might result, according to James G. Miller, professor of psychiatry at the University of Michigan.

Hartman tied astronaut reliability in with what he called "sensory overload." He emphasized that it was the engineer, the designer of the systems and subsystems, who would have a more direct influence on operator reliability insofar as loading is concerned than the human factors specialist. When designing a system, Hartman asked that engineers consider the following factors:

• When periods of high load density occur, performance drops off gradually, and the effects do not become apparent for some time.

• For the high task load situation, the operator is limited by a built-in, fixed ceiling in his ability to integrate, organize, and respond to a sequence of events.

• Operator reliability can be achieved by redesigning the system to eliminate these periods of operator load. Only a segment-by-segment analysis of the operators' job can isolate those periods where the task has exceeded the operator's capabilities.

• Vigilance, which involves very low signal rates, is highly susceptible to fatigue effects and probably should be engineered out of the astronaut's job. A low-signal-rate item would probably be a dial reading telling of a meteor shower.

• On the other hand, moitoring, which involves moderate signal rates, is an inherent part of the job of a systems operator. When carried out against a background of related activities, monitoring can be maintained at an efficient level over extended periods.

• It may be necessary to make reentry largely automatic until space flight itself establishes the limits of man's capability at this point in the mission.

• The long-term effects of fatigue and diurnal variation will probably be less critical than early workers in space medicine anticipated. Exploratory research suggests that considerably less sleep will be required in the weightless environment.

• Reliability is not accidentally achieved. The astronaut's job must be structured to insure that proficiency is maintained at a high level.

• **Hypnosis and hypothermia**—When it comes to changing man so that he can more easily adapt to his environment and also that he may be tested for proficiency in a new environment, Roy Dorcus, UCLA professor of psychology, saw hypnosis ready to play an important role. He outlined areas in which it might be useful:

• In creating realism in models constructed for simulating space conditions.

• In implanting ideas for reducing fear and anxiety involving unknown situations.

• In reducing boredom by compressing unoccupied time and creating illusions of stimuli to fill time.

• In directing attention to specific tasks to be performed under stress.

• In lowering metabolic rate and reducing oxygen intake.

• In maintaining awkward positions in such a manner as to make them more tolerable.

• In training individuals to induce self-hypnosis so that they may bring about sleep when desired and awaken at any time in an alert condition.

In another exotic method to change man to meet the space environment more easily, F. John Lewis, professor of surgery at Northwestern University School of Medicine, described some of his work in the intense cooling of warm-blooded animals, hypothermia. He observed that to match the shortage of oxygen, the shortage of food, the monotony in the small cabins, that the greatly reduced metabolic activity in the deep narcosis produced by hypothermia would be ideal.

"Attractive, indeed, for the space traveler would be the choice of hibernating during long periods when there was nothing that he had to do." Unfortunately, though, "this desirable state can not be attained yet in homeothermic animals." He added that "short intense cooling to near freezing temperature is quite well tolerated by warm-blooded animals even though prolonged cooling is not."

• **Drugs and servos**—The most imaginative alteration in man was proposed by Nathan Kline, director of research of Rockland State Hospital, Orangeburg, N.Y. Based upon the unconscious control our body exerts over our nervous system and glands, Kline's proposal was that machinery external to man be devised as additional servo loops to make him more efficient.

"This self-regulation needs to function without the benefit of consciousness in order to cooperate with the body's own autonomous homeostatic controls. One such device, which is already available, is the ingenious osmotic pressure pump capsule developed by S. Rose for the continuous slow injections of biochemically active substances at a biological rate." Kline pointed out that this device could be buried in an animal which would lead a reasonable normal life even while the injection was going on. Such a system is possible today, he said, with the selection of appropriate drugs.

Inert Fabrication Plant Operational

BRIDGEVILLE, PA.—The world's first airless, high-temperature, metal processing plant is in operation at Universal-Cyclops Steel Corp.

Designed by the firm's Refractomet Division, with the cooperation of the Navy's Bureau of Weapons, the facility turns out refractory mill products of unusually high integrity insured by the absence of the contaminating elements in air and by working temperatures up to 4500°F.

The Inert Fabrication (Infab) plant is a welded steel enclosure 42 ft. wide x 97 ft. long x 23 ft. high containing an impactor, a rolling mill, furnaces, a ten ton crane and 84,000 cubic feet of 99.995% pure argon. There is additional space available for more equipment.

The inert atmosphere is directly responsible for elimination of many of the operations in the conventional processing of refractories—operations necessitated by the catastrophic oxidation and air contamination which occurs when metals such as molybdenum are heated above 1500°F in air.

The optimum working temperature of a metal is about 85% of its melting point. This insures maximum utilization of the inherent strength properties. In the case of refractories, these hot working temperatures are usually approximately twice that needed for steel.

• **Inert atmosphere**—The argon pressure within the Infab room is maintained at 0.5 oz psi above the outside atmospheric pressure to minimize the entry of contaminating air. Due to the high temperatures generated by the fabrication process, argon is withdrawn from the room at 120°F, cooled, purified and returned at 30°F. Mean temperature within the room averages between 80 and 100°F. Specifications, exceeded in operation, call for the entering argon to contain no more than 150 ppm of nitrogen, 40 ppm of oxygen, 50 ppm of water vapor, and 5-10 ppm of oil and other hydrocarbon vapors.

• **Mill facilities**—The horizontal forging impactor is fully automatic and normally controlled from a console outside the room. A large picture window of special glass screens out the ultraviolet radiation emitted from the heated metal. Driven by compressed argon, the impactor dies strike with 15,000 ft. lbs. per blow on opposite sides of the heated ingot.

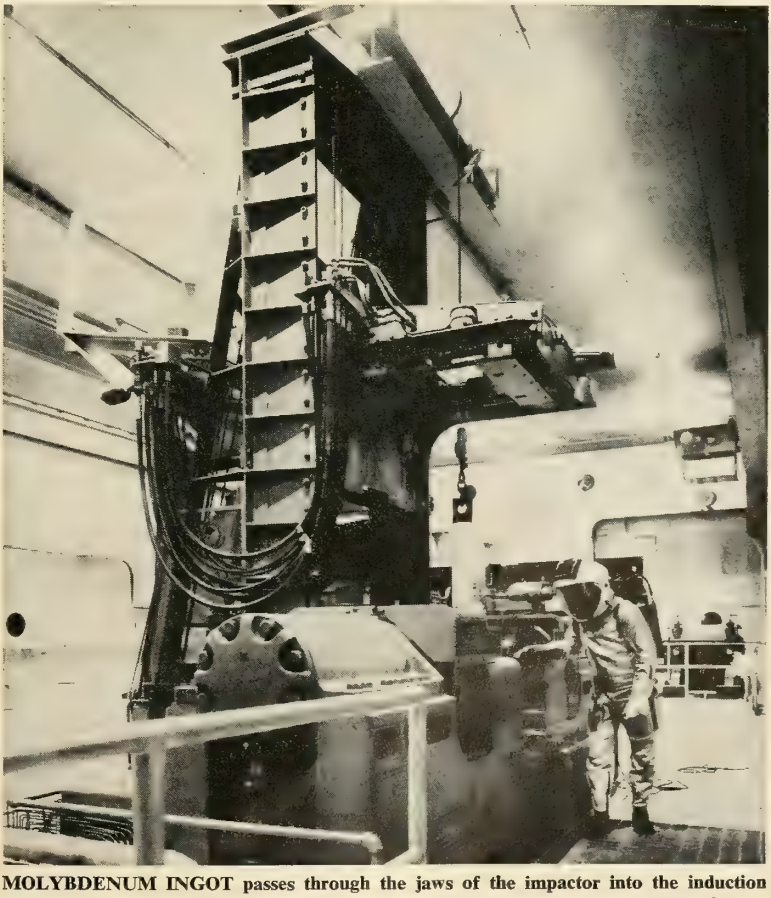
Ingots are heated in induction furnaces located immediately below the forging zone. Transfer takes two seconds and keeps heat losses to a minimum. Normal impact products are 4 in. round cornered square billets and sheet bars 2 in. x 10 in. in cross-section.

The Birdsboro rolling mill is equipped with motorized screw-down, automatic feeding and is normally operated from an outside console similar to the impactor. Two induction furnaces at the end of the rolling table can take the metal up to 4000°F.

The mill has both flat and grooved rolls and can produce bars down to 0.5 in. diameter and sheet up to 15 in. across and 96 in. long. Through pack rolling, sheet gages of 0.020 in. are obtainable. To avoid contamination of the room, all lubricating points on the machines have been sealed.

• **Personnel locks**—The Infab room has three personnel locks. One is used for normal passage and the other two for emergency exits. The main lock is flushed with nitrogen to remove the air before the inner door is opened. The argon purification cycle rapidly removes the nitrogen. Personnel carry their air supply and a cooling unit on their back. Communications and power outlets are located around the room. Each technician wears a four-layer, gas-tight suit. Maximum care is taken to insure that none of the normal body oils escape to contaminate the room.

Optimum safety standards are ob-



MOLYBDENUM INGOT passes through the jaws of the impactor into the induction furnace. Three furnaces with induction coils of varying size can heat it to 4500°F.



ENGINEERING PROGRESS ISSUE and the MISSILE/SPACE ENCYCLOPEDIA

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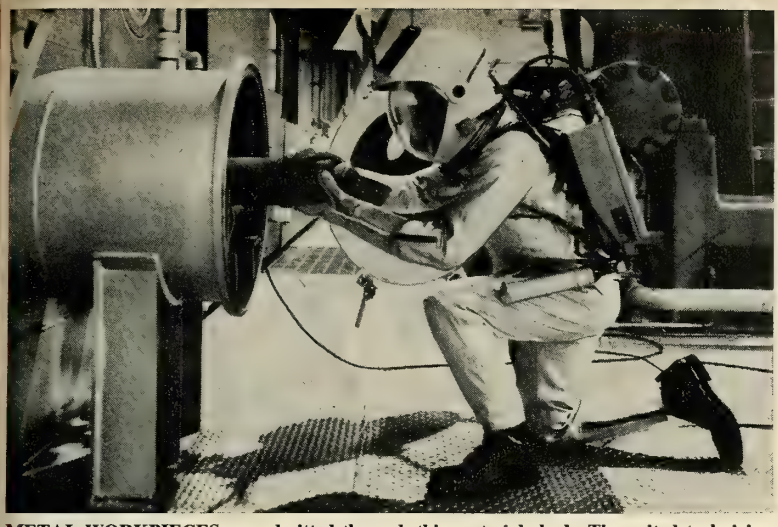
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THE MISSILE/SPACE WEEKLY

missiles and rockets

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METAL WORKPIECES are admitted through this materials lock. The suited technician can use a 10-ton overhead crane to move the heavy ingots.

served. Each man has a spare oxygen bottle which can be activated by pulling a lanyard. The two emergency exits can be reached easily from any point in the room. In addition, a man is stationed outside of each of the personnel locks.

The actual work performed by personnel within the room will be light. They serve as trouble shooters in case of mechanical difficulties and aid in the movement of the metal workpieces.

• **Ingot entry**—A cylindrical materials lock, 2 ft. in diameter and 16 ft. long containing roller tables, admits the prepared ingots. Large pieces of equipment and materials enter the room through the fifth lock. This chamber is 8 ft. high, 16 ft. long, and 8 ft. wide.

Normal powder metallurgy methods are followed in preparation of ingots for milling operations. Powdered metal is initially formed into a controlled shape through vacuum and mechanical agitation in a bag loading device.

The powder, and its plastic container, is compacted isostatically in a converted naval gun barrel using water pressure. The compacted electrode is sintered with final density reaching 95% of theoretical.

The electrode is then melted in a modified General Electric consumable vacuum arc furnace—producing .12 in. diameter ingots 70 in. long and weighing up to 3000 lbs. Other facilities at Universal-Cyclops can produce ingots of the same length, 17 in. in diameter and weighing up to 6000 lbs., depending on the metal. The ingot is then admitted to the Infab room after conditioning.

The firm will concentrate on molybdenum, tantalum, tungsten, columbium and their alloys. Company spokesmen point out that Infab is a pilot production plant capable of around 2000 lbs. of finished mill products daily.

NBS Presses Research on Hot Gas, Plasma

The space-fostered interest in the behavior of hot gases and plasmas has prompted the National Bureau of Standards to establish a special research program to unify and strengthen its activities in this field.

NBS has planned a long-range experimental and theoretical program to develop the necessary measurement standards, basic data, theoretical guidance and interpretative techniques for determining relevant properties of hot gases.

Many long-standing NBS projects —investigations of ionosperic and solar phenomena, atomic properties and hot gas research, and study of radio wave propagation in plasmas—are to be included.

Data necessary to prediction of hot gas behavior will be derived from atomic-energy-level investigations, studies of transition probabilities and work on collision cross-sections.

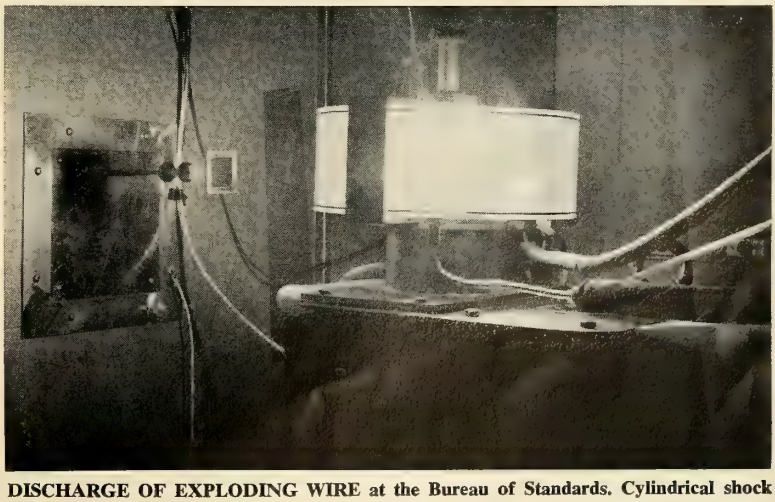
Efforts to characterize plasmas accurately involve:

• Searching for a meaningful substitution for temperature when local thermodynamic equilibrium does not exist.

• Theoretical studies devoted to the application of non-equilibrium statistical mechanics to hot gases.

• Development of thermodynamic data for ionized plasma over the range of 10,000°K to 10,000,000°K. As of now, there is no experimental data of state above 1000°K. NBS is immediately interested in determining thermal conductivities of hydrogen and helium in shock wave between 10,000° and 50,000°K.

In addition, microwave diagnostic techniques are being developed to provide a physical understanding of plasma configurations. Theoretical work on the physics of stellar and planetary atmospheres is also included—since these provide convenient and important examples of non-local thermodynamic equilibrium, high-temperature gases.



DISCHARGE OF EXPLODING WIRE at the Bureau of Standards. Cylindrical shock waves so generated provide needed data in plasma research.

Graphite R&D Boosted With $12 Million From AF

New types of graphite and graphite-based materials for nozzles, nose cones and leading edges of space vehicles will be provided through an accelerated development program conducted by Union Carbide under a $12-million Air Force contract.

Morse G. Dial, chairman of the board of Union Carbide, announced last week that an Advanced Material Laboratory will be constructed at Lawrenceburg, Tenn., to carry out the program.

Built by the firm and equipped by the Air Force, the laboratory will consist of a raw materials plant, a pilot processing plant, a completely equipped laboratory and office facilities.

The primary objectives are to explore raw materials and processing techniques which may cut by one third the variation of mechanical and physical properties found in the best grades of graphite currently available, and reduce manufacturing time from weeks to days. These objectives are to be attained for pieces larger than 3 x 6 ft. Finally, a processing facility will be developed to produce such graphites in quantity for proper evaluation under full-scale conditions.

Experienced scientists at National Carbon Co., a division of Union Carbide, will participate in the program.

The Air Force says that if the high-temperature properties of graphite can be improved, several knotty problems in missile and space vehicle design will be simplified. Graphite is known to be stronger than any material above 2700°F—and this strength increases up to 4500°F. (M/R, Nov. 23, 1959, p. 16)

GE Develops Low-thermal Alloy for Ceramic Seals

A new alloy with thermal expansion properties close to those of alumina has been developed by General Electric, Schenectady, N.Y.

This means that the electric industry can now take full advantage of the high strength, high heat resistance and insulating properties of alumina in metal-to-ceramic seals, according to Dr. Guy Suits, Director of Research.

Designated Fernico-5, the alloy is a result of combining iron, nickel and cobalt in such a way as to optimize the ferromagnetic properties. The low thermal expansion is a direct consequence of this.

The alloy is vacuum-melted—eliminating oxygen-level control additives, providing low gas content in the melt, and allowing better control of the iron-nickel-cobalt ratio.

names

Henry J. Hirtzer: Manager of engineering for the past 2½ years, elected vice president of Donner Scientific Co., a subsidiary of Systron-Donner Corp. Prior to joining the firm in 1956 as senior engineer, he served as project engineer for Statham Laboratories; senior areodynamicist, McCullough Motors Corp.; and stress analyst with North American Aviation, Inc.


HIRTZER

Dr. Hanns S. Wolff: Formerly on the engineering staff of W. L. Maxon Corp., appointed chief of the new Electronics Laboratory at Republic Aviation Corp. Is the holder of more than 125 patents.

Horace G. Irwin: Named space systems project engineer for the Douglas Aircraft Co.'s *Delta* and *Thor-Able* space vehicle programs, succeeding **Ted J. Gordon** named project engineer for the *Saturn* S-IV second stage.

Arthur W. Dobson: Joins Perkin-Elmer Corp. as manager of marketing research, responsible for directing all activities of the Central Marketing Research Dept. Was previously assistant manager of product analysis with American Machine and Foundry Co.


DOBSON

G. T. Atkins, (USN ret.)—Appointed head of the Project Management Dept. at Thiokol Chemical Corp.'s Elkton Division.

Sherwin U. Miller, M.D.: Elected director of the Life Sciences Division of Space Systems Laboratories, Space Systems & Industrial Automation, Inc. Was formerly director of space medicine at the Space Research Laboratories of Litton Industries.

Ernest N. Ljunggren: Appointed vice president for the Minuteman Systems Management division of Autonetics, division of North American Aviation, Inc.

Robert M. Snow and **Dr. Glenn E. Fellows:** Formerly manager and assistant manager, respectively, at Melpar's Applied Science Division, join Bay State Electronics Corp. to establish a research division.

D. W. Hege: Manager of the Advanced Design subdivision of Rocketdyne, division of North American Aviation, Inc., named a consultant to the Propulsion Panel of the Air Force's Scientific Advisory Board. Prior to his present position was for four years program manager of the *Atlas* rocket engine development.

Thomas W. Donohue: Former sales manager for Statham Development Co., appointed to the new post of director of marketing for Missimers Inc. Previously served as general manager of Tomlee Tool and Engineering Co. and as chief engineer of General Mills Inc.'s Mechanical Development Division.

Dr. Grant E. St. John: Appointed director of research and development, Tube Division of Microwave Associates, Inc. Was previously senior project engineer with Watkins-Johnson Co. and prior to that was supervisor of a research and development group with Bell Telephone Laboratories, Electron Tube Development Dept.


ST. JOHN

Murray A. Schwartz: Joins the technical staff of United Technology Corp.'s Research Division as head of its high-temperature materials program. Was formerly manager of the ceramics section of Ford Motor Co.'s Aeronutronic Division.

David E. Hemingway: Appointed general manager of the environmental engineering laboratories of Richard D. Brew & Co., responsible for all testing activities, laboratory development and marketing programs.

Sam Polur: Named sales and advertising director of Electro Networks, Inc.

Benjamin J. Pensiero: Formerly with a private consulting firm, joins Philco Corp.'s Government and Industrial Group as manager of marketing administration.

G. William De Sousa: Named marketing manager of Sperry Semiconductor Division, Sperry Rand Corp. Was formerly vice-president-marketing in the Semi-conductor Division at Hoffman Electronics Corp.

Ray Primmer: Joins National Astro Laboratories as manager, Quality Assurance Division.

Beryl L. McArdle: Former manager of the Intelligence Systems Dept., Electronics Division, appointed scientific advisor on the staff of **Dr. Royal Weller,** vice president-engineering for Stromberg-Carlson Division of General Dynamics Corp.

Frederick J. Senft: Joins the Condenser Products Co., a division of The New Haven Clock and Watch Co., as chief engineer.

Edward F. Canfield: Named marketing manager for Philco Corp.'s Research Division.

soviet affairs

By DR. ALBERT PARRY

Marshal of rocketry

is the latest high office created in the Soviet armed forces. The revelation of the new command in Moscow went almost unnoticed in the tumult caused by the shooting down of our U-2. Yet the official confirmation by Nikita Khrushchev of this long-rumored news constitutes an important development in the organization of Russia's rocket-and-missile arms. Rocketry is now definitely a separate Soviet command, on an equal footing with the army, the navy, and the air force of the U.S.S.R., if indeed not higher than the three older services.

The earliest indication

of the new Soviet organization came from England late last year. A report by the Institute of Strategic Studies in London stated: "The personnel operating the Soviet missiles have been organized into what is virtually a fourth arm of the services numbering about 200,000 men under the command of an engineer general who has under his control all factories in which nuclear bombs are manufactured, all testing sites, all factories in which rockets and guided missiles are produced, and rocket and guided missile units." The number of the main Soviet missile bases under this "engineer general" was given in the London report as some 100.

The Soviets remained mum

on this London report even after it was cited as authentic in the December, 1959, issue of *The NATO Letter*. But finally, on May 1, 1960, Soviet Minister of Defense Marshal Rodion Malinovsky greeted the Red Square parade as "soldiers of the army, fleet, and rocketry," using the word "rocketry" for the first time in such a salutation. Malinovsky spoke just a few hours after his subordinates had notified him that a Soviet rocket shot down the American U-2 plane. Three days later, on the evening of May 4, Nikita Khrushchev himself, while chatting at a reception at the Czechoslovak embassy in Moscow, turned to a nearby Russian marshal and casually introduced him as "Nedelin, Marshal of Rocketry." Thus the new command and its chief were officially unveiled.

Marshal Mitrofan Ivanovich Nedelin

is indeed an "engineer general" of long standing, with a distinguished career in Soviet artillery. He has been a marshal since 1953 (the year of Stalin's death), and until quite recently his official titles were "Marshal of Artillery; Commander in Chief, Soviet Army Artillery; chief of the Main Artillery Administration, U.S.S.R. Ministry of Defense." Born in either 1903 or 1904 (Soviet records are not too exact on this), he joined the Red army after the Russian civil war, and was graduated in the late 1920's from an artillery training school, and in 1935 from the Dzerzhinsky Artillery Academy in Moscow.

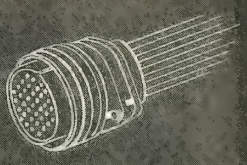
He fought in Spain

in 1936-39 as an artillery adviser to the Loyalists. On returning home he was a colonel of artillery in and around Moscow. In World War II he organized and commanded large artillery units, particularly proving himself as one of Russia's ablest organizers of artillery logistics. He was credited with successful moving up of artillery supplies during major mobile operations in the Soviet offenses beyond Russia's borders. He emerged from the war a colonel general, with numerous decorations. A zealous Communist, this head of Soviet rocketry is an alternate member of his party's central committee, which may mean that he is one of the Soviet military men playing a political role as well.

Thanks to Nedelin's rocket men

in Sverdlovsk, who were praised for reportedly knocking down the U-2, the marshal himself will doubtless get another medal to add to his collection. And now that his post has at last been publicly revealed, the world may well expect further news of him.

BENDIX
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ENVIRONMENT RESISTANT
Connectors



Bendix MS-R series are the small, lightweight, more efficient and compatible environment resisting class of connectors as specified in the latest version of MIL-C-5015.

Main joint and moisture barriers at solder weld ends have integral "O" rings. Grommet design of "slippery rubber" is sealing medium for individual wires. This provides easier wire threading and friction-free travel of grommet over wires.

Many other features are described in MS-R Bulletin. Send for your copy today, or

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For dependable service

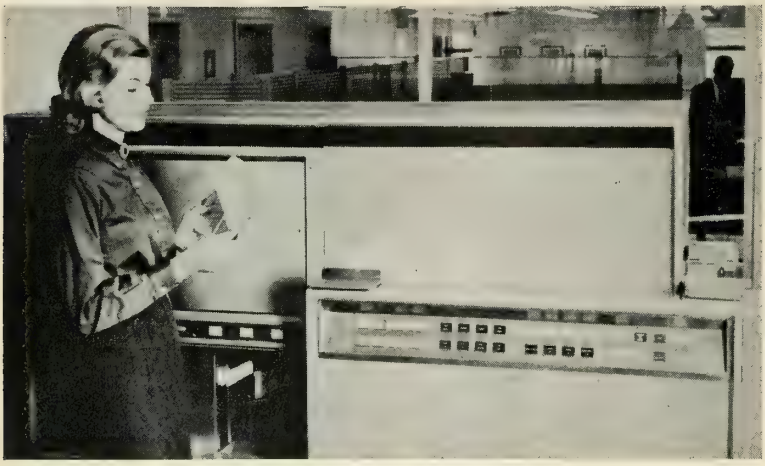
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Circle No. 12 on Subscriber Service Card.



Univac Card Printer Developed

Punched cards, used by the billions in many business operations, can now be computed, edited, punched and printed on both sides in a single operation by a system developed by the Remington Rand Univac Division of Sperry Rand Corp.

The system is based on a new unit, called the Univac On-Line Card-Punching printer, which prints a total of 1820 characters of information on one punched card at speeds up to 1560 lines a minute, permitting users of the Univac Solid-State 80 computer to reduce the size of their files and speed up search time.

The "one-line" principle permits data to be fed directly at high speed from the central computer to the printing unit and eliminates intermediary steps.

A storage capacity of 50,000 characters of data allows a wide variety of programing, control, editing and arithmetic operations.

The new unit punches alphabetic or numeric data in as many as 80 columns simultaneously at the rate of 150 cards a minute, while reading and verifying the accuracy of the information punched. At the same time, it prints up to 13 lines, 70 characters wide, on one or both sides of the cards. Printing is done between rows of punching. This makes it impossible to print over previously punched holes, thus preserving valuable printed data.

Circle No. 225 on Subscriber Service Card.

Mercury Vapor Filter

A respirator cartridge developed for protection against the vapors of elemental mercury in air is being marketed by American Optical Co. Designed for use with the R-5000 series of interchangeable respirators, each cartridge includes a particulate filter for retention of airborne particulate and a vapor adsorbent bed for retention of metallic mercury vapors.

The R-88 cartridge will also protect against organic vapors as well.

Circle No. 226 on Subscriber Service Card.

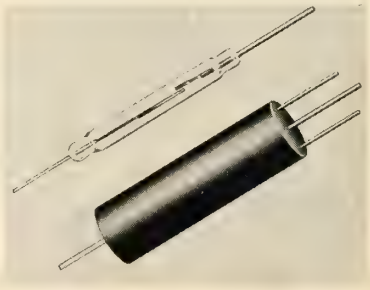
High-Speed Reed Relays

Reed relays developed by Struthers-Dunn, Inc., are based on an unusual design incorporating a short pole piece with a longer moving reed which permits higher operating speeds with conventional reed switches.

A hermetically-sealed, glass-encapsulated magnetic reed switch is surrounded by an operating coil to provide SP-ST normally open relay action. Maximum operating current is 1 ampere. Load life at one-quarter of maximum rating is on the order of 200 million operations. Minimum operating power is approximately 100 milliwatts.

The switch itself is 3¼ in. long by .215 in. diameter. A single contact relay with coil as illustrated is approximately 9/16 in. in diameter.

Circle No. 227 on Subscriber Service Card.

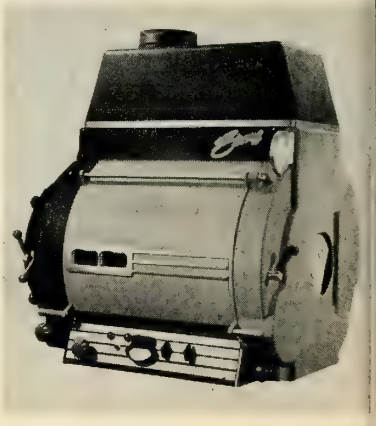


Solar Energy Simulator

A blown type arc for artificial simulation of solar energy is being manufactured by Strong Electric Corp.

Known as the Jetarc, it efficiently collects useful radiation by first-surface reflectors and concentrates it at the reimaging point, from where it can be projected by a quartz objective system in a pattern shaped to fit the work area.

A circular radiation pattern totals 374 watts with an 80% uniformity of field or a total of 668 watts with a 60% uniformity of field. Higher- or lower-energy unit areas can be obtained by variation in optics or projection distance. Larger areas can be covered by multiple employment of lamps using either superimposed or overlapping pattern technique.



A continuous spectrum is available from .25 to 5.+ microns, with a spectral energy distribution very close to solar energy distribution above the earth's atmosphere. The Jetarc source can be oriented in any plane without loss of stability.

Circle No. 228 on Subscriber Service Card.

Solid-State Decommutator

A solid-state, completely digital telemetry decommutator is now available from Electro-Mechanical Research, Inc. The new decommutator, designated the Model 185A, accepts most pulse-type telemetry signal inputs, PAM, PDM or PCM, over the extremely wide sampling-rate range of 10 to 4600 pps, and provides digital or analog outputs. PCM bit rates

(serial) to 60,000 bits per sec. and word lengths of 16 bits (serial or parallel) can be handled. Between 10 and 128 channels or words per frame can be accommodated.

The Model 185A employs all solid-state circuitry for ruggedness and low power consumption. Through solid-state design a complete 48-channel de-commutator occupies only 52½ in. of rack height. Modular, computer-type construction is used throughout.

Circle No. 229 on Subscriber Service Card.

Epoxy Glass Rolled Tubing

Continental-Diamond Fibre Corp., a subsidiary of The Budd Co., announced production of rolled epoxy-glass tubing that has the electrical and physical properties required of NEMA G-11 sheets.

Known as Dilecto GB-125EFT, this rolled tubing is made from epoxy resin impregnated glass cloth that is rolled and cured-in mandrels. The new tubing grade is designed for use in transformers and other heavy electrical equipment and for use in military electronic equipment. In such use, it features excellent physical properties, flame retardance, arc resistance, and high flexural strength at 150°C.

CDF's new Dilecto GB-125EFR tubing is available in 3/16-in. to 12¾-in. ID and ¼-in. to 13½-in. OD with a minimum wall thickness of 1/32 in. The tubing length is 38 in.

Circle No. 230 on Subscriber Service Card.

Non-Destructive Tester

An ultrasonic materials tester for non-destructive inspection of material which can support ultrasonic waves is being manufactured by Circo Ultrasonic Corp.

The Circosonic Model CM100 is completely portable, designed for in-plant use, simple and economical to operate, and can use any common plant power supply. Accessories for a wide range of applications are available.

Components are a generator and receiver for high frequency vibrations sent in a pulsed beam through material to be inspected and discontinuities, as well as the opposite end, reflect vibrations back to receiver indicating size and location of reflecting areas on the viewing screen.

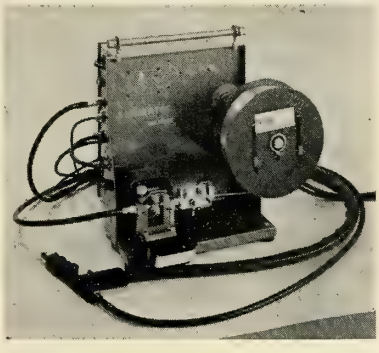
Circle No. 231 on Subscriber Service Card.



Welder Line Announced

A new line of "Sigmatic" welding machines for consumable electrode, inert-gas welding of the fullest range of metals and thicknesses has been announced by Linde Co. Three mountings of standardized welder components are available: SWM-11 frame-type unit; SWM-12 sled-type unit; and SWM-13 cart-type unit.

Adaptable electronic controls, which are primarily designed for the constant-potential power source, are easily converted to use conventional (constant current) power supplies. Other optional control features include a wire-feed delay until the arc is struck (useful in welding the .030- to .100-in. thickness range), and continuous operation without depressing the torch trigger.



Circle No. 232 on Subscriber Service Card.

C-Band Oscillator Cavity

A miniaturized C-Band Oscillator Cavity, tunable from 5350 mc to 5950 mc, has been announced by Trak Electronics. Tuning is accomplished by adjusting a screw located at one end of the Trak Cavity. The C-Band Trak Oscillator Cavity is used in beacons, transponders, and similar applications. Preliminary specifications are as follows:

There is a 10w peak minimum over the band. (0.001 duty cycle, 1 microsecond pulse). Higher powers may be obtained using higher pulse voltages. Depending upon the individual tube selected, output powers exceeding 50W peak have been obtained at the low end of the band. It can withstand 100 G for 3 milliseconds in each of three major axes.

Circle No. 233 on Subscriber Service Card.

ENGINEERS
SCIENTISTS

9 vital problem areas relating to space exploration

—now under investigation at REPUBLIC AVIATION

- designing space propulsion systems with long-term uninterrupted operational capability (nuclear and plasma sources)
- creating optimum life support systems for the space environment
- combining microminiaturization with maximum dependability in space electronics systems (through cryogenics and other techniques)
- accelerating materials development to meet extreme thermal and radiation conditions of space flight
- developing navigation and guidance systems with true space flight capabilities
- creating new order of reliability in re-entry control techniques
- advancing the state-of-the-art in spaceship ejection capsules
- meeting the hyperaccuracy requirements of inter-planetary flight trajectories
- speeding space science research through new mathematical and programming techniques

Highly qualified engineers and scientists will find that Republic's Scientific Research Staff and Applied Research & Development Division offer outstanding opportunities for original work in these crucial areas.

Inquiries to Mr. George R. Hickman, Technical Employment Manager, concerning these senior positions at Republic's new Research and Development Center will be treated in strictest confidence.

REPUBLIC AVIATION
Department 4F-3
Farmingdale, Long Island, New York

Constant Cutting Lathe

A Universal Constant Cutting Speed Lathe that eliminates the need for speed control cams and computations has been announced by the Lodge & Shipley Co., Cincinnati, Ohio.

Built in Powerturn 45° Copymatic models in sizes from 2013 to 3220-37, the new lathe provides constant cutting speed at any point, regardless of contours. Beside giving greater accuracy and smoother finish, this machine eliminates the cost and delay of providing a special speed control cam for each job, gives longer tool life and minimizes tool grinding.

Circle No. 234 on Subscriber Service Card.

Motionless Computer

Servomechanisms Inc. has developed a new form of analog computer that can solve problems without mechanical motion of any kind.

The computer, technically called a "solid-state analog computer," performs the specialized functions of an analog computer, but with no moving parts. It is a miniature solid block of "vacuum-deposited" material which has sufficient versatility to simulate the components of the standard analog computers, requiring the same inputs and supply the same type of outputs. Initial use will be in aircraft and space flight applications.

Circle No. 235 on Subscriber Service Card.

new literature

VECO CHOPPERETTE DATA SHEET. The VECO "Chopperette" solid-state transistorized chopper is described and illustrated in a 4-page data sheet now available. Complete details of operation are included: typical applications with diagrams, switching characteristics of the Chopperette and its use, plus electrical characteristics.

Circle No. 200 on Subscriber Service Card.

TANTALUM FOIL CAPACITORS. With the introduction of a line of etched tantalum foil electrolytic capacitors, Ohmite Manufacturing Company has released a new bulletin describing this line and its existing plain foil line. The literature lists the extensive range of values in both the etched and plain foil capacitors stocked by Ohmite. Clearly shown are the MIL values in plain foil capacitors stocked by Ohmite distributors.

Circle No. 201 on Subscriber Service Card.

EPOXIES IN THE FOUNDRY. Ten applications enabling savings of up to 60% are outlined in a new three-color, eight-page brochure. Blow core boxes, loose pieces, spotting slugs, match plates, core sticks, cope and drag patterns, fillet pastes and pattern coating resins are but a few of the applications described in the booklet published by Furane Plastics Incorporated.

Circle No. 202 on Subscriber Service Card.

BALANCING MACHINES. Two complete lines of static-dynamic balancing machines are described in a 20-page bulletin from the Tinius Olsen Testing Machine Company. The brochure describes Olsen compensator and pivoted cradle machines, including special adaptations for jet engines and components, automobile engines and completely automatic balancing machines. In addition, the bulletin includes an informative dissertation on the nature, causes and correction of unbalance with descriptions and schematic diagrams of four different balancing methods—compensator, nodal bar, pivoted cradle and electrical network.

Circle No. 203 on Subscriber Service Card.

PRECIOUS METALS — INDUSTRIAL APPLICATIONS. The brochure outlines sizes, compositions, and uses of solid and clad gold and silver strip, tubing, wire, brazing alloys, and waveguide tubing. Typical platinum and platinum alloy clad-metal combinations are noted, along with basic specifications for sheet, strip, rod, wire, foil, and tubing. The brochure also contains information on platinum thermocouple wire, platinum-clad electrical contacts, rhodium plating solutions, and other platinum products.

Circle No. 204 on Subscriber Service Card.

BALL BEARING ENGINEERING. A 28-page brochure presenting concepts for applying thin-sectioned large bore ball bearings to equipment designs is available from Kaydon Engineering. Installation drawings illustrate how thin Kaydon Reali-Slim bearings save weight, space and cost. Applications shown range from wire-twisting machines to paper-making machine press rolls, and from heavy-duty lathes to submarine periscopes.

Circle No. 205 on Subscriber Service Card.

SILICONE GUIDE. An up-to-the-minute summary of the forms, properties and applications of Dow Corning Silicones is contained in this 16-page brochure. Silicone products reviewed range from adhesives to release agents, laminating resins to rubber compounds, and electrical insulation to water repellents. The table of contents is arranged according to applications — enabling quick, easy reference to silicone materials that resist the effects of time, heat, moisture, weathering, oxidation, and chemical attack.

Circle No. 206 on Subscriber Service Card.

when and where

JUNE

American Nuclear Society, National Meeting, Palmer House, Chicago, June 12-14.

Seminar in Design Engineering, Pennsylvania State University, University Park, June 12-17.

1960 Radio Frequency Interference Symposium, sponsored by the IRE, Shoreham Hotel, Washington, D.C., June 13-14.

American Institute of Mining, Metallurgical and Petroleum Engineers, International Powder Metallurgy Conference, Biltmore Hotel, New York City, June 13-15.

Symposium on Molecular Structure and Spectroscopy, Dept. of Physics and Astronomy, Ohio University, Columbus, June 13-17.

1960 Cornell University Industrial Engineering Seminars, Ithaca, N.Y., June 14-17.

Special Summer Program on Fluid Power Control, Massachusetts Institute of Technology, Cambridge, June 14-24.

American Institute of Chemical Engineers, Del Prado Hotel, Mexico City, Mexico, June 19-22.

AIEE Summer General Meeting. Atlantic City, June 19-24.

University of Connecticut, Institute for Practical Research on Operations, Storrs, June 19-25.

Atomic and Molecular Gas Beams Symposium, University of Denver, Denver, June 20-22.

ASME Applied Mechanics Conference, Pennsylvania State University, University Park, June 20-22.

Gordon Research Conference, Colby Junior College, New London, N.H., June 20-24.

Institute of Navigation, 16th Annual Meeting, Air Force Academy, Colorado Springs, June 23-25.

International Machine Tool Trades Exhibition, Brettenham House, Lancaster Place, London, W. C. 2, June 24-July 8.

Fourth National Convention on Military Electronics, sponsored by IRE PGMIL Sheraton Park Hotel, Washington, D.C., June 27-29.

JULY

Metallurgical Society of AIME Conference on The Response of Materials to High-Velocity Deformation, Estes Park, Colo., July 11-12.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

contracts

NASA

$44,000,000—Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif., for development of a 200,000-pound-thrust liquid hydrogen-fueled engine.

$124,480—Doyle and Russell, Norfolk, Va., for services and materials for liquid fuel storage at Wallops Island.

$87,600—The T. J. Hume Co., Lorain, Ohio, for construction of the High Energy Rocket Research Facility Control Building for Plum Brook Facilities, Sandusky, Ohio.

$42,000—Consolidated Aerodynamics Corp., Washington, D.C., for recorder, amplifier and systems.

$38,840—The Klein Steel Co., Bellevue, Ohio, for fabrication and erection of structural steel for the Altitude Rocket Test Facility at Plum Brook Facilities, Sandusky, O.

AIR FORCE

Solverine Diesel Power Co., Detroit, for precise power ground support generator sets which may be used with the newest supersonic jet planes and missiles. Amt. not disclosed.

$20,000,000—Food Machinery & Chemical Corp., New York, N.Y., for multi-million-pound quantities of Dimazine storable, high-energy liquid rocket fuel.

$15,000,000—Siegler Corp., for automatic electronic launch control equipment for the *Atlas*. Subcontract from **Convair-Astronautics Division.**

$12,000,000—National Carbon Co., a div. of Union Carbide Corp., for research and development of space aeronautical-vehicle grade graphites.

$1,700,000—Astronautics Div., Chance Vought Aircraft, Inc., for constructing airframe and special support equipment for the *TS-609A* space research and test rocket.

$126,008—Sperry Rand Corp., Phoenix, Ariz., for flight path computing system law/exhibit.

$62,776—The J. C. Carter Co., Costa Mesa. Calif., for propellant flow control valves.

NAVY

$3,300,000—The Martin Co., Orlando, for *Bullpup* missiles.

$3,139,448—Raytheon Co., Missile Systems Div., Oxnard, Calif., for missile spare parts and evaluation flight tests.

$238,750—The Cardan Company, Los Angeles, for construction of high explosive magazines, Naval Missile Facility, Point Arguello, Lompoc, Calif.

$77,453—Magnetic Controls Co., Minneapolis, for portable temperature control systems to be used with missile inertial guidance gyroscopes.

$74,800—Consolidated Electrodynamics Corp., San Diego, for magnetic tape record-reproduce equipment.

$65,951—Northwestern University Aerial Measurement Laboratory, Evanston, Ill., for labor and materials to conduct a weapons system study relating to the Sidewinder 1C.

$57,991—Chrysler Corp., Engineering Div., Detroit, for conducting a research program on semiconducting compounds for thermo-electric power generation at high temperatures.

ARMY

Hogan Faximile Corp., a subsidiary of Telautograph Corp., for high-speed recorders to be used in connection with *Nike-Zeus* missile program. Amt. not disclosed.

$9,238,454—Hercules Powder Co., Wilmington, Del., for continued production and plant maintenance at Radford, Va., arsenal.

$7,335,285—Thiokol Chemical Corp., Bristol, Pa., for continued production and plant maintenance at Longhorn Ordnance Works, Marshall, Tex.

$6,642,496—Chrysler Corp., Detroit, three contracts for repair parts and modification services on the *Jupiter* missile.

$4,341,750—Western Electric Co., New York, N.Y., for the *Nike-Hercules* program. Work will be done at Winston-Salem, N.C. and at **Douglas Aircraft**, Santa Monica.

$4,114,000—Johnson, Drake & Piper, Inc., Downey, Calif., for construction of two *Atlas* missile launching silos at L. A. Ordnance District.

$2,700,000—Martin Co., Orlando, Fla., for the *Pershing* missile system.

ARMY

$1,950,000—Raytheon Co., Waltham, Mass., for engineering services for the *Hawk* missile system.

$1,887,763—Chrysler Corp., Detroit, for *Redstone* missile engineering services.

$1,741,500—The Wurlitzer Co., North Tonawanda, N.Y., for multi-purpose electronic bomb fuzes.

$513,350—Sperry Rand Corp., Salt Lake City, Utah, for repair parts for *Sergeant* guided missile system (two contracts).

$300,000—Sperry Rand Corp., Salt Lake City, for publications for the *Sergeant* guided missile system.

$223,092—Douglas Aircraft Co., Santa Monica, Calif., for launching area items: *Nike-Hercules*.

$208,256—Gilfillan Bros., Inc., Los Angeles, for repair parts for *Corporal* missile system.

$119,778—Douglas Aircraft, Santa Monica, Calif., for spare parts for the *Nike* system.

$113,350—Sperry Rand Corp., Salt Lake City, for repair parts for *Sergeant* guided missile system.

$109,250—North American Aviation Inc., Rocketdyne Div., Canoga Park, for research of high-energy monopropellants.

$97,058—General Machine Products Co., Inc., Trevase, Pa., for *Thruster*.

$96,250—Radioplane, Div. of Northrop, Van Nuys, Calif., for C-2B flight control system for the *OQ-19B* target missile.

$85,330—Ryan Aeronautical Co., San Diego, for target missile flight service.

$74,975—Hughes Aircraft Co., Culver City, Calif., for development, demonstration of breadboard reflector scanned high power radar.

$69,989—Sperry Rand Corp., Salt Lake City, for *Sergeant* Missiles.

$60,000—Packard Bell Computer Corp., Los Angeles, for digital arbitrary function generator.

$53,417—Firestone Tire & Rubber Co., Los Angeles, for spare parts for *Corporal* missile system.

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editorial . . .

Nuclear Testing—Morals vs. Survival

It is easy for people who have no responsibility for defending this country or its allies to call for a complete cessation of nuclear weapons testing. From a moral point of view, they are right.

But war and the weapons of war aren't moral. They are designed—from the longbow to the big bomb—to surprise, bewilder, terrify, overwhelm and overpower the enemy. Let's consider a few hard facts of our defense or military situation:

There are only three countries on this earth which can wage an all-out war—Soviet Russia, the United States and Red China. Any world holocaust today must involve at least two of those powers.

It is inconceivable in the present climate that the United States would go to war against any of the Western nations or a coalition of Western nations. It is most remote that we should be involved in fighting Israel. But if they are involved in a war with Russia or China—so would we be.

There are no other nations in the world with armed forces powerful enough to pose any military threat.

This being the case, we have two things to fear. The first is that we might blunder into war with Russia or Red China, or both. The second is that we might intervene to stop communist aggression and find U.S. forces (even within a NATO or United Nations framework) pitted against Chinese or Russian forces in the guise of volunteers or otherwise.

In the first instance we would obviously use nuclear weapons. In the second we might or might not. If the aggression occurred in the Western hemisphere we would have the advantage of short logistic lines for both supplies and manpower.

If, as is most likely, it occurred in the other side of the world, either the Russians or the Red Chinese could pour into the conflict supplies and men sufficient to overwhelm us unless we had superior firepower.

Equally or perhaps more important is the fact that our military forces—Army, Navy and Air Force—are geared to the use of atomic weapons. Numbers have been sacrificed for firepower. Restricted to conventional weapons, we would be defeated by attrition.

Whether the situation we have reached is the best or worst is not a point here. It is a situation we're stuck with—and we must make the best of it.

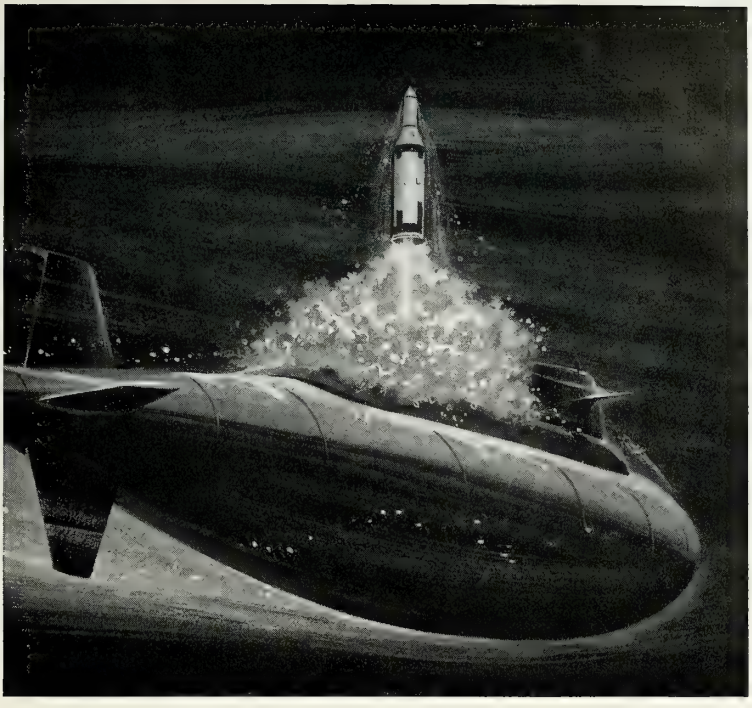
Which brings us again to the testing of nuclear weapons. On the authority of Dr. Edward Teller, possibly the free world's foremost nuclear technician, we are on the verge of perfecting small "clean" nuclear weapons. They lack only further testing.

They would be comparable in effectiveness to an artillery barrage. They could arm small commando forces. They would reduce the warhead size and weight of small missiles for all forces. They would add immeasurably to the mobility and firepower of our ground forces. These weapons would, according to Dr. Teller, reduce our armament costs greatly; he further argued that they should also be given to our allies for all of the foregoing reasons.

Because of the time element involved—because the missiles are second-generation—there is a possibility that the small warheads of *Minuteman* and *Polaris* may not have been sufficiently tested to absolutely guarantee their reliability. These are the ballistic missiles which will provide the bulk of our retaliatory defense for the next several years.

So, ordering the cessation of testing of all nuclear weapons is not as simple as the moral problem involved. Survival is a factor, too, and we doubt very much if a few more tests would raise the world's tension noticeably. Not after the events of recent weeks.

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missiles and rockets

THE MISSILE/SPACE WEEKLY

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missiles and rockets

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THE COVER

X-15 engine which suffered an explosion in its engine bay last week. The mishap may delay the program by as much as six weeks. See story on p. 18.

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Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

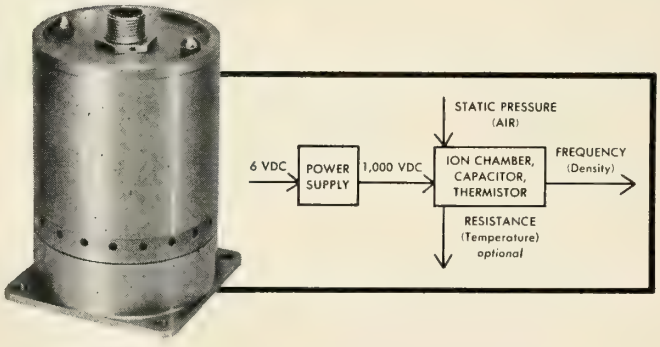


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when and where

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American Institute of Chemical Engineers, Del Prado Hotel, Mexico City, Mexico, June 19-22.

American Institute of Electrical Engineers, Summer General Meeting, Atlantic City, N.J., June 19-24.

University of Connecticut, Institute for Practical Research on Operations, Storrs, June 19-25.

Atomic and Molecular Gas Beams Symposium, University of Denver, Denver, June 20-22.

ASME Applied Mechanics Conference, Pennsylvania State University, University Park, June 20-22.

Institute of Navigation, 16th Annual Meeting, Air Force Academy, Colorado Springs, Colo., June 23-25.

International Machine Tool Trades Exhibition, Machine Tool Trades Association, Brettanham House, London, June 24-July 8.

Fourth National Convention on Military Electronics, sponsored by IRE Professional Group on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 27-29.

Institute of the Aeronautical Sciences, National summer meeting, Ambassador Hotel, Los Angeles, June 27-30.

JULY

Metallurgical Society of American Institute of Metallurgical Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Prof. Group on Communications Systems and Army Signal Corps, Statler-Hilton Hotel, Washington, D.C., August 1-3.

Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, August 1-12.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, August 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, Cortez Hotel, San Diego, Calif., August 9-12.

ASME-AIChE Heat Transfer Conference and Exhibit, Statler-Hilton, Buffalo, N.Y., August 15-17.

XIth International Astronautical Congress, Stockholm, Sweden, August 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, August 23-25.

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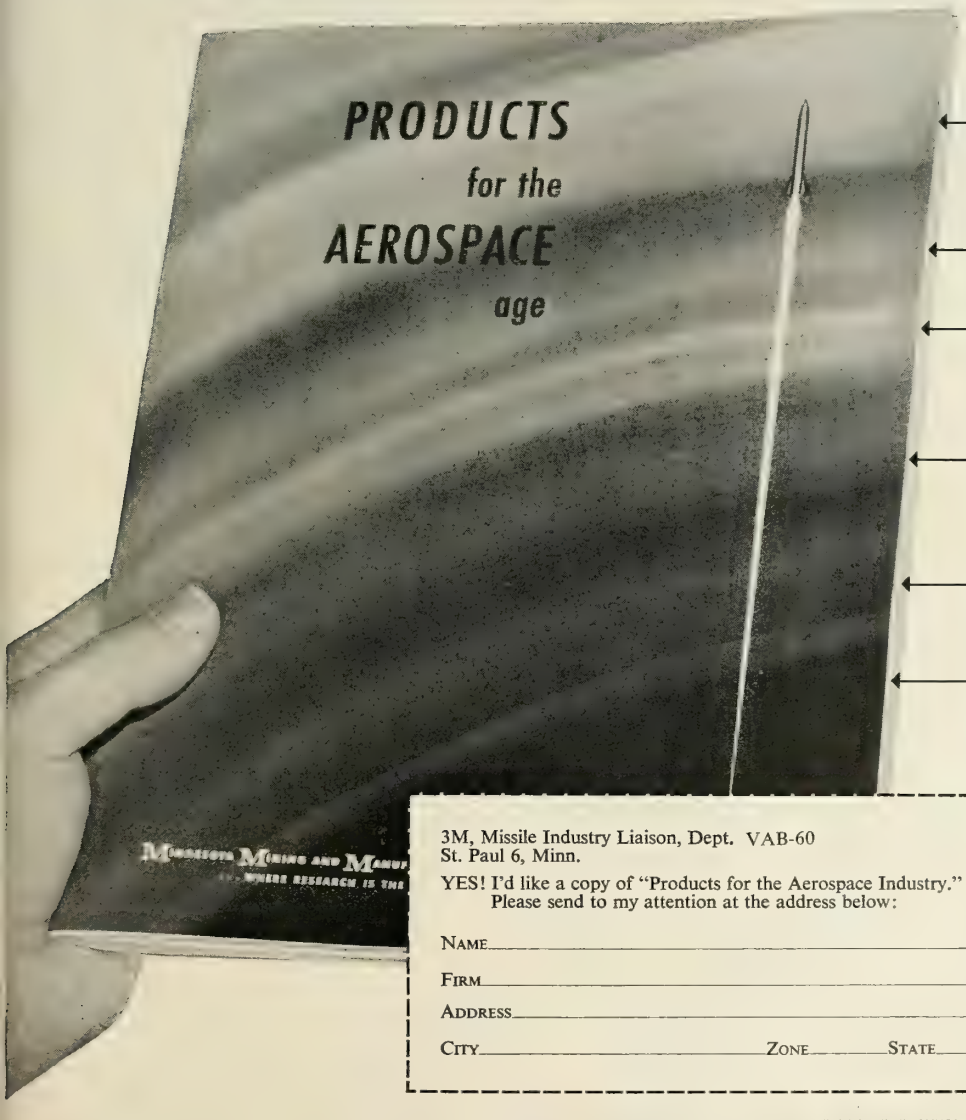
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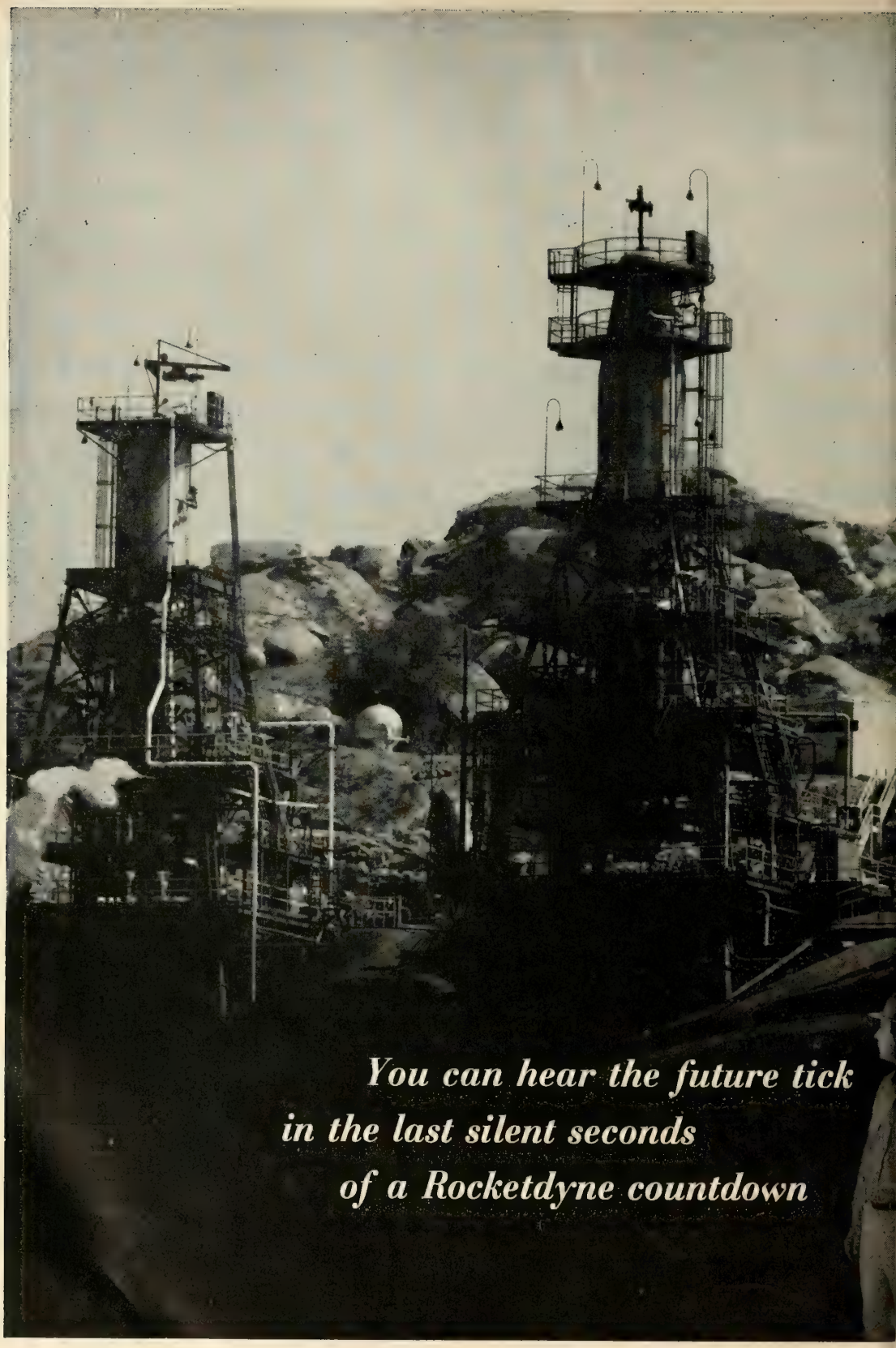
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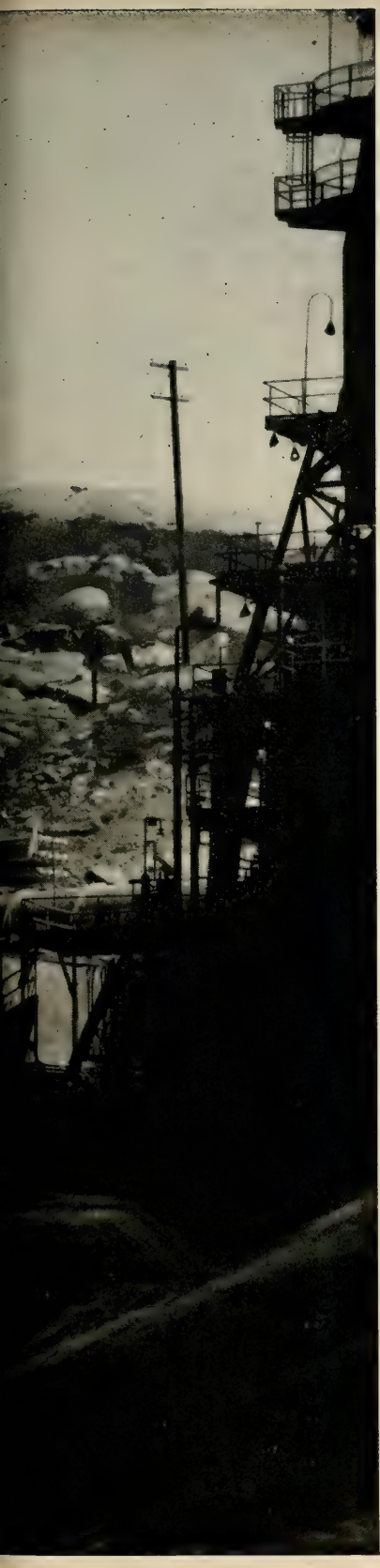
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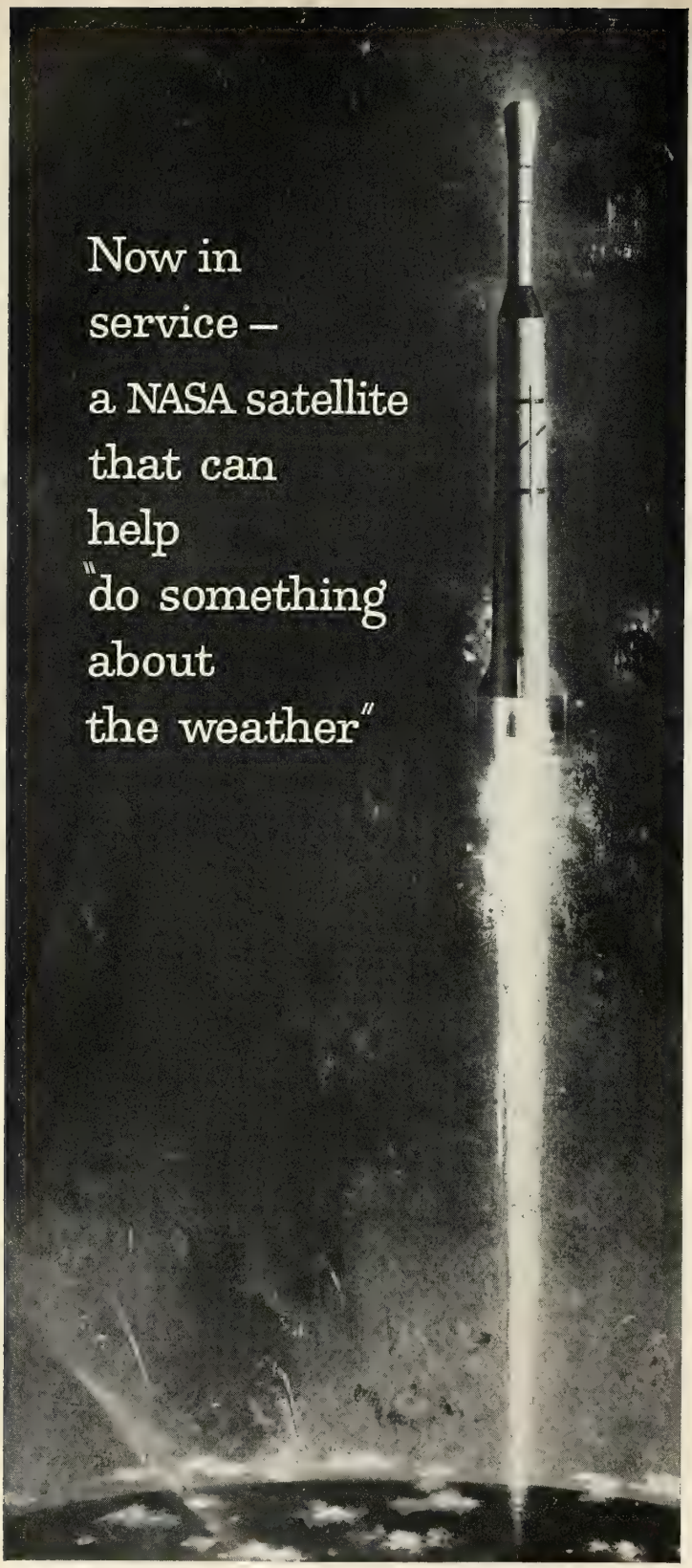
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TIROS (Television Infrared Observation Satellites) would serve weather observers—relaying information on cloud cover, temperatures, solar radiation

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The Countdown

WASHINGTON

Jupiter on Attu?

Latest embellishment to a rumor that the U.S. may set up a missile base on Attu in the Aleutians is that the missiles may be 1500-mile *Jupiters*. Attu is about 500 miles from the Soviet Kamchatka Peninsula, where many long-range Russian missiles are believed to be based—including some at Petropavlovsk.

Memo to Moscow

Privately some presidential campaign engineers are complaining about the lack of Soviet cooperation in goading along the "space issue." They are finding it difficult to dramatize the issue in the pre-convention scramble in the absence of any new Soviet space accomplishments.

Academic Dollars

The furor over increasing the defense budget continues to appear academic to most Washington insiders. They contend the Eisenhower Administration is holding to its policy of maintaining a barely minimum deterrent. No matter how much more money Congress votes, it won't be spent in 1960.

Into the Van Allen Belt

First shots in Project *Nerv*—NASA's study of the lower Van Allen belts—will be fired from the Pacific Missile Range in August. NASA will use for the first time the new four-stage, solid-fueled *Journeyman*, assembled by Aerolab, to boost a scientific payload to about 1200 miles altitude. Recovery will be attempted about 1000 miles downrange.

Harvest Moon Shot

An *Altas-Able* moon-orbiter heads the list of NASA space shots being lined up for the third quarter of the year—probably September. Payload will be a duplicate of the one that failed last Thanksgiving Day. In the same time period, NASA also will attempt to orbit another *Echo* balloon and fire three ballistic shots in the *Mercury* program (a fifth *Little Joe*, an un-manned *Atlas-Mercury*, and an unmanned *Redstone-Mercury.)*

INDUSTRY

Rover Showdown Nears

Step toward settling the NASA-AEC dispute over how to test the *Rover* nuclear rocket will come this month with the award of a NASA study contract on the problem. Many NASA officials favor attempting to launch the rocket first from a stable orbit. But AEC experts prefer a straight ground-launch.

Slip at Cheyenne

Air Force officials are expressing dismay at lengthening delay in getting the first combat *Atlas* pads ready at Warren AFB outside of Cheyenne, Wyo. They were scheduled to be operational in May, but the timetable has now slipped to September.

Chopper Bullpup

Navy development officials have succeeded in firing a *Bullpup* from a Sikorsky HUS-1 helicopter—opening up the possibility of using the radio-guided air-to-surface missile for close-in support of ground troops.

Nike-Zeus Target Radar Tryout

First trial of the 78-ton target tracking radar for the *Nike-Zeus* using live missiles should come in a few months. The TTR made by Continental Can Co. has been shipped to Ascension Island in the Atlantic for tests against missiles fired from Cape Canaveral.

Minuteman Gets Rolling

This week the Air Force will start trial runs of 14-car *Minuteman* trains out of Hill AFB, Utah. The trains will be made up of DOD equipment, but no missile hardware or GSE will be carried in the early deployments scheduled to run through November. The Association of American Railroads is furnishing the engines, operating crews and rails.

INTERNATIONAL

Bosch Arma In British Purchase

In a joint ownership arrangement, American Bosch Arma and DeHavilland Holding Ltd. have acquired S. G. Brown Ltd., Watford, England. Brown is a major producer of precision navigation and gyroscopic equipment.

Crete Becomes Missile Stockpile

Word from Paris has NATO stockpiling missiles on the Island of Crete. Also in the Mediterranean, Britain is storing missiles on the Island of Malta.

First Spanish Rocket Test

Some Spanish scientists and astronautic "aficionados" expect to launch their first experimental rocket in July. Site of the firing and mission of the rocket has not been disclosed.

British Getting Improved Honest John

The British Army's 39th Heavy Regiment is in line to have its M31 *Honest John* tactical missiles replaced soon by improved versions of the same missile.

despite their claims . . .

Soviet Military Outlay Appear

The size of the Soviet military budget has been the subject of considerable discussion and speculation among U.S. officials, military men and experts on Soviet affairs.

Facts are hard to come by. The Soviet budget is misleading. And many attempts to determine the true value of the ruble border on the metaphysical.

The opinion generally held is that Soviet military spending today is about equal to U.S. military spending—and has been so for about five years. But where the United States has to spend only about 9% of its Gross National Product to maintain this level of spending, Russia must spend about 25% of its GNP.

The highly authoritative Stanford Research Institute last winter issued a comprehensive report on the Cold War, agreeing for the most part with this estimate. However, it pointed out that because of Russia's growing GNP new military increases would be possible in the coming decade.

Bernard W. Poirier, a foreign research analyst for MISSILES AND ROCKETS, *has sifted through much of the available material and arrived at the more ominous conclusion that the rise in Soviet military spending is already well under way. Here is his analysis.*

by Bernard W. Poirier

Pious Soviet claims—and figures—to the contrary, Russian military spending today is taking a sharp turn upward.

Indeed, an analysis of the Soviet budget shows:

• Hidden military expenditures not detailed in the published version of the budget have been steadily increasing since 1957.

• The rate of increase in the Red spending program for arms has more than tripled this year over the 1959 amount.

• At least six months before the U-2 incident, the Kremlin programed 8½% of the entire national budget for military intelligence, foreign subversion and espionage.

Significantly, the Soviets planned last fall to spend 178% more on military programs than they admitted publicly in their 1960 budget. This was two months after Premier Khrushchev's meeting with President Eisenhower at Camp David and seven months before what is now generally conceded by the west to be a deliberate Soviet scuttling of the Paris Summit Conference.

Gaining an insight into the financial manipulations of Soviet leaders is difficult. However, many highly regarded specialists have reported similar results in foreign publications after independently analyzing various portions of the Soviet economy and national budget.

The analysis presented here reflects a compilation of this information. Furthermore, the data has been correlated with comparable findings by the author and established Soviet economic trends.

• **Rubber ruble**—Except for property assets, the total actual Soviet budget closely resembles the country's Gross National Product. The Russians spend almost one-quarter of their national budget on the military portion, although their official figures show that percentagewise this share has declined for three successive years. (The United States annually spends less than 1/10th GNP on defense and the total U.S. budget, by comparison, represents less than 1/6th of the present GNP.)

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Table 1 illustrates the official Russian Budget as it is presented to the world. In recent years the Russians propagandized the smaller allocations for the Armed Forces and have attempted to justify this action by pointing to their reduction in military personnel.

Actually their military budget has forged upward at a faster rate than their expanding national budget despite the release of manpower to Russian industrial and agricultural needs.

Dollar comparability of the Russian budget to the U.S. budget gives an erroneous interpretation to the problem of clearly analyzing their economy. Theirs has no comparability to the economies of free nations.

They have no procurement of missiles, aircraft and ships. Their industrial facilities are all Government Furnished Equipment. They produce their own weapons and these are "sold or purchased" on paper only. The prices are adjusted to conform to the needs of the State.

The reduction in military personnel has not been sufficient to offset the greatly increased rate of military build-up.

The "Budget Ruble" is a strange animal. It is not the commercial ruble nor the tourist ruble. Whether it represents .222169 gram of fine gold is of no consequence. The rate of exchange of the Ruble for Dollars at tourist rates (4 for $1) or at black market rates (15 for $1) does not show the actual size of their budget. Consider simply that their budget more closely resembles their Gross National Product than our budget does. Remember that the Ruble is strictly controlled even to its circulation in the Soviet Union. Such a degree of control is never experienced in free nations.

The important consideration is, "What does their budget do?"

• It directly maintains the costs of 80% of a highly regarded but controversial educational system.

• It maintains heavy industry, chemical and consumer industries, utilities, transportation, scientific research in industrial methods, internal security, public works and public health.

• It maintains all the military might of 175 divisions; 30,000 aircraft and over 1,600,000 tons of naval seapower.

ɔ Climb

While the free nations exist and unction as the result of free economies, he Russian economy is the result of dictatorial direction by the State Administration. Russian deficit spending s wiped away like chalk off a blackɔoard.

Russian rulers use the state-conrolled press to present a national ɔudget in a few generalized categories since they need not account underhanded financing to anyone, especially the Russian public.

The Budget category of National Economy includes agriculture, heavy industry, hydroelectric power, consumables, atomic energy, transportation, construction, etc.

The Science and Culture category includes education, sports, scientific research (Industrial and Rocket), information media, military infrastructure, etc.

According to outstanding authorities like *"Est & Ouest," "Europaische Wehr-Korrespondenz"* and others, the officially adopted "Unspecified Funds" category is administered by the KGB (Committee on State Security) for the support of espionage activities, compilation of intelligence, and foreign communist activities.

The actual Russian budget comes into sharper focus when the price supports for consumer goods and agricultural products are included (i.e. 1959 = 260.3). Transfer of weapons production costs (1959 = 26.7) and of rocket research (1959 = 28.3) is also necessary. Intelligence and espionage costs correctly belong in the military portion of the Budget, so does military infrastructure costs hidden from the public eye.

The Support of Weapons' Costs in the actual Military Portion (Table 2) is the best available computation of the difference between the true cost of weapons production and the amount credited to "procurement."

It is interesting to note that 28.3 billion rubles went to rocket research in 1959 and 39.5 in 1960. The costs of maintaining 80% of their educational system in 1959 was 94.3 billion rubles and 102.0 in 1960.

The Russians seem to make excellent use of their military funds. Their actual 1960 military funds (267.1) maintain 3,200,000 military personnel and 200,000 persons in rocket production. Moreover:

- They maintain up-to-date aircraft capable of airlifting 10% of their 100,000 airborne troops at a moment's notice.
- They maintain over 165 missile bases, missile production centers, and missile testing and evaluation sites; 20,000 first line tanks and 15,000 second line tanks; 37 cruisers; 230 destroyer types; about 475 submarines; over 20,000 military jet aircraft and about 30 types of missiles.
- They equip land forces with the latest equipment including 203mm atomic cannons; 12 tube 247mm, 4 tube 200mm, and 16 tube 140mm barrage rockets; 45mm and 57mm repeating anti-tank cannons tested in Antarctica; the new "Simonova" semi-automatic carbine; and new "lead uniforms" and portable atomic rockets.
- They produced enough nuclear bombs to test-explode at least 23 in 1958. (Reportedly the U.S. tested about 30 that year).

The increase over the official budget category is determined by computing the difference between the official budget amount and the actual budget amount. The difference is divided by the official amount. (i.e. 1960: $\frac{267.1 - 96.1}{96.1} = 177.9\%$).

The rate of annual increase or decrease of one budget amount over the former comparable budget amount is determined by dividing the larger amount of difference by the smaller amount of difference and subtracting the whole number 1. (i.e. 1959: $\frac{D^2}{D^1} = \frac{275.3}{244.2} - 1.00 = .127$ or 12.7%).

Table 1 OFFICIAL ANNUAL SOVIET BUDGET
(In Billions of Rubles)

Principal Categories	Actual 1957	Actual 1958	Actual 1959	Estimated 1960
National Economy	244.7	257.1	308.7	.....
Social and Culture	188.4	212.2	232.0	.....
Armed Forces	96.7	96.3	96.1	.....
State Administration	11.9	11.9	11.5	.....
Sub-Total	541.7	577.5	648.3	.....
Unspecified Funds	62.1	50.2	59.3	.....
BUDGET TOTAL	603.8	627.7	707.6	744.8

Table 2 ACTUAL RUSSIAN BUDGET
(In Billions of Rubles)

	1957	1958	1959	1960
National Economy	433.0	462.4	542.3	599.8
Budget Category	232.3	240.2	282.0	311.7
Price Supports	200.7	222.2	260.3	288.1
Social and Culture	160.8	184.1	203.7	242.9
Military Portion	209.8	213.5	225.4	267.1
Budget Category	96.7	96.3	96.1	96.1
Espionage, etc.	62.1	50.2	59.3	62.5
Transfers:				
—Production from N. E.	12.4	16.9	26.7	32.6
—Rocket Research (S & C)	27.6	28.1	28.3	39.5
Support of Weapons' Costs	11.0	22.0	15.0	36.4
State Administration	11.9	11.9	11.5	11.6
GRAND TOTAL	815.5	871.9	982.9	1121.4

Table 3 COMPARATIVE TABLE

Whole Budget Comparison	1957	1958	1959	1960
Actual Russian Budget	815.5	871.9	982.9	1121.4
Officially adopted Russian Budget	603.8	627.7	707.6	744.8
Difference	211.7	244.2	275.3	376.6
Increase over Official Budget	35.0%	38.9%	38.9%	50.6%
Rate of ruble increase over prior	.....	15.4%	12.7%	36.8%
Military Budget Comparison				
Actual Military Funds	209.8	213.5	225.4	267.1
Officially adopted category	96.7	96.3	96.1	96.1
Difference	113.1	117.2	129.3	171.0
Increase over budget category	116.6%	121.7%	134.5%	177.9%
Rate of ruble increase over prior	.....	3.6%	10.3%	32.3%

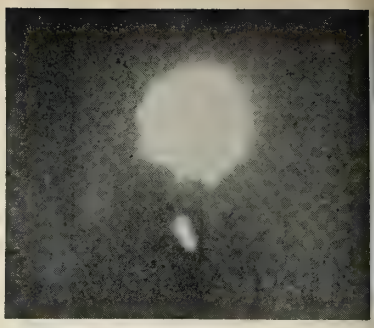
Table 4 ACTUAL MILITARY BUDGET STATISTICS

	1957	1958	1959	1960
Military share of Total Budget	25.7%	24.5%	22.9%	23.8%
Increase over official Budget category	116.6%	121.7%	134.5%	177.9%
Rate of ruble increase over prior	.....	3.6%	10.3%	32.3%





GOING: *Nike* **explodes above prey.**



GOING: Its blast ignites *Corporal.*

Nike-Hercules Can Now

by James Baar

A highly-improved version of the Western Electric *Nike-Hercules* will soon become the Free World's first antimissile missile for use against tactical missiles.

It also is expected to be made mobile so that it can be swiftly deployed for use against tactical missiles launched against the rear areas of a battlefield.

• **Significant success**—Until now, the *Nike-Hercules* has been capable of knocking down only aircraft and air-breathing missiles. However, the new model of the air defense missile system proved it was capable of knocking down tactical ballistic missiles in a secret test over White Sands Missile Range earlier this month.

The Army has disclosed that on June 3 an improved *Nike-Hercules* destroyed an incoming Firestone *Corporal* high over the New Mexican desert.

Army spokesmen said the *Hercules* radar picked up and began tracking the liquid-propelled *Corporal* immediately after it was launched. The command-guided *Nike-Hercules* was directed to intercept the *Corporal* on the latter's downward leg.

As the *Corporal* streaked toward its target at a speed of more than Mach 3, the *Nike-Hercules* closed on it from above. The *Nike's* proximity fuse detonated the missile's high explosive warhead when the *Corporal* was still yards away.

Blazing *Nike* fragments riddled the *Corporal* and it exploded. Seconds later flaming *Corporal* parts tumbled toward the desert, trailing streamers of dirty smoke.

• **New radar is key**—Army spokesmen said all improvements in the *Nike-Hercules* system are in the radars. They said the improvements tripled the system's capability.

The principal improvement apparently is in a new General Electric radar that makes it possible to acquire and track much smaller and possibly faster targets at the same and greater distances than previously possible.

The Army said the improvement in *Hercules* is not directly connected with the development of the *Nike-Zeus* antimissile missile. However, a spokesman said information gained from work on the *Hercules* system would help *Zeus.*

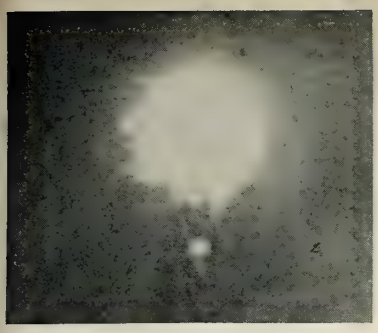
The *Nike-Hercules* is designed to destroy incoming ICBM warheads streaking toward their targets at Mach 20.

Previously the *Nike-Hercules* has scored hits on Lockheed Q-5 drones at higher than 70,000 feet. The air-breathing drones were flying at nearly Mach 3.

The incoming *Corporal* destroyed by the *Hercules* was traveling at better than Mach 3. However, the Army indicated that capability of the new *Her-*

Nike-Hercules

Type	**Surface-to-air**
Range	**75 miles plus**
Length	**39 ft.**
Diameter	**31.5 in.**
Ceiling	**100,000 ft. plus**
Weight	**10,000 lbs.**
Stages	**Two**
Propellant	**Solid**
Warhead	**Nuclear/high explosive**



GOING: *Corporal* **burns furiously.**



GONE: *Nike* **blast engulfs target.**

Stop Tactical Missiles

cules system was not necessarily strained by the *Corporal's* challenge.

The Army said the June 3 anti-missile missile test was the first involving a *Nike-Hercules*. However, it was not the first time that one missile has destroyed another missile.

The Army has hit an *Honest John* with a *Hawk*. But this test was not considered a forerunner to an operational system.

• **Conversion kits ready**—Western Electric, prime contractor for *Nike-Hercules*, General Electric and other *Nike* contractors are already producing conversion kits incorporating the new improvements in the *Nike* system. Work was begun under a $20-million Army contract announced last February 29.

The conversion kits can be used to revamp present *Nike* sites with relative ease. The cost has not been disclosed.

The Army also has not disclosed how many of the more than 250 *Nike* batteries in the United States and the dozens scattered around the world will be converted. However, the *Nike* batteries that could make the best use of the improved feasibility would be those emplaced in NATO countries.

At present, about six *Nike* battalions each with four or more batteries have been deployed with U.S. troops in Europe. *Nike* batteries are also deployed with European troops in a number of countries including Italy, Norway and Denmark.

Finally, *Nike* batteries are deployed in Greenland, Alaska, Okinawa and Formosa and plans are under way to deploy them in Hawaii.

The majority of *Nike* battalions in the continental United States still are equipped with the less effective *Nike-Ajax*. However, the conversion to *Nike-Hercules* has been progressing rapidly.

More than 80 *Nike* batteries are reported to have been converted to *Hercules* to date.

The first *Nike-Ajax* were deployed in 1953. The 25-mile-range missile is considered effective against any manned Soviet bomber. *Ajax* is a completely mobile system, although it is deployed in fixed sites.

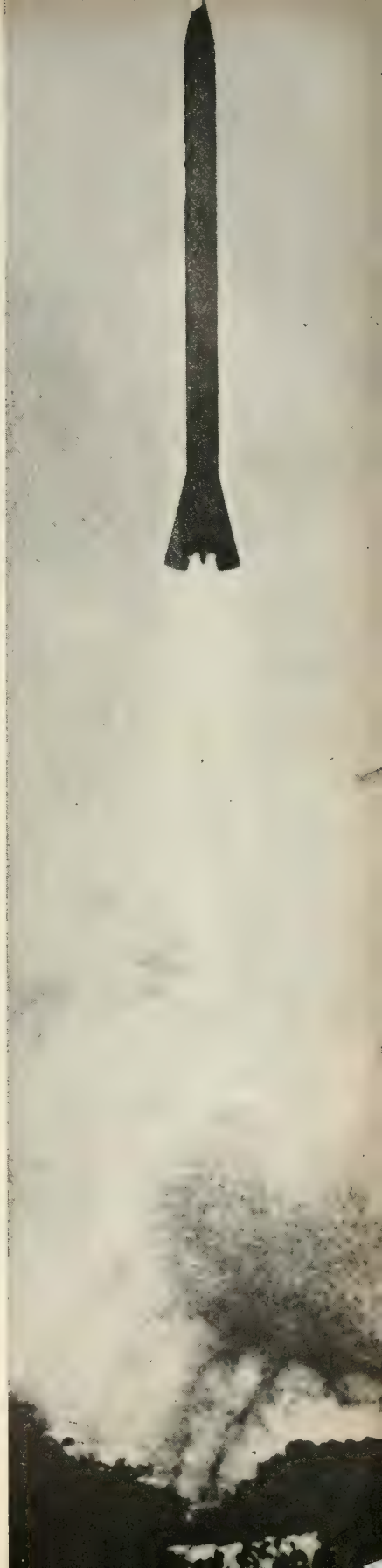
Little information has been available on Army plans to make the *Nike-Hercules* system mobile. But work on the mobile system has been going on for some time.

A principal argument used against the mobile system is that it was being designed for the disappearing threat of Soviet aircraft attack. Meantime, the Army has continued to look at other proposals for the development of anti-missile missiles for use on the battlefield.

Nike-Hercules' improved capabilities now make it more attractive as a mobile battlefield system. One of the most persuasive arguments being advanced in its favor is simple but forceful: It is here.

Corporal

Type	**Surface-to-surface**
Range	**75 miles**
Speed	**Mach 3 plus**
Length	**45 ft.**
Diameter	**30 in.**
Weight	**11,000 lbs.**
Stages	**One**
Propellant	**Liquid**
Warhead	**Nuclear/high explosive**



Boeing Wins Contract for Navy's First ASW Hydrofoil

Antisubmarine warfare took a historic step this last week with award of a $2-million contract to Boeing for construction of the Navy's first hydrofoil warship—a missile-packing patrol craft.

The ship is expected to be the forerunner of a fleet of hydrofoil patrol craft and much larger hydrofoil destroyers.

They would be used to combat enemy submarines lurking off U.S. coasts. The larger hydrofoil destroyers would be used to launch antimissile missiles at submarine-launched IRBM's (M/R May 23, p. 12).

The Navy awarded the much-coveted $2,082,215 contract for the first hydrofoil patrol craft—dubbed the PCH—to Boeing's Aerospace Division at Seattle. The Navy said Boeing's proposal was the lowest of 11 submitted. A total of 35 firms were invited to make bids.

Boeing announced that it has leased facilities from the J. M. Martinac Shipbuilding Corp. at Tacoma, Wash., for construction of the PCH and for conducting sea trials. Delivery is expected in early 1963.

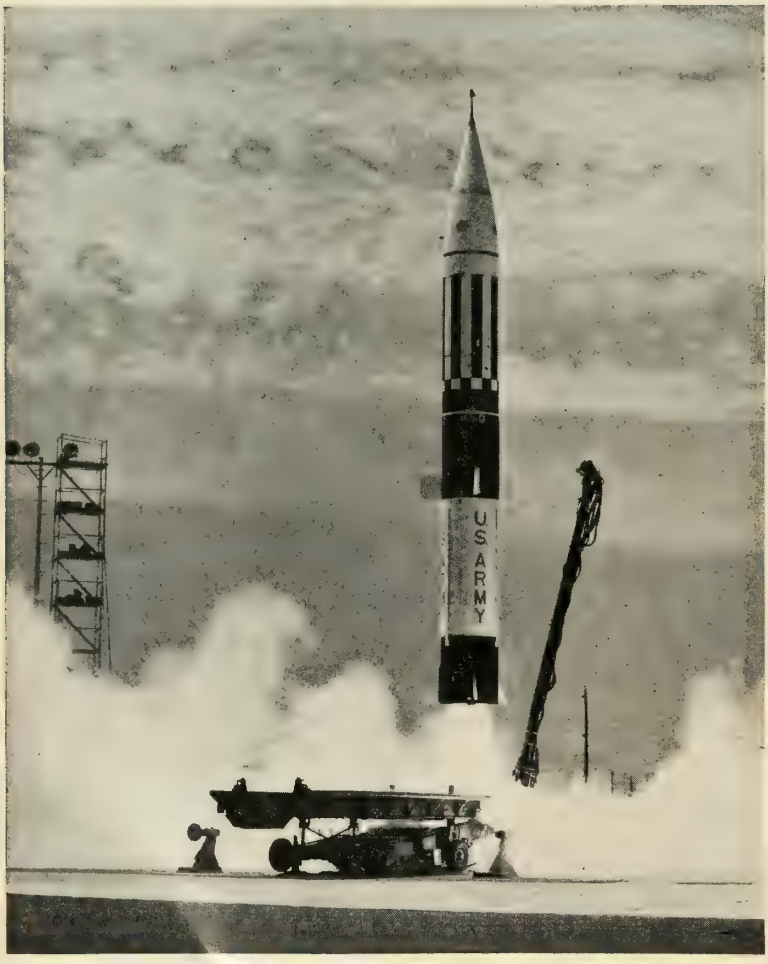
The first PCH will be 115 feet long and will displace 110 tons fully loaded. It is expected to rip over the surface of the sea at 50 knots.

The ship will be powered by two Bristol-Siddeley 3000-horsepower gas turbine engines. The British engine's name is the Proteus. The PCH also will be powered by an auxiliary 600 horsepower diesel for conventional sea travel.

The PCH is expected to be armed with such advanced ASW missiles as Minneapols-Honeywell's *Asroc* and the most advanced sonar equipment.

The hydrofoil destroyer would be armed with similar ASW weapons plus such antimissile missiles as the Westinghouse *Typhon* or a seagoing version of the Convair *Mauler*.

pershing passes fourth test



PERSHING RISES from transporter-erector-launcher in fourth successful test of Army's new solid-propelled battlefield missile June 9. Martin missile was preset to perform erratic movements in its short flight over the Atlantic from Cape Canaveral. Range safety officer was alerted to possibility the missile might have to be destroyed because of excessive conditions, but it wasn't necessary. As in previous flights, only first-stage Thiokol motor was live. Second stage was dummy.

Debus to Boss NASA Launch Activities at Both Ranges

Dr. Kurt H. Debus will be responsible for launch operations on the Atlantic and Pacific Missile Ranges, the National Aeronautics and Space Administration announced last week.

Debus, who has been head of missile firing for the Army Ballistic Missile Agency, has already taken charge of NASA launch activities at Cape Canaveral. When his ABMA group transfers to NASA on July 1, Debus will head a new Launch Operation Directorate, which will supervise NASA activities on both missile ranges (M/R, June 13, p. 20).

The NASA group will also take over completion of ABMA's obligations to the Army for launching *Pershing*, *Jupiter* and *Redstone* missiles at the Cape.

At the Pacific Missile Range, NASA activities will be confined to sounding rocket shots for more than a year. The first major NASA shot, a polar-orbiting *Nimbus* advanced weather satellite, is due to be launched down PMR by a *Thor-Agena B* vehicle in the fourth quarter of calendar 1961.

Dr. Hans Gruene will be Debus' deputy. Assistant directors will be Karl Sendler for instrumentation, Albert Zeiler for facilities and Clarence C. Parker for operations. Col. Asa M. Gibbs will have dual functions as chief of the NASA Office of Test Support and a member of the staff of the commander of the Atlantic Missile Range.

Debus' directorate will assume and expand the functions of the present NASA Atlantic Missile Range Operations Office. Melvin N. Gough, director of AMROO, will be transferred to NASA headquarters as flight operations coordinator for the assistant director of space flight operations.

Strike Threats Ease at Some Plants But Rise at Others

The labor-management dispute between machinists and the missile industry died down in certain areas last week and flared up in others.

Settlements were reached with the United Auto Workers at Douglas Aircraft, covering their plants at Long Beach, Calif., and Tulsa, Okla., and at North American's Rocketdyne Division. The proposed Douglas Contract for UAW workers at Charlotte, N.C., is still under discussion.

International Association of Machinists locals at Douglas are expected to agree with the UAW settlement.

But at Lockheed's Missile and Space Div., the IAM broke off negotiations last Tuesday, claiming that the company's latest offer was "unsatisfactory." Lockheed plants at Sunnyvale, Palo Alto, Santa Cruz, and Van Nuys were still being struck by the IAM at week's end.

A Federal Court decision last week prohibited Convair's IAM employees at Cape Canaveral from picketing other concerns at the Cape. NLRB Lawyers had complained that the IAM's Cape local had engaged in unfair labor practices by picketing and distributing handbills to induce workers other than those at Convair to leave their jobs.

First Standard IBM 7090 Computer in Action at ABMA

HUNTSVILLE—The first standard IBM 7090 transistorized computer went into operation at the Army Ballistic Missile Agency last week to process trajectory simulation data for the *Saturn* space booster.

A second 7090 will be installed in August. Ultimately the two systems will replace three existing large computers in the Computation Laboratory. They will almost triple the laboratory's capacity by performing in eight hours what was done previously in 20. Cost of each new system is 25% more than the standard IBM 709, yet each is six times faster—performing nearly 14 million logical decisions per minute. (By comparison the old card program calculator used in 1951 for *Redstone* missile development operated at 2174 decisions per minute.)

Typical early problems to be handled by the twin 7090's will include vibration effects and heat transfer caused by interaction of the eight *Saturn* engines in cluster, thrust alignment, multiplexing of fuel and oxidizing agent and guidance evaluation. Trajectory simulation will be an enormous cost saver, enabling study of a multitude of conditions during thousands of "paper" flights into space.

IBM officials said that a total of 82 of the 7090's will be delivered to industry and government by next May 1. These include two special purpose 7090's already in use at the Thule Ballistic Missile Early Warning station.

Aerospace Corp. hits snag In getting Board Members

Organization meetings at Secretary of Air Force levels are scheduled this week on the formation of the Aerospace Corp., successor to Space Technology Laboratories. The job of choosing a 10- or 12-member board is expected to last until the end of the month.

The biggest unsolved problem seems to be the selection of board members and obtaining their acceptances. Among those mentioned as possibilities are: Gen. James McCormac, former AF director of development; Roswell L. Gilpatric, AF under secretary from 1950 to 1953; Roger Lewis, Pan American World Airways executive vice president; Gen. Earl Partridge, former chief of the Air Defense Command; and Trevor Gardner, former AF assistant secretary for research.

Richard E. Horner, associate NASA administrator, has been reported to be a possibility but sources now report there is little indication Horner is interested. Several board memberships will be filled from academic ranks if present plans are followed, with men from California Institute of Technology and Massachusetts Institute of Technology in the lead.

Aerospace will operate on a cost-plus-fixed-fee basis as an Air Force contractor. Unlike STL Aerospace will not deal directly with contractors on a management basis. Instead, the new company will probably provide the recommended patterns and policy for research and development and leave administration to the Air Force.

STL would retain systems engineering and technical direction for the *Atlas, Titan* and *Minuteman* weapon systems until completion of the programs. Advanced planning, basic research and development now done by STL, plus some administrative services, would be transferred to the new corporation. The Air Force may ask STL to help draw a plan of operation for guiding the new non-profit corporation.

Grand Central Rocket Co. Names Brunetti President

Dr. Cledo Brunetti has been appointed president of the Grand Central Rocket Co.

He has been operating head of the company as vice president and general manager since September, 1958. At that time, Charles E. Bartley, founder and president of Grand Central, resigned. He now heads Rocket Power/Talco Division of the Gabriel Co.

Model of Momentum

This machined aluminum model, with 14 concave faces, serves as a physical representation of the hypothetical "Fermi surface" to illustrate the characteristics of electron motion in metal.

As electrons move through the latticework of atoms, their momenta vary according to their direction. The momenta also vary in different metals, depending upon the number of atoms per unit volume and the number of conduction electrons per atom. In the model—developed at the General Electric Research Laboratory—these variations are represented by the varying distances from the center to the surface.

The diagram illustrates how measurements of the momenta of conduction electrons are made as sound waves (q) are sent into a metal sample in



which their direction of movement is controlled by a magnetic field (H).

Payload for Moon

27 Companies Bid for NASA Study Contract

Twenty-seven companies are bidding for a study contract on a 2500-lb. space payload capable of delivering 150 to 300 lbs. of instruments to a soft landing on the moon. The project has no name as yet.

The National Aeronautics and Space Administration expects within a month to award the study contract, which could lead to business totaling $50 to $100 million for the winner. The six-month study itself will be worth $100,000 to $125,000, a NASA spokesman said.

The vehicle would be boosted to escape velocity by an *Atlas-Centaur* launching rocket and would be aided on its trip to the moon by mid-course and terminal guidance. NASA officials want the payload to fall to the moon at not more than 27 ft./sec. A man in a parachute falls to earth at about 30 ft./sec. By comparison, the *Ranger*, a rough-landing moon vehicle, is to hit the moon at more than 300 ft./sec.

The contractor will have to design the entire vehicle. Much of the 2500-lb. package will be the weight of small rockets required for mid-course and terminal guidance. The actual landing package is to weigh between 500 and 700 lbs.

The vehicle is expected to fly about 1963. First *Atlas-Centaur* flights are due in 1961, but, presumably NASA scientists will not want to entrust an expensive moon package to the launch system until it develops reliability.

A bidders' conference on the moon vehicle was held May 13 at Jet Propulsion Laboratory. Bids were received on June 6.

NASA has not stated whether it plans to award one or more study contracts. In the *Ranger* competition earlier this year, three companies, Ford Motor Co., North American and Hughes Aircraft, were chosen for relatively brief competitive follow-up studies before the contract was finally awarded to Ford's Aeronutronic Division.

The X-15 Explosion

Initial investigations into the explosion that severely damaged *X-15* No. 1 last week indicate that the blast did not occur in the engine chamber, but was probably caused by a fuel leak or a spark.

NASA *X-15* officials received this news with a sigh of relief. Had the explosion occurred because of structural fault of the space-plane's XLR 99 Reaction Motors engine, the program would have been set back many months.

A new engine was shipped to Edwards AFB last Monday, and will presumably be fitted into *X-15* No. 2. Delay from the explosion is expected to be about six weeks.

The explosion occurred when a hydrogen peroxide tank blew up in the plane's engine bay during engine tests. Shortly before the explosion, the engine had been shut down automatically due to an unidentified malfunction. The pilot, North American's Scott Crossfield, had pressed the recycle button just prior to the explosion.

Damage was extensive in the aft empennage and engine bay. Though ripped from the aft section, the forward portion including landing gear and wings did not appear to be seriously damaged.

'Spine' for Dolphin



BARREL LINERS from 16-in. battleship guns are being used as the capped "spine" of the *Dolphin* dummy-*Polaris* launch and training vehicle. The former gun liner holds compressed air that ejects several tons of water ballast after the *Dolphin* is launched from the submerged submarine and breaks through the surface of the sea. The dummy missiles are recovered and reused in crew training and launching system checkout.

GE Makes Turbodrives To Be Used in Centaur

General Electric Co. is producing turbodrives for propellant boost pumps that will be incorporated in the *Centaur* space vehicle, it was revealed last week.

Walter C. O'Donnell, general manager of GE's Aircraft Accessory Turbine Department in Lynn, Mass., said the new fuel system will result in weight savings of more than 350 lbs. GE will supply turbodrive units to Pesco Products Division, Borg-Warner Corp., which will mate them to boost pumps. Convair (Astronautics) Division of General Dynamics is developing the *Centaur* vehicle for the National Aeronautics and Space Administration. Pratt & Whitney Division, United Aircraft, is developing the engines.

The turbodrives, patterned after General Electric's AM-10 auxiliary power unit used in the *X-15* rocket aircraft, will power the liquid hydrogen and LOX boost pumps in the second-stage engine.

Most current liquid-fueled rocket engines depend on pressurized gas to deliver propellant to the engine's main pump. Warren A. Poole, GE project engineer, said the use of boost pump feeding—which does not require as much pressure and tank structure—makes possible the weight savings. Use of an intermediate boost pump will make it possible to design fuel and oxygen tanks to the structural requirements of the vehicle.

GAO review indicates . . .

Vega-Agena-B Mix-Up Cost Millions

Accounting office says AF refused to tell NASA of Agena-B plans and told of disinterest in Vega only after it was under way

by Paul Means

The Air Force's failure to communicate to NASA its plans to develop *Agena-B* caused a duplication of effort costing the nation $16 million in badly needed space money.

This conclusion can be drawn from the General Accounting Office's review of NASA's *Atlas-Vega* program, cancelled last December. (See M/R, Dec. 21, p. 15).

Why did the U.S. develop "two rocket vehicles with similar payload capabilities and about the same date of availability?" According to the review, it was because:

- The Air Force refused to tell NASA of the *Agena-B* project at a time when *Agena-B's* contracts had been let;
- The Air Force and ARPA informed NASA they would have no need for *Vega*, diminishing the need for the vehicle, only after it was under way;
- Lack of coordination between NASA's development of *Vega* and the availability of the Air Force's *Atlas* launch pads slowed down the project until NASA allegedly had little need for it.

To prevent this type of wasteful duplication, the Administration had held an interagency meeting between NASA and effected DOD organizations on Dec. 15, 1958, for the purpose of forming a National Space Vehicle Program.

At that time, according to the GAO report, NASA described *Vega* to the DOD representatives. But even though planning of the *Agena-B* "must have" preceded the meeting, "yet there was no evident communication of that planning by the Department of Defense . . ."

Out of this meeting came the report to the President entitled "A National Space Vehicle Program," dated Jan. 27, 1959. This document, presented "almost two weeks after the first contractual action" was taken "in the development of the *Agena-B* stage . . . makes no mention of the *Atlas-Agena-B.*"

When NASA did finally learn about the competing program is not clear, the report states, but "we were told by officials of NASA that it was not until late in the summer of 1959."

Vega was developed as a general-purpose vehicle in the national Launch Vehicle Program to be used until the development of *Centaur*. NASA had expected that DOD would use the vehicle also. "However," according to the report, "it seems that DOD had no intention of using the vehicle."

"The most concrete evidence that DOD did not intend to use the *Atlas-Vega* was its decision to proceed with the development of the *Atlas-Agena-B* which was roughly comparable," the report states.

"A NASA official . . . told us that during the December 1958-January 1959 interagency discussions representatives of DOD stated they had no interest in *Atlas-Agena.*"

Without DOD acceptance, "the sole prospect for extensive interim, general-purpose use of *Atlas-Vega* lay in NASA space activity. This prospect grew dim as the work got well underway and was extinguished by the time cancellation was announced," according to the report.

The slippage in *Vega's* schedule, the GAO report said, was principally because "satisfactory arrangements for launch facilities had not been made with the Air Force."

At the time *Vega* was initiated there were only two launch stands (numbers 12 and 14) which were capable of launching multistage, *Atlas*-boosted vehicles. "These stands . . . were then scheduled for full-time use until 1961 . . ." (One of these stands was damaged in Nov. 1959, by the explosion of an *Atlas-Able.*)

Vega's flight schedule couldn't have been carried out, according to the report, because "construction of additional launch facilities was approved . . . on May 15, 1959, and . . . the initial contract for these facilities was entered into on June 10, 1959. Construction of an *Atlas* launch stand requires 18 months," the report said.

The report adds, however, that "neither the *Atlas-Vega* nor the *Atlas-Agena-B* had an advantage over the other in availability as a general-purpose space vehicle."

The reason for this, according to the report, is that the *Atlas-Agena-B* program was also held up by nonavailability of launch facilities, and that the Air Force was more interested in using the *Agena-B* on top of the *Thor* IRBM's in the *Discoverer* series.

- **Which was better?**—Although the two were equally handicapped in terms of availability, GAO said, "the amount by which the payload capability of the *Atlas-Vega* exceeds that of *Atlas-Agena-B*, though minor, might be decisive in the choice of a "permanent" space vehicle or in the choice of a vehicle to perform some specific mission."

And slippage in *Vega's* schedule had "resulted in a NASA decision to change the missions of these vehicles from a satellite and a space probe, respectively, to 'lunar orbiters'."

Would *Vega* have made a better "lunar orbiter" vehicle than *Agena-B*? Many NASA spokesmen think so. (See M/R, May 2, 1960.) They think, however, that *Agena-B* can be modified with the proper three-axis guidance system (which *Vega* would have possessed) prior to its use (spring of 1961) as a lunar orbiting vehicle.

- **Why was Vega cancelled?**—The report states that "although pre-flight development (of *Vega*) was about on schedule through time of cancellation, it had become increasingly improbable that more than a few scientific payloads would be flown with *Atlas-Vega.*"

Yet in May of this year, NASA let a contract with Lockheed to buy 16 of the competing *Agena-B* vehicles. (See, M/R, May 2, p. 15). Since the GAO report claims that the *Vega* had slightly

greater capabilities than the *Agena-B*, and 16 *Agena-B's* were purchased after *Vega's* cancellation, it would appear that *Vega* must still have had a mission at the time cancellation.

NASA insiders say that the President reacted with criticism of the Air Force when he discovered their development of *Agena-B*—a vehicle which had not been included in the National Space Vehicle Program. But since the Air Force's *Agena-B* program was a *fait accompli*, either the *Vega* or the *Agena-B* had to go.

The decision was in favor of the *Agena-B*. NASA sources say it was a political choice—based on the fact that Congressional criticism would be greater if an Air Force program were cancelled than it would be if the NASA program were cancelled.

How the Two Programs Progressed

Atlas-Agena B

Dec. 15, 1958—The *Agena B* stage was not named or described in the interagency meeting on U.S. launch vehicles. Representatives of AFBMD speaking for ARPA discussed their upper stage vehicles, classifying them as "existing," "under development," or "under study or in component development." One of the "existing" stages listed was the 117L which was the basis for the *Agena B* stage development. (The 117L stage has also been referred to as the *Agena A, Hustler, Sentry*, and *Discoverer*.)

No mention was made of any plans to develop the *Agena B* stage by giving the 117L engine restart capability and increased tank capacity and by making other modifications.

Missions were discussed for the *Thor-117L* and the *Atlas-117L*.

Jan. 16, 1959—AFBMD issued Contract Change No. 8 to Lockheed, the contractor for the reconnaissance satellite weapons system of which the *Agena* stage is one part, to initiate a "study and test program to investigate parameters and methods required to provide a restart capability" for the *Agena* engine. The contemplated program was to include preliminary design and an altitude test program. Restart capability, which did not exist in the *Agena A*, is a feature of the *Agena B*.

Jan. 27, 1959—The *Atlas-Agena B* was not mentioned in the document prepared by NASA describing the national space vehicle program. This document referred to the *Atlas-Hustler*, which was the same as the *Atlas-Agena A*, saying that it would have only about half the load-carrying capability of the *Atlas-Vega*.

April 10, 1959—ARPA issued amendment 4 to ARPA order No. 17-59 to the Commander, ARDC. Task No. 3 of this amendment provides as follows:

"Modify the *Bell-Hustler* stage to obtain dual burning capability, simplify guidance and control system, structual simplification such that payloads of arbitrary shapes may be carried, and increased propellant carrying capacity."

The *Bell-Hustler* stage referred to in this order is the *Agena* stage. The modifications cited are the principal differences between the then existing *Agena* stage and the *Agena B* stage.

We were informed by ARPA personnel that studies to determine the optimum tank size for the *Agena* stage were still in progress at the time amendment 4 to ARPA order No. 17-59 was issued. At that time a 60-percent increase was indicated.

April 24, 1959—AFBMD, in implementing amendment 4 to ARPA order No. 17-59, directed Lockheed to begin a design and development program to provide a restart capability for the *Agena* engine and to design and develop such other changes as were required to make other portions of the propulsion system compatible with the restart capability.

Because Lockheed objected to the broad wording of this statement, a clarifying revision was issued on June 3, 1959.

June 2, 1959—AFBMD and Lockheed agreed that the optimum tank capacity for the *Agena B* stage would be double that of the *Agena A*.

June 3, 1959—The contract change which had been issued to Lockheed on April 24, 1959, was revised to specify that Lockheed should (1) provide a single restart capability, (2) design and develop larger tankage, (3) design and develop a modified guidance system, and (4) design and develop such other changes as were necessary to make the vehicle subsystems and ground support equipment compatible with the specified changes.

June 4, 1959—ARPA concurred in the AFBMD/Lockheed decision concerning the optimum tank capacity for the *Agena B*.

Atlas-Vega

Dec. 15, 1958—*Atlas-Vega* was proposed by NASA in the interagency meeting on U.S. launch vehicles. Although not named as such, it was one of a group of vehicles described collectively by NASA as the type of program they would like to see established. The vehicle's first stage was identified as a modified *Atlas* ICBM; the second stage was to be powered by a 33,000-pound-thrust, liquid oxygen-kerosene engine; and the third stage was to be based on the 6000-pound-thrust, storable-propellant engine being developed by JPL.

Jan. 5, 1959—Beginning date for allowing costs under contract NASW-30 with the General Electric Company for *Atlas-Vega* second-stage engines.

Jan. 15, 1959—In consequence of informal requests by NASA, Convair submitted a proposal for development of a medium-energy upper stage for the *Atlas* booster, and GE submitted a proposal for modification of its model X 405 rocket engine. The upper stage vehicle proposed by Convair was essentially the *Vega* second stage. The major engine modifications proposed by GE were (a) provision of a capability for an initial altitude start and for restart of the engine and (b) an increase in nozzle expansion ratio from 5.5:1 to 25:1. These proposals eventually matured into contracts.

Jan. 27, 1959—The *Atlas-Vega* was listed as the first in a series of general-purpose space vehicles in a national space vehicle program described in a document prepared by NASA.

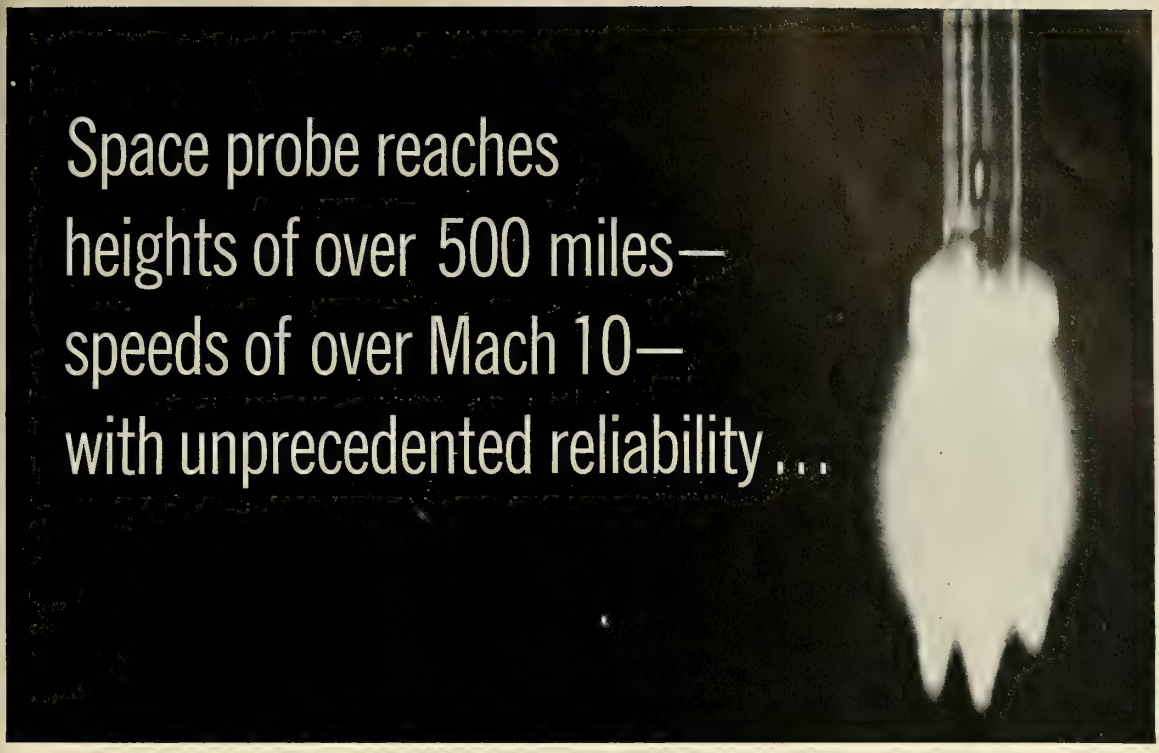
Jan. 30, 1959—NASA made funds available to JPL for development of the 6,000-pound-thrust, storable-propellant engine for use in the *Atlas-Vega* third stage.

Mar. 1, 1959—NASA contract NASW-45 entered into with Convair for (a) the design, development, manufacture, and test of eight *Vega* upper stage vehicles, (b) the design of modifications to the *Atlas* booster to make it compatible with the *Vega* upper stage, and (c) the launching of eight complete *Atlas-Vega* vehicles. However, the contract was not executed until May 21, 1959.

Mar. 18, 1959—NASA contract NASW-30 entered into with GE for modification of the model X 405 rocket engine and for delivery of 11 modified engines and spare parts. Contract NASW-30 provides for payment of costs "incurred in the performance of this contract starting on Jan. 5, 1959, through date of this definitive contract."

Mar. 26, 1959—NASA made funds available to JPL for development of the *Atlas-Vega* third stage.

May 21, 1959—Contract NASW-45 between NASA and Convair was signed.



...AND BRISTOL SIDDELEY SUPPLY THE POWER

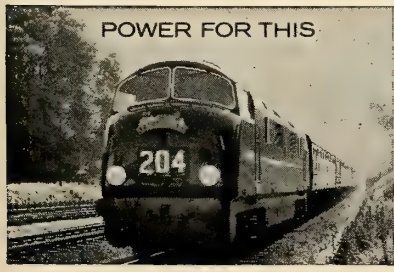
One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant, the Gamma produces a total sea-level thrust of 16,400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of only 700 lb.

At the Woomera rocket range in Australia, the Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with a reliability that is unprecedented.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. *By combining these components in single or multi-chamber lay-outs, thrust requirements from 500 lb up to 100,000 lb can be met.*

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Bristol Aero-Industries Limited, 200 International Aviation Building, Montreal 3, Canada. Telephone: University 6-5471



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The Bristol Siddeley Orpheus powers the Fiat G 91, NATO'S light fighter.



The Bristol Siddeley Proteus powers the Britannia airliner.

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Boeing Science Lab Gets New Home

SEATTLE—Boeing Scientific Research Laboratories moved last week into a new $2,250,000 home, a university-like building across the Duwamish River from Boeing Airplane Co.'s home plant.

The move marked a major step forward in the growth of the research organization which Boeing established slightly more than two years ago to provide a strong link with the nation's scientific community.

Of the slightly more than 100 persons on the BSRL staff, some 50 are scientists. Main floor of the new building contains 24 laboratories with immediately adjacent offices for the scientific staff members. A library and seminar room are on the second floor, with a calibration laboratory and metalworking shop in the basement. The building is planned so that additional wings can be added as needed.

Boeing established BSRL with these purposes in mind:

- To provide a channel of communication with the scientific world and create an "awareness" within the company of scientific progress.
- To provide special help for the engineering department in an atmosphere which might aid in the conversion of basic scientific development into practical engineering applications.
- To discover something useful.

The laboratory will not take on any classified work. This will permit free collaboration between Boeing scientists and those of other countries. For a similar reason, it will do very little proprietary work, according to BSRL director Guilford Hollingsworth.

To promote contact between the BSRL scientists and the Boeing engineering departments, there will be no cross-charging to other departments for work done by BSRL. This, it is felt, will encourage the engineers to bring their problems to the BSRL group. The company anticipates that the research laboratory staff members may spend up to one-third of their time assisting others in the company. The remainder of the time they will be free to work on projects of their own in surroundings strongly reminiscent of a university campus.

At present, BSRL work is going on in such fields as flight sciences, gas dynamics, plasma physics, geoastrophysics, solid state physics and mathematics research.

Emphasis is on the theoretical. In plasma physics, for example, BSRL staff members are not concentrating primarily on transport properties but are more interested in such things as the characteristics of static plasma and the radiation characteristics of hot plasma. In the solid state laboratory, the scientists are not delving into ways to build a better transistor but are researching the mechanics of solids.

BSRL at present does not plan to take on outside contract work although this policy may be modified in the future.

mergers and expansions

LOCKHEED's California Division has opened a $3-million plastics center in Burbank. The 100,000-sq.-ft. facility will be used for development and manufacture of aerospace and consumer plastic products. Lockheed has over 400 technicians and engineers currently engaged in plastics products, with 22 manufacturing and research engineers working exclusively on development of new products and production techniques.

THOMPSON RAMO WOOLDRIDGE INC. dedicated its Colwell Engineering Center in Euclid, Ohio. The Tapco Group Materials Dept. engineering and technical staff will be the first occupants of the 32,000-sq.-ft. center. The facility is named after Arch T. Colwell, vice president-engineering, research and development since 1937 and head of these activities for 30 years.

MOTOROLA INC. plans to sink $1.2 million into the commercial aviation electronics business it acquired from Lear, Inc. Some 400 employees will move into a recently purchased plant in Culver City, Calif., and the division's present facilities in Santa Monica will be increased by 37,000 sq. ft.

LYTLE CORP. has acquired the Allied Research & Engineering Division of Allied Record Manufacturing Co. The Hollywood facility will be operated as a division of Lytle, and continue in the production of electroformed parts, especially for missile components. Nicholas Sannella, Jr., has been named manager.

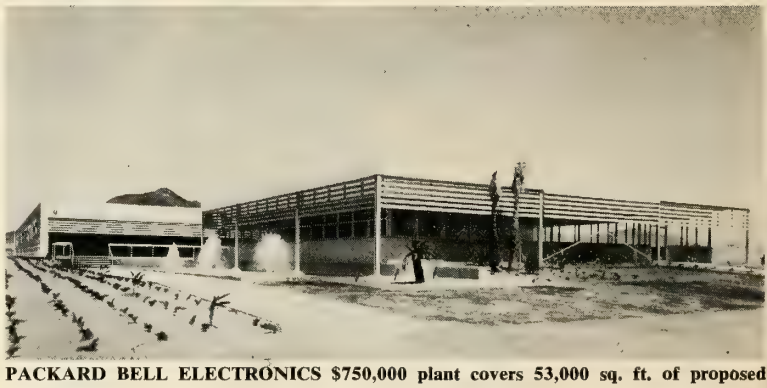
INTERNATIONAL RESISTANCE CO.'s Burlington, Iowa, division will add 30,000 sq. ft. to its present 56,000-sq.-ft. facility. A 25% boost in employment is expected to accompany the expansion.

POLARAD ELECTRONICS CORP. has made its first diversification out of the field of microwave test equipment with the establishment of the Scientific Instruments Division. It will go into development and production of precision instruments for research in chemical, biological and medical fields.

CONTINENTAL-DIAMOND FIBRE is spending over $1 million for additional treating and press equipment for its laminated plastics products at its Newark, Del., plant.

EPSCO-WEST has established a West Coast branch of its components division to handle its line of transistor digital circuit cards, modules and magnetics.

Added Space for Packard Bell



PACKARD BELL ELECTRONICS $750,000 plant covers 53,000 sq. ft. of proposed 350,000-sq.-ft. electronics complex at Newbury Park, Conejo Valley, Calif. Its Technical Products Div., advanced electronics equipment manufacturers, will be housed here.

AEROJET-GENERAL CORP. has bought Firestone Tire and Rubber Co.'s Missile Engineering Laboratory at Monterey, Calif., for an undisclosed amount. Although Firestone will retain an unimproved 10 acres at Monterey, it is moving its missile work to its Los Angeles facilities. The 10 acres purchased by Aerojet includes a 12,000-sq.-ft. building and is adjacent to the Monterey Peninsula Airport.

BELL AIRCRAFT CO.'s sale of its defense business to Textron, Inc., has been approved by stockholders. Textron will pay $22 million for the business, which it will call Bell Aerospace Corp. Bell Aircraft will be renamed Bell Intercontinental Corp. Top Bell management will go with the subsidiary. Bell Intercontinental will retain land and buildings used by the defense group, but rent them to Bell Aerospace for $1.3 million under a 10-year lease.

In another transaction, Textron acquired Dorsett Plastics Corp., fiberglass boat manufacturers in Santa Clara.

MICROLAB has begun construction on a 15,000-sq.-ft. addition which will double its manufacturing area. The Livingston, N.J., firm manufactures precision coaxial components for the electronics industry.

KAWECKI CHEMICAL CO., Boyertown, Pa., has purchased 50% of Penn Rare Metals common stock in a recent cash transaction . . . NEMS Clarke Co. has opened a sales and service office in Los Angeles . . . Vitramon Inc., capacitors manufacturers, has moved to a new plant in Monroe, Conn.

ULTRASONIC INDUSTRIES INC. has formed a Canadian subsidiary to market its diSontegrator ultrasonic cleaning equipment and other devices . . . Electronic Specialty Co. has established a European sales, maintenance and distribution center . . . Cain and Company has acquired Memo, Inc., a group of electronics sales engineers.

financial

Ryan Aeronautical—A 37% increase in sales brought totals up to $51 million for the first half of the 1960 year, from $37.2 for the same period last year. Net six months income was $881,010.

Electronic Communications, Inc.—Net sales of $11.5 million were down from $18 million for the first half of 1959. Net income went down to $89,282 from $496,203. Backlog of orders was slightly up, reaching over $16 million compared to a backlog at the end of the first half of 1959 of $15.8 million.

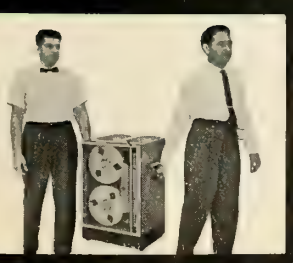
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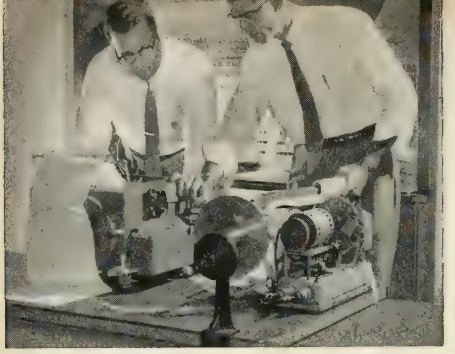


Portability demands little compromise in performance. Flutter, tracking, overall performance and reliability approach or equal the most elaborate and expensive instrumentation tape recorders.

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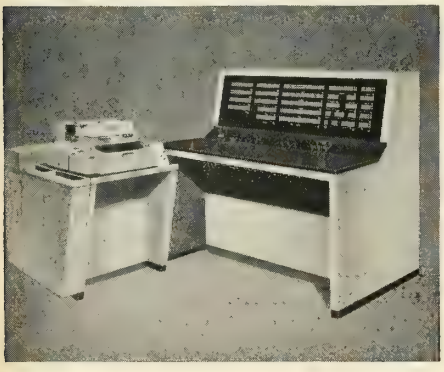
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The Univac Scientific computer is used to simulate and prove the projected design of new systems. This concept of mechanized design, which may be described as the use of one computer to build another, eliminates prototype building and attains a degree of reliability once regarded as only theoretically possible.



A technician follows the wiring diagram produced by the Univac Scientific. This application of mechanized design greatly facilitates the production of reliable automatic data processing equipment.



A significant achievement of mechanized design is the BOGART computer, produced by Remington Rand Univac, for the U.S. Navy. Intensive preliminary testing of the projected system made it possible to reduce the size of the computer while materially increasing its reliability through the use of transistors and printed circuitry.

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SEA SURVEILLANCE SYSTEM FOR THE U. S. NAVY

AN/USQ-20 (Advanced Computer for the U. S. Navy)

Additional information describing capabilities and experience or career opportunities may be obtained by writing to Remington Rand Univac at the above address.

Technical Countdown

ADVANCED MATERIALS

Stress Relief Metal Loss Reduced

Copper or aluminum precoats designed to protect metal parts during hot forming, stress-relieving heat treating, or annealing have been developed by Chance Vought. The precoating acts as a lubricant for subsequent forming, stops oxidation, and is easily removable.

Refractory Single Crystals in Production

Single crystals of tungsten, molybdenum, columbium, tantalum, and their alloys are in production at the Linde division of Union Carbide. The production breakthrough is applicable to other metals and expansion of the process is in progress (see story on p. 34).

Largest H-11 Tool Steel Forgings

Forward and aft rocket motor closures 40 in. in diameter and weighing 840 lbs. are being produced by Wyman-Gordon. The components represent the largest H-11 tool steel pieces ever forged in a closed die. The firm says that 50-in. diameters are possible.

PROPULSION

Stable Monopropellant

Guanidinium perchlorate, a compound with applications as an explosive or monopropellant, is now available from National Northern Division of American Potash & Chemical Corp. The compound, thermally stable to 350°C, is being produced in pilot plant quantities.

Second-hand Boosters Look Good

Recovery and reuse of large boosters have been proved feasible in studies at Rocketdyne. Rocket and turbojet engines recovered from the ocean within six hours show negligible effects of corrosion if properly cleaned. Studies are part of NASA program which calls for reuse of giant *Saturn* boosters.

ELECTRONICS

Wraps Taken Off SAGE Projector

SAGE Rapid Processing Photographic Projector (RP3) was publicly shown for the first time in London last week. The device photographs the radarscope, develops the photo, and projects it on an 18-ft. diameter screen within six seconds. The RP3 operates automatically, giving SAGE sector commanders a continuous picture of potential enemy aircraft or missiles in flight.

New Minitrack in Works

NASA's new Minitrack network is scheduled for operational status by December. The 136-mc facilities will be able to track satellites in orbits of any inclination, including polar (see story on p. 28).

A Real Hot Dish

Even antennas are being "air-conditioned" these days. Gabriel Electronics has just developed a 16-in.-diameter parabolic which is completely heated for deicing reflector and feed. Heaters are turned on automatically whenever the temperature drops below 39°F.

Radar Gets Credit for Kill

Army is being coy as to the exact nature of the high-performance radar that got credit for last week's knockdown of a *Corporal* by the *Nike-Hercules*. They cite a threefold improvement in capability but will not elaborate on specifics.

Nuclear Space APU Costly

A ¾-million-dollar AEC/Air Force contract for a 300-kw nuclear mechanical space power system was won by AiResearch Division of Garrett Corp. Major subs are Aerojet's Aetron Division (reactors) and Westinghouse (electrical generators). After an initial 18-month design-study phase, the task will eventually require 5-6 years and $8-10 million. Over 25 proposals were considered in this hotly contested project.

$$ Saved in Spite of Phone Bill

A recurring $10,000 item on Douglas Aircraft's long-distance phone bill is a welcome expense. It's the rental charge for a 2200-mile data link connecting the company's Charlotte, N.C. missile plant to its Santa Monica computer facility. Even with operating costs, total is 2/3 less than expense of a duplicate complex and up to five days are saved in obtaining computer solutions (see story on p. 38).

Hydrogen APU/Cooler Proposed

AiResearch has proposed use of liquid hydrogen in an integrated auxiliary power unit and cooling system for *Dyna-Soar* type re-entry vehicles. Based on a recently completed quarter-scale mockup, this is a state-of-the-art system, says the Division's missile system chief, J. G. Kimball—all it needs is a vehicle in which to put it (see story on p. 36).

Exotic Propagation Studied

The possibility that other than conventional antenna and feed systems can be used to advantage for UHF transhorizon propagation is part of a study being conducted by Sylvania for the Air Force. Other phases of the research will look at r-f radiation from flame-excited plasmas.

ALRI Team Chosen

The team has been chosen to produce the ALRI (Airborne Long Range Input) system for the Air Force. Burroughs Corporation is manager of the weapon system contract to produce this system for the seaward extension of SAGE. Others on the team: Electronic Communications, AC Spark Plug, Lockheed Aircraft Service, GPL Division of General Precision, Philco, and Technical Products Division of Packard-Bell.

3200-cps Power Supply for Eagle

Eagle missile and its launching Missileer aircraft will be equipped with 3200-cycle electronics system instead of conventional 400-cycle. No reasons for the innovations have been given, but one advantage would be smaller size and lighter weight for power supplies.

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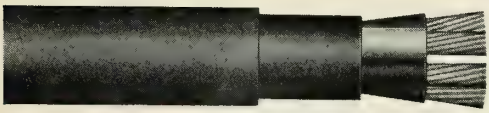
From missile cable to magnet wire

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Anaconda Wire and Cable Company manufactures the broadest line of wire and cable in the industry. A nationwide network of nine fully integrated plants offers cable capability marked by continuous research, product development and rigorous quality control. Some of the many complex cable constructions currently being manufactured by Anaconda are described below.



Umbilical Breakaway Cable. Anaconda designed and manufactured this 99-conductor composite breakaway cable for the "Corporal" —one of America's first missiles.



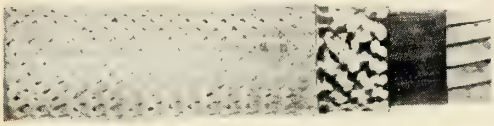
Portable Power Cable. Designed for maximum durability and meets flame tests of the Bureau of Mines. Available with or without grounding wires, round or flat constructions.



Ground Support Cable (MIL-C-13777). Power and control cables for interconnecting units of complex weapons systems.



Launch Control Cable. Seventy-conductor, flexible copper strand, polyethylene insulation, tinned-copper braid shield, nylon jacket, planetary stranded, oil-, gas-, flame-, moisture-resistant over-all jacket.



Polaris Cable. Digital transmission and synchro resolver cable developed for the firing system of Polaris submarines. Withstands open-end hydrostatic pressure of 300 psig.

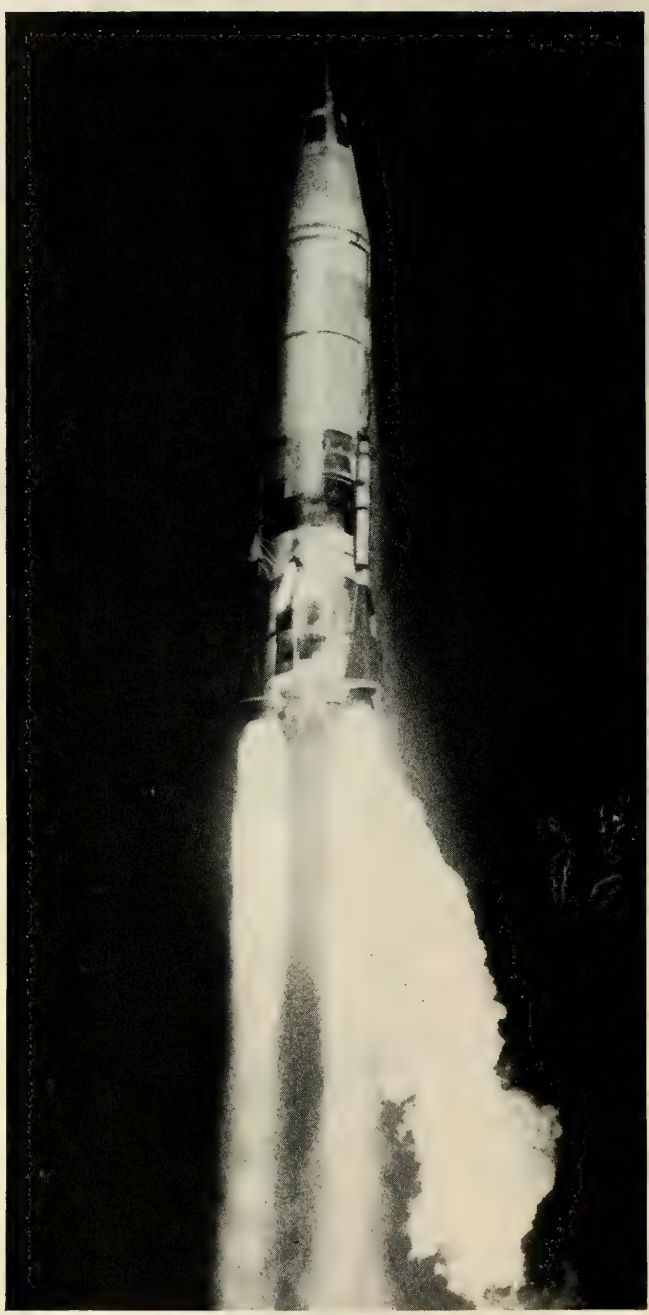


Nuclear Reactor Cable. Developed by Anaconda for U.S. Navy. In addition to its absolute watertight features withstands high-temperature operations in the order of 500 F.

Instrument Probe Cable. Miniature coaxial construction. No. 40 Awg Evanohm resistance conductor, cellular polyethylene insulation, tinned-copper braid shield, PVC jacket. Overall diameter 0.100".



Radiation Resistant Satellite Cable. Four-conductor miniature construction. Tinned-copper conductors, color-coded HYRAD [irradiated polyolefin] insulation, flame-retardant, 90% copper braid shield, irradiated HYRAD jacket overall.

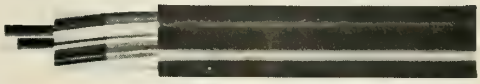


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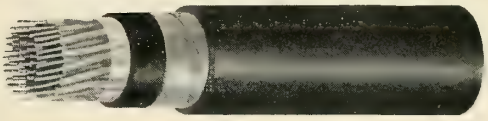
Computer Cable. Multiconductor construction for interconnecting units. Conductors to MIL-W-16878, extruded nylon jacket over primary PVC insulation, tinned-copper braid shield, color-coded PVC jacket over each pair, overall PVC jacket.



260C High Temperature Missile Cable. Silver-plated copper conductors, fused-wrapped Teflon insulation, flor-glass tape abrasion barrier, Teflon impregnated fiberglass inner braid, silver-plated copper braid shield 90% coverage, Teflon impregnated fiberglass outer braid, conductors cabled, Teflon impregnated fiberglass braid overall.



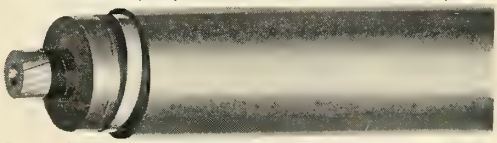
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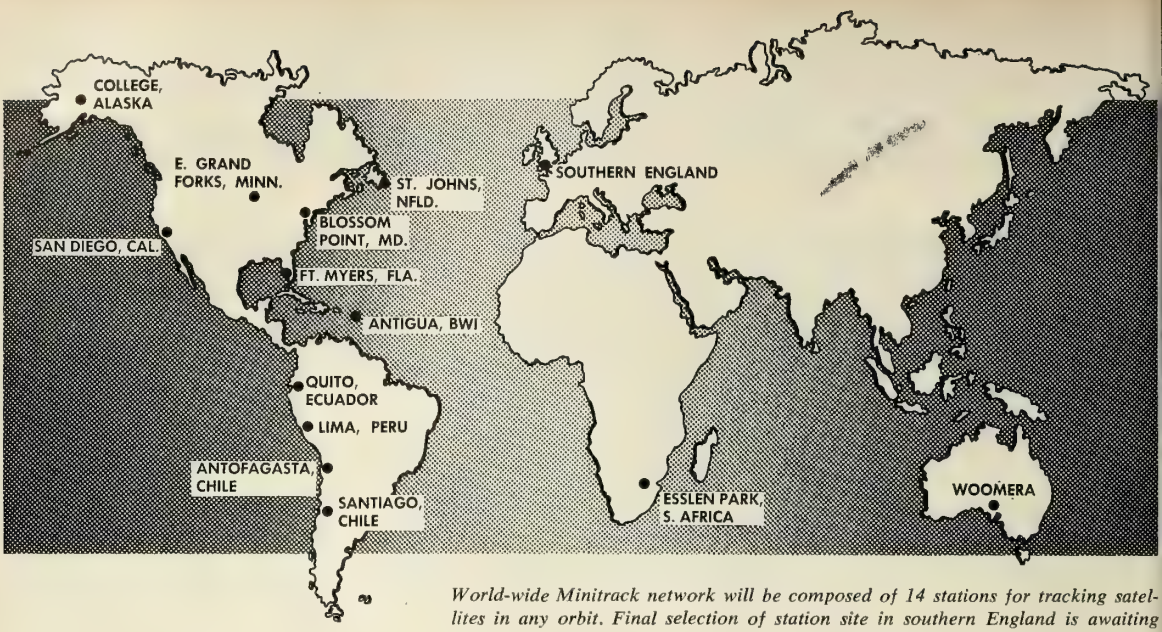
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World-wide Minitrack network will be composed of 14 stations for tracking satellites in any orbit. Final selection of station site in southern England is awaiting outcome of current negotiations. Each station will get at least two new receivers.

ground support equipment

New Minitrack to Cover All Orbits

by Hal Gettings

A new NASA Minitrack satellite tracking and data acquisition network is scheduled to be in operation by December of this year. The 14-station, world-wide facility will use the new 136 mc band authorized by the International Telecommunications Union.

According to Robert Coates, associate chief of the space agency's tracking system division, the new network will be similar in many respects to the highly successful Minitrack dedeveloped to track low-inclination IGY satellites. But it will incorporate many new features to make it possible to track satellites at any inclination, from equatorial to polar. Existing 108 mc facilities will be retained.

• **Based on interferometer system**—The Minitrack system uses the interferometer principle for determining satellite positions. Two pairs of antennas, one on an east-west baseline and the other on a north-south, are used to measure the two direction cosines needed to specify the satellite's positions and determining orbits.

The long-baseline interferometers for the 136 mc band will be fitted inside the present 108 mc equipment so that the center of the two systems will be at the same point. The individual antennas of the long-baseline interferometers—or "fine" systems—are eight-element slot arrays with a fan-shaped beam of approximately 10° by 47°.

Present 108 mc stations have the beam oriented north-south, for best interception of satellites traveling roughly east-west in low-inclination orbits.

The new 136 mc facilities will consist of two different interferometer systems. One system will have the fan beam oriented north-south for low-inclination orbits, and the other will have an east-west orientation for high-inclination (including polar) orbits.

The 108 mc ambiguity antennas cluster around the center of the antenna field. Consequently, the new 136 mc ambiguity antenna complex is located away from the center. The off-center location introduces a small parallax error in the calibration which must be compensated for.

The 136 mc ambiguity antennas have symmetrically shaped beams about 75° wide. This allows the use of one set of ambiguity interferometers for both high- and low-inclination orbits. Baselines of each pair are 3.5 and 4.0 wavelengths—since the physical size of suitable antennas makes half-wavelength baselines impractical. Equivalent 0.5 and 7.5 wavelength baselines will be obtained by combining the phase signals of the 3.5 and 4.0 wavelength baselines to resolve the ambiguities of the long baselines.

New tracking receivers for measuring the phase difference between antennas will use the same unique principle of operation as the present 108 mc receivers. Each receiver contains two separate front-end chassis, each connected to one of the interferometer antennas. The two front-end output signals—separated in frequency by a 100 cps phase-locked difference in their respective local oscillators—are combined and fed into the first i-f amplifier. Only minimum gain is used prior to combination, in order to reduce the drift in differential phase between the two signals. After combining, both signals travel through the same i-f amplifiers and mixers to further reduce the possibility of appreciable differential phase shifts.

The 136 mc receivers are triple-conversion superhetrodynes with a predetection bandwidth of 10 kc. They have a noise figure of about 3 db and a dynamic range of 70 db or more.

The outputs of each receiver contain both analog and digital phase meters. The system is designed so that one digital bit is equal to approximately four seconds of space angle in the most sensitive part of the interferometer pattern.

The analog and digital phasemeter outputs will be recorded on multichannel strip-chart recorders along with time signals. In addition, in the near future an automatic digital punch will put the phase readings of all the antenna combinations and a time reference on teletypewriter tape five times a second for immediate transmission to the NASA computing center. The computer is programed to automatically reduce the data and then use it for orbital computation.

• **New equipment for data acquisition**—The main telemetry antenna for the new band will be a self-tracking quad-yagi with a gain of approximately 19 db. The antenna will have crossed yagis permitting diversity reception on two orthogonal linear polarizations, or on circular polarization. The 4-yagi elements will be arranged for phase monopulse operation for automatic tracking. Tracking receivers will be very similar to those just described.

The unique X-Y antenna mount was designed specifically for tracking satellites over the entire sky above a 15° horizon. It has no gimbal-lock positions above the 15° elevation. The ratio of shaft velocity to tracking velocity is unity at the zenith where satellite angular velocities are a maximum; the velocity ratio is high only near the horizon where satellite angular velocities are low. With this combination, excessive shaft velocities are not required. The antenna will follow any satellite pass including the close approach of one in a highly eccentric orbit.

There will be at least two new 136 mc telemetry receivers at each of the 14 stations in the Minitrack network. The receivers are being developed specifically for data acquisition from satellites. The receiving system will consist of low-noise preamps mounted on the antenna and the main receivers located in a nearby building. The preamps will have a noise figure of 3 db and a bandwidth of 3 mc centered at 136.5 mc. The new receivers will also be able to obtain doppler data.

Equipment will be available at each station for direct simultaneous magnetic-tape recording of the undetected and detected telemetry signals from the receivers.

Each station will have only enough data reduction equipment to permit monitoring system operation. It is not planned to have data processing at every station except for special cases where real-time reductions are necessary.

A central facility has been installed at the Goddard Space Flight Center for reducing data on the magnetic tapes from all the stations. At the present time, this center is equipped to handle PDM/FM-AM and FM-FM telemetry. Instrumentation for other types of telemetry is being acquired. Methods to improve the speed and accuracy of data reduction are being developed.

• **Precision time standard added**—Each station in the 136 mc network will have a new precision time standard to provide coded time signals and standard frequencies. Frequencies of 1 kc, 100 pps, and 1 pps are fed to a digital clock which continues the countdown to one pulse per 24 hours and provides a visual display of time in hours, minutes, and seconds.

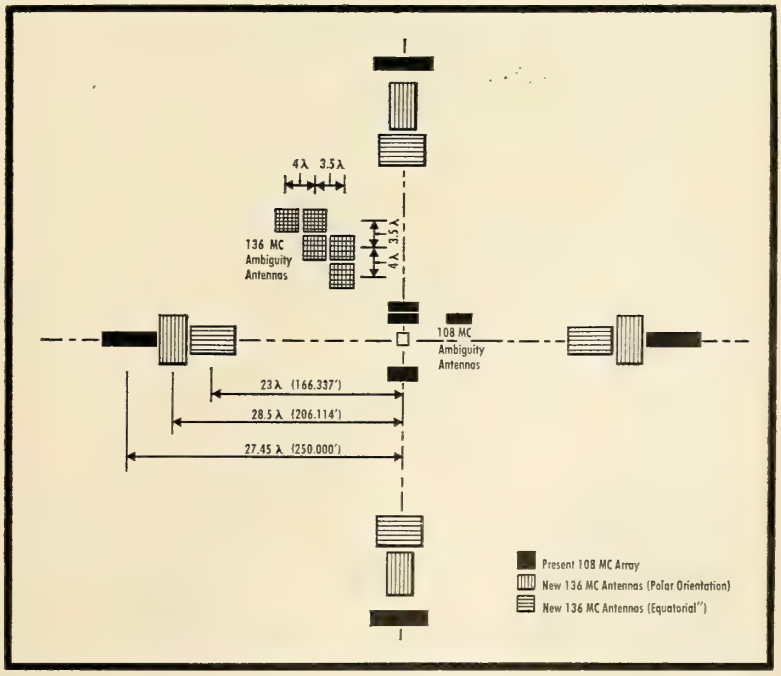
The digital clock also produces two time codes. The first is a combination 1 pps time signal and a serial-digital code of the time in tens of hours, hours, tens of minutes, minutes, tens of seconds, and seconds. This time code is used for precision time marks on strip-chart recorders.

The second time code was designed for putting accurate time on magnetic-tape recordings of telemetry signals in a form compatible with electronic computers for automatic data reduction. This code consists of time-of-year (GMT) in seconds, minutes, hours, and day of year. A complete time frame occurs once each second.

At present, the time standards at each station are synchronized with WWV within ±2 milliseconds. Uncertainties and variations in propagation delay time cause most of the errors in adjusting the time standard. Recent measurements of VLF propagation times indicate that it should be possible to make radio synchronization of clocks ten times more accurate—or better—using VLF instead of WWV frequencies. This is being investigated at Goddard for use at the Minitrack installations.

• **Calibration accuracy two seconds of arc**—Both the present 108 mc and the new 136 mc Minitrack are calibrated by comparison of the optical and radio positions of a night-flying air craft photographed against a star background (M/R, 5/2/60). System calibration accuracy is two seconds of arc, an order of magnitude better than the Minitrack system probable accuracy of 20 seconds of arc.

• **Future will demand higher frequencies**—The 136 mc instrumentation has been designed to meet future requirements for data acquisition and satellite tracking in that band. The bandwidths needed for tracking are relatively small; the total bandwidth required for tracking will fit into the



NEW 136 MC antenna installations will be fitted inside present 108 mc interferometers. Phase-angle difference detected by paired antennas yields satellite position data. Parallax error due to off-center ambiguity antenna location is compensated for.

136 mc band even though the number of satellites in orbit greatly increases.

Tracking at higher frequencies will be necessary in the future, when experiments will demand greater accuracy than that obtainable with present equipment. As an example, geodetic problems such as establishing accurate continental ties will require greater tracking precision.

Systems for precision radio tracking of satellites should operate at frequencies higher than 136 mc, to reduce the effects of ionospheric refraction. Therefore, the bands in the gigacycle range probably will be used for this purpose. A preliminary study of systems for precision radio tracking has been started at Goddard. This will form the basis for the development of a radio tracking system with an accuracy of a few seconds of arc.

The 136 mc band will not accommodate the bandwidths needed for future data acquisition. The sum of the bandwidths required for NASA satellites scheduled for launching in 1961 is about equal to one megacycle—the total bandwidth in the 136 mc band. A greater number of satellites are scheduled in each of the following years; many of these will be large, complex vehicles which will require wide bandwidths for data transmission.

For example, the projected orbital astronomical observatory will be sending TV pictures to earth. Project *Nimbus* satellites will require several megacycles bandwidth for transmission of TV photos. It is apparent that the heavy load of narrow-band telemetry and the additional wide-band telemetry requirements in the near future will demand data acquisition equipment in the 136, 400, 1427, and 1700 mc bands.

A primary disadvantage of the higher frequencies is that satellite-to-ground propagation loss increases as the square of the frequency. To keep satellite transmitter power requirements reasonable, it is necessary to increase antenna gains to compensate for this loss. The gain must be accomplished at the ground station since larger and/or directional antennas on satellites pose too many problems to be practical at present.

NASA is planning several satellites which will have highly eccentric orbits. These satellites will call for very-high-gain antennas for telemetry reception at the long ranges of apogee. Other satellites will require the high gain of a large antenna because of the very wide bandwidth required for telemetry. Some special projects will have both wide-bandwidth and long-range requirements—necessitating the use of high antenna gain for data acquisition.

Tory IIA Testing Will Emphasize Safety

JACKASS FLATS, NEV.—Testing of the Tory IIA nuclear ramjet reactor for the *Pluto* program, to begin here by November, will strongly stress detailed data returns and system safety.

Construction of the maintenance and disassembly building for Tory IIA is well under way, and should not delay the test program. Test cell facilities, now virtually complete, include numerous high-pressure tanks, some built of stainless steel.

Reactor design, directed by the Lawrence Radiation Laboratory of the University of California, is virtually complete; it will change only in minor respects before test firing, according to the Atomic Energy Commission.

Three LRL scientists, C. S. Barnett, H. C. McDonald and P. M. Uthe, told the American Rocket Society recently that several hundred data pickup points will be incorporated into the Tory IIA system, which has a small, high-power-density, air-cooled reactor designed for high-temperature operation.

They said the instrumentation used for basic data collection will also be used, in the interests of simplicity and economy, for control of the reactor experiment. Separation of the two functions was not considered necessary because of the nature of the nuclear experiment.

• **Many channels**—The control room housing the recording and indicating equipment is about two miles from the unshielded reactor in its test bunker. Cables carry signals from the reactor and facility transducers to the control room, after amplification in the test cell.

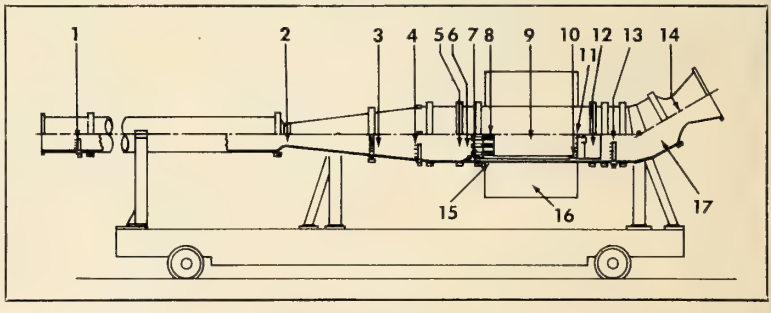
The Tory IIA recording and indicating system revolves around 258 channels of 1.5 cps, pulse-width modulation tape recording equipment, and 72 channels of 120 cps analog strip chart recorders. Additional instrumentation includes meters, scalers and slow response strip chart recorders.

LRL lists the physical quantities to be measured as:

• Neutron flux level of the reactor core and time rate of change in the flux level.

• Air flow rate through the reactor.

• Air temperature and pressure distribution at the reactor core entrance



1—Two total pressure rakes with four probes each. Two total temperature probes (rakes on horizontal center line). **2**—Two static pressure taps. **3**—Two static pressure taps.

4—Two total pressure rakes with four probes each (rakes on horizontal center line). **5**—Three vibration accelerometers, one vertical, one horizontal, and one axial. **6**—Two static pressure taps. Three wall temperature taps. **7**—Three vibration accelerometers, one vertical, one horizontal, and one axial, mountd on front structure. **8**—Eight high-temperature strain gauges mounted on tension rods. **9**—168 thermocouples within core. **10**—Three vibration accelerometers, one vertical, one horizontal, and one axial, mounted on base plate. **11**—One total temperature rake with 19 probes. **12**—Three vibration accelerometers, one vertical, one horizontal, and one axial.

13—Two pressure rakes with four total pressure probes each. One static pressure probe each. Two total temperature probes each. Three wall temperature taps (rakes on horizontal center line). **14**—Two static pressure taps. Three wall temperature taps. **15**—49 ambient temperature strain gauges on structural core components. **16**—13 thermocouples within core, four on reflector, nine on reflector vanes. **17**—Four wall temperature taps.

and again at its exit.

• Material temperature distribution within the core.

• Dynamic and static strain (stress) in the core support structure.

• Vibration of large structural components of the reactor.

• Operating temperatures of auxiliary components.

The neutron flux level and time rate of change of flux level are required for analysis of the reactor behavior and for feedback to the reactor control system.

Air flow and heat transfer characteristics of the Tory IIA core are determined by air temperature and pressure distributions at the reactor extremities and the air flow rate through the reactor core. Complete determination is made with inclusion of data pertaining to temperature of core components. Similarly, these parameters (gas temperature and pressure, and materials temperatures) also serve to warn of dangerous conditions in the core.

Core support structure is instrumented for strain at design pressure differentials before high power and high temperatures are applied. Results are used to predict safety of the structural members when design conditions are applied. The strain gages in the system will not be in operation during high-temperature conditions in the reactor.

Vibrational characteristics of the reactor will be determined through pickups for acceleration and velocity mounted on the core support structure and the air ducts. Since system safety is the prime consideration, there will be little effort to make a detailed breakdown of vibration data.

System safety is also the prime consideration in measurements of the auxiliary components temperature. Nearly all these subsystem outputs are used in a go/no-go manner; they are expected to have little effect on the principal operation.

• **Nuclear measurements**—Eleven nuclear detectors in the system will keep tabs on reactor power from shutdown level to 1000% design power. In addition, an air exhaust monitoring system will detect fission product activity. AEC officials have previously stated that fission products introduced into the atmosphere by the *Pluto* nuclear ramjet will not be any greater than that introduced by the *Rover* nuclear rocket. Two scintillation beta counters in this subsystem will give a semiquantitative indication of airstream activity.

The most extensive measurements in the entire system will be made on the temperatures involved, since the Tory IIA is characterized by its very high operating temperatures. A total of 243 thermocouples for such data collection will cover ranges from room temperatures up to 2000-3000°F. The bulk of these thermocouples, most of them standard design, will be placed in the core fuel elements and structural parts.

Pressure data will be obtained through 36 or more pressure transducers, not including standard dial-type pressure gages. Included in this count are the unbonded strain gages made by Consolidated Electrodynamics Corp., and the Giannini potentiometer types. Pressure measurements range up to 600 psi.

The considerable amount of air mass flow through the core lends a great deal of importance to vibration and strain measurements. Six Endevco 2242 vibration transducers (5-120 cycle) will be mounted on the core, and six Consolidated Electrodynamics 4-121 radiation-resistant vibration transducers (20-2000 cycle) on the air duct structure. The core transducers are expected to be removed after the pre-nuclear blowdown tests and prior to the nuclear power operation.

Prior to nuclear operations, a room temperature blowdown strain survey is planned for core structural members. For these tests, 61 strain gages are

Who Does What for Pluto—

Three organizations are prime contractors on Project Pluto, *the Air Force-Atomic Energy Commission program for developing a nuclear ramjet engine. They are Lawrence Radiation Laboratory of the University of California, Atomics International Division of North American Aviation, and the Marquardt Corp.*

Lawrence Radiation Laboratory has overall system responsibility and does theoretical and laboratory work on the reactor. Atomics International does materials research. Marquardt does engine design and provides laboratory engineering of non-nuclear components.

There are four major subcontractors: American Car & Foundry Corp., Curtiss-Wright Corp., Brush Beryllium Co. and General Electric Co. ACF builds the reactor shell and a car to hold it in the test program. Curtiss-Wright's Research Division is studying the properties of beryllium oxide for use as reflector and moderator material. Brush Beryllium provides the beryllium compounds. The GE Aircraft Nuclear Propulsion plant is developing fuel elements.

Three companies—Chance Vought, North American and Convair—have made studies for the Air Force of a Pluto-*propelled missile named* SLAM *(Supersonic Low-Altitude Missile).*



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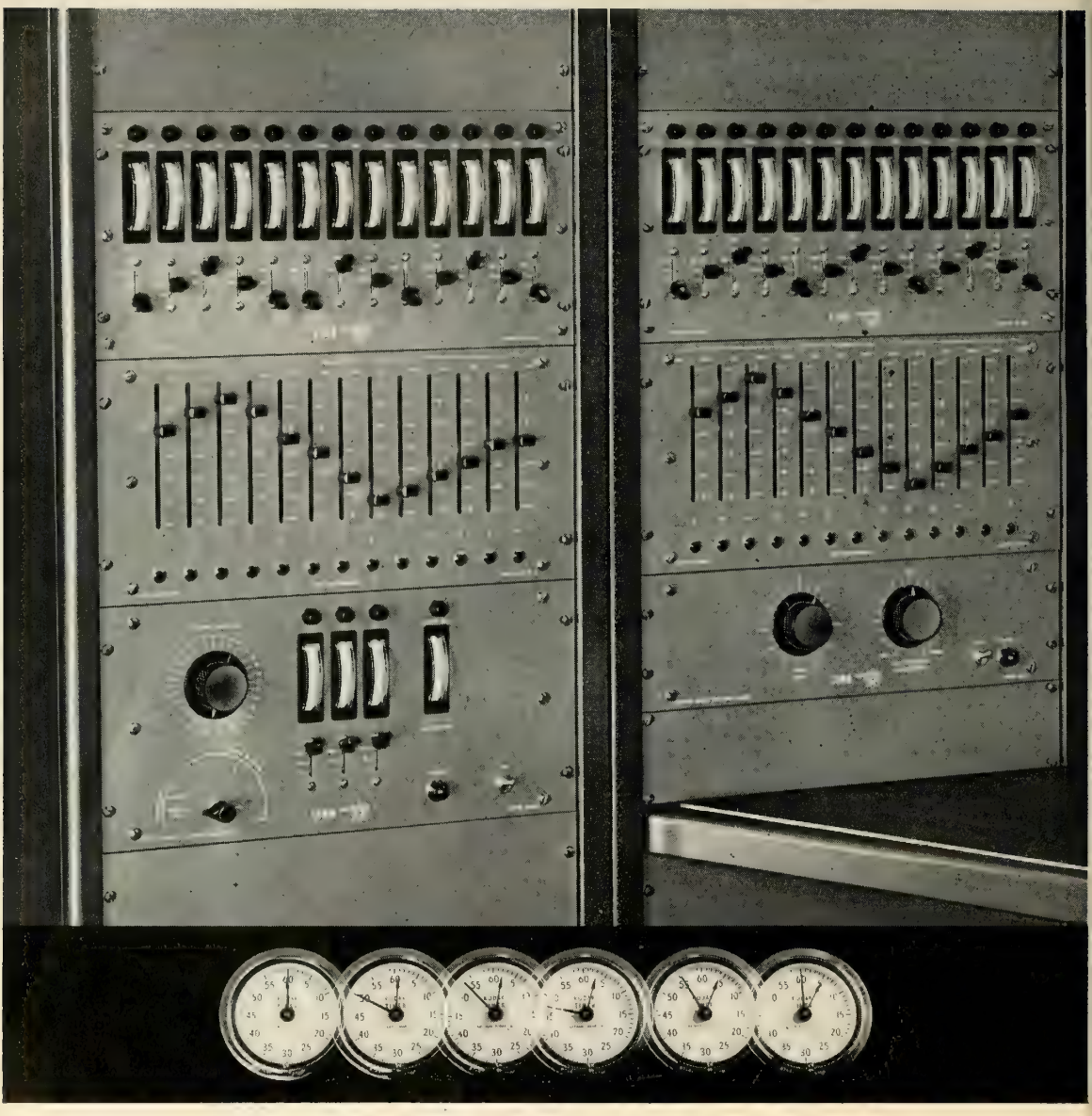
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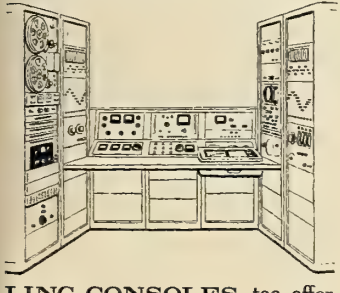
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mounted throughout the core. Fourteen are high-temperature gages providing data up to 1000°F, the remainder are standard paper gages.

Air mass flow rate will be measured via a system using one 12 in. x 5 in. and one 22 in. x 14 in. venturi tube. These are equipped with temperature-compensated absolute and differential pressure transducers. The flow rate of interest lies between 3 and 1000 lbs./sec. To cover this range, five differential and four absolute pressure transducers are needed. Outputs of these pickups is controlled through a switch in the control room.

• **Operation**—The principal characteristic of the Tory IIA system is its versatility, according to the Lawrence Lab. "Due to the nature of the experiment," it says, "instrumentation requirements are constantly changing with respect to both the number and type of instrumentation channels necessary." Some requirements, the laboratory adds, will not be known until after initial field tests have been conducted.

A major requirement of the instrumentation system is that test conductors have a "quick look" presentation of critical parameters. This would enable the operating personnel to scan and assimilate a large amount of pressure and temperature data for proper test operation.

If trouble develops in the reactor core during a power run, the operation director can cause a "scram" in a number of ways. This appropriate word —scram—refers to the rapid reduction of reactivity within the core. It can be achieved by applying full control rod effects to the core and/or introducing a substance such as boron to the core, thus absorbing neutrons and squelching the nuclear reaction.

LRL and its associated contractors hope to avoid a scram at full power; the reactor can routinely tolerate scrams at lower power levels. A scram selector switch on the nuclear console permits the operator to select the number and kinds of things which he wants to cause a scram.

• **Data collection systems**—One of two main data collection systems in the Tory IIA setup is that consisting of three units of ASCOP (Applied Science Corp. of Princeton) 1% accuracy, 1.5 cps bandwidth, pulse-width modulation data systems.

The second principal system is comprised of nine 8-channel Offner Dynograph recorders to provide ink records of outputs from strain gages, vibration pickups and pressure pickups which have frequency components of interest up to 150 cps.

Flow rate and temperature of air supplied to the reactor by the blow-down facility is computed and displayed in the control room. Operators in the control room determine the air temperature and flow rate from large circular indicators. A small analog computer supplies these indicators with a voltage proportional to air flow rate and temperature. The computer inputs are the signals transmitted from the flow and temperature transducers. Minneapolis Honeywell Electrick MV/1 transmitters are used for direct cable transmissions of these signals.

The mass flow measurement system is being supplied by CompuDyne Corp.; preliminary design was by the Marquardt Corp.

Another feature is a Raytheon "Rayspan" spectrum analyzer for monitoring and analyzing transient and steady-state noise and vibration wave forms expected to occur at various points.

An Ampex 14-channel tape recorder will provide continuous recording of data with frequencies above 150 cps. This data may later be resolved and analyzed with the Rayspan unit.

The control console in the Tory IIA control room is designed to be operated by eight men: operation director, nuclear operator, nuclear control engineer, coolant engineer, air temperature operator, air flow operator, core data observer and data collector.

CPI Wins Navy Contract For Studies on Skimmers

Stability and control problems with ground-effect machines will be studied by Cleveland Pneumatic Industries, Inc., for the Office of Naval Research.

The recently won contract will provide a one-year program to analyze over-water operation of such air-pressure-suspended vehicles. Three principal areas will be investigated by Cleveland's Systems Engineering Div.: (1) response to a generalized forcing function, (2) effect of annular jet interaction with a deformable surface, and (3) general characteristics of manual control systems.

Dual-Thrust Tartar Motor In Production for the Navy

Booster and sustainer are in a single unit in the *Tartar* surface-to-air Navy missile, Aerojet-General reports.

The powerplant has a high-thrust, short-duration booster that launches and accelerates the missile to supersonic speed. Then a lower-thrust, longer-duration sustainer maintains speed. Aerojet said it is the first dual-thrust, dual-grain solid propellant motor to go into production for the Navy. Aerojet was recently awarded a $2.5 million production contract.

Big Single Crystals Grown en Masse

Linde uses arc fusion method to produce boules free of inclusions, sees it as big advance in technology

by John F. Judge

Large single crystals of the refractory metals are being grown by the Linde Co., division of Union Carbide Corp. on a mass production basis.

Details of the process have not been revealed. It is known, however, that an arc fusion method similar to the Verneuil flame fusion process is involved.

The Verneuil process is used in Linde's production of synthetic sapphires, star sapphires and oxide crystals. Its principal advantage, carried over into the new development, is that no container for the molten substance is required. In addition, wider temperature and atmospheric ranges result when an electric arc is substituted for combustion flames.

The boules grown in Linde's East Chicago plant range up to a maximum of 12 in. long and 0.75 in. diameter. Each boule, the company says, is free of inclusions.

• **Effect of inclusions**—The danger of chemical attack is increased with the presence of inclusions, which also have an undesirable effect on mechanical properties. Linde says that the boules are more ductile and can be worked at much lower temperatures than currently available polycrystalline specimens. Threads have been tapped into single-crystal tungsten bolts without cracking.

• **Crystallographic direction**—The production boules are also characterized by homogeneity and controlled crystallographic orientation. The crystals now available have random orientations. In the metal crystals, according to Linde, the most likely orientation is with the <100> direction making an angle of 30° with the cylinder axis.

Special crystals can be made where the <100>, <110>, or <111> crystallographic directions are parallel to the cylinder axis of the "as grown" crystal. These special orientations are accurate to within ±5°.

A certain amount of lineage in each of the crystals can be expected, says Linde. Lineage, in this case, is defined as areas which are misoriented with respect to each other by not more than 5°. Tungsten crystals up to 0.25 in. diameter can be grown without lineage. Preliminary studies indicate that other metals may be grown without lineage in smaller diameter sizes.

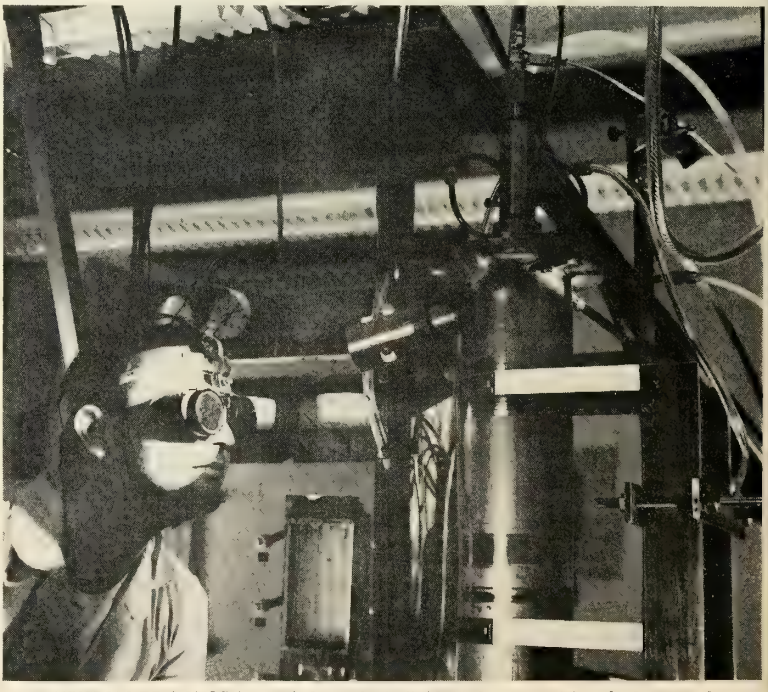
There are no grain boundaries or porosity in the boules. Extremely high purity has been achieved.

• **Theoretical importance**—Tungsten apparently is the only body-centered cubic crystal that is a true cube. For this reason there is theoretical interest in single crystals of this material —the equations governing can be applied without alteration. The absolute single crystal, if obtainable, will help significantly to increase knowledge of the nature of metals.

• **Crystals in stock**—Linde has nine refractory materials available in single-crystal form—tungsten, molybdenum, vanadium, columbium, tantalum, titanium carbide, titanium monoxide, titanium sesquioxide and molybdenum disilicide. Materials to be available in the near future include columbium carbide, vanadium sesquioxide, titanium diboride and tungsten disilicide. Crystals are in the "as grown" form and in swaged or fabricated shapes. Some of the non-metal crystals are expected to find applications as semiconductors in high-temperature and corrosive enviroments.

According to Linde, the development has removed ". . . a serious limitation on progress in the science and technology of high-temperature materials." The National Academy of Sciences has referred to lack of single crystals as a handicap in this area.

Linde is pressing research on the expansion of the crystal growth process, and creating and characterizing new single crystals.



ARC FUSION PROCESS is carried out in individual furnaces. The single crystals produced can be worked at lower temperatures than conventionally produced refractory metals and retain their characteristic qualities.

Materials Analysis Aided By CEC-built Spectrometer

The first commercially available mass spectrometer to qualify as a materials research instrument has been developed by Consolidated Electrodynamics Corp. and delivered to the Air Force's Wright Air Development Center, Wright-Patterson AFB, Ohio.

The high-resolution instrument is expected to contribute in areas that have traditionally defied analysis by commercial means.

According to CEC, the spectrometer is capable of identifying and estimating trace impurities in solids such as semiconductors, ceramics, cermets and high-performance structural materials. Its use makes possible the detection of metal impurities of less than one part per million.

High molecular weight polymeric molecules can be structurally identified with the instrument. The mass range is 2 to 2000.

Unknown materials can be identified through molecular weight information supplied by the spectrometer. Positive separation between molecules such as N_2 and CO is possible even though their molecular weights differ by as little as 1 part in 2500.

A double-focusing resolving system, in combination with a radio-frequency spark ion source, extends the analysis capabilities to cover solids. The mass resolving system is of the Mattauch-Herzog type and simultaneously differentiates between ions within a sample which have the same mass but different velocities.

The spectrometer was developed with the assistance of an R&D contract from WADC by the Central Research Division of CEC, subsidiary of Bell and Howell.

Hydraulic System Seals For Space Under Study

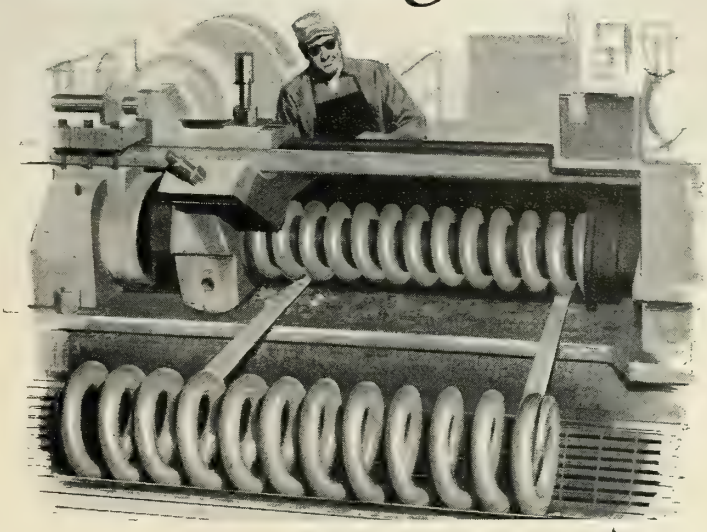
The effect of moon-orbiting conditions on fluid power system connections will be investigated by Republic Aviation Corp. under an Air Force contract totaling $80,000.

According to program requirements the metallic seals must be capable of leakproof operation in temperature ranges from –320° to 800°F.

The vastness of space and the increased altitudes of advanced aircraft are placing greater dependence on fluid power systems for servomechanisms and remote controls.

William Mayhew, chief of Republic's Fluid Systems Laboratory, says that the seal, or gasket, is the key element in the successful operation of such hydraulic systems.

50 years of progress in Shock Mitigation...



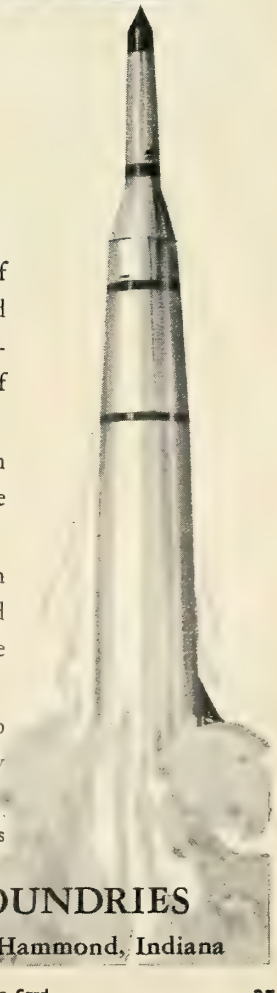
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ICBM missile roars away from launching system which makes extensive use of ASF shock mitigation units.

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Integrated Power-Cooling for Space

Dramatic weight saving is effected in AiResearch unit using liquid hydrogen; system is designed for Dyna-Soar type space craft

by William J. Coughlin

LOS ANGELES—An integrated power and cooling system employing liquid hydrogen has been proposed for boost-glide re-entry vehicles of the *Dyna-Soar* type by the AiResearch Manufacturing Division of Garrett Corp.

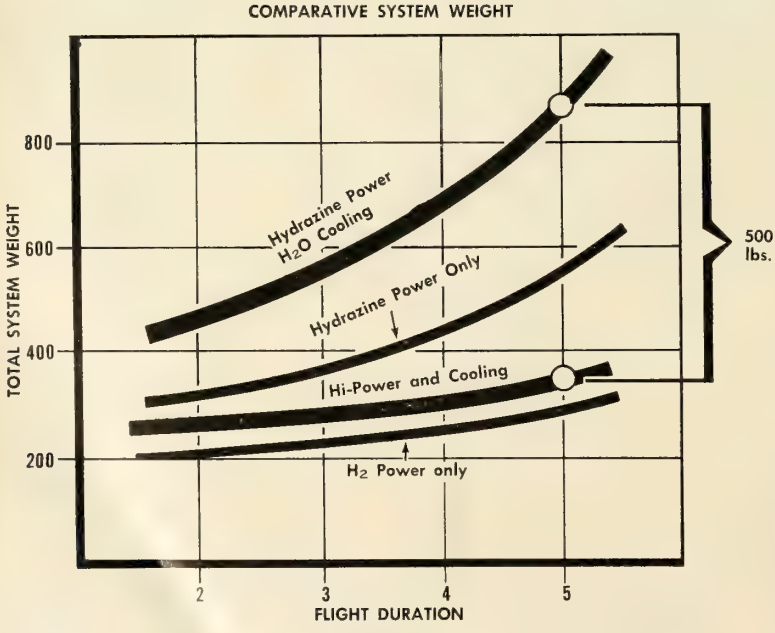
The system is designed to provide secondary power for control, communications and other electronic equipment together with cooling for that equipment, for the pilot and for re-entry. It will supply all necessary power except that for propulsion, and is reported to substantially reduce total vehicle weight.

A quarter-scale mockup has been constructed and AiResearch reports that all hardware needed to put the system together already is in existence.

"Integration of the two systems is the problem, not the development of components," says John G. Kimball, assistant to the chief of missile systems. "We are ready to go ahead with the project. We could have built it some time ago on a state-of-the-art basis, but until now there has been no vehicle to use it."

The system is designed to provide integrated power and cooling for both orbital and space missions for periods between 10 minutes and 14 days. For power requirements of less than 10 minutes, solid propellants or batteries generally are more applicable. Beyond 14 days, solar or nuclear powerplants take over—as fuel requirements of the hydrogen system begin to exceed the fixed weight penalty of those plants.

• **Exploiting cooling**—Basis of the system is liquid hydrogen's potential as a coolant. Its principal competitor as a fuel in this application—hydrazine—has no cooling potential of its own.



HYDROGEN UNIT is 500 lbs. lighter than dual N_2H_2 and H_2O system.

Hydrogen stored at minus 419.72°F, for example, when heated to 285°F will absorb 2545 BTU's in one lb. of hydrogen while at the same time producing one h.p., Kimball points out. The power system, in effect, provides a heat sink for the use of life support engineering.

One difficulty in selling this concept, the AiResearch missile engineer says, has been that historically power and environment have been approached in the aircraft industry as separate problems. AiResearch, one of the few U.S. firms active in both fields, is pushing the integrated concept as a significant weight saving.

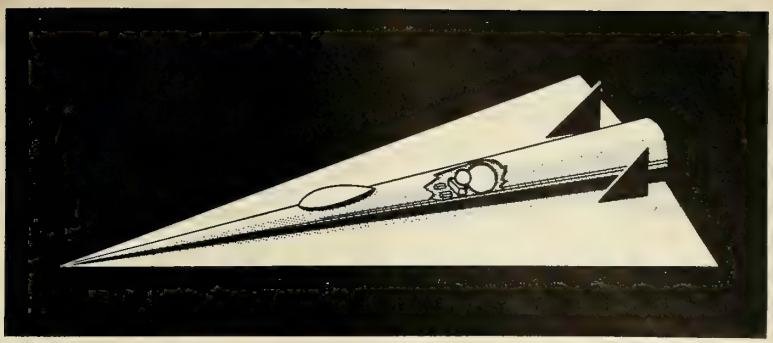
Under the AiResearch proposal, hydrogen flows from the tankage through a cooling loop, through a power loop and then overboard.

The cooling and power potentials can be exploited in various applications. Where use of lithium hydroxide presents a weight problem for carbon dioxide removal, with one lb. of lithium hydroxide required to absorb one lb. of CO_2, two heat exchangers can be employed in the hydrogen system to freeze out the CO_2, using them alternately with provision for ice removal.

For vectoring and attitude control, mid-course corrections, and re-entry alignment, a backpressure system can be used on the turbine exhaust to provide low thrust levels at a relatively small cost in fuel. Higher thrusts can be obtained by employing a separate system fed directly from the common hydrogen tank.

Use also can be made of the liquid hydrogen for infrared detector cooling. Kimball notes that while liquid helium cryostats offer considerable potential in this application, the power required to achieve the extremely low temperatures entirely by mechanical refrigeration appears exorbitant, on the order of 4000/1 watts. By placing the helium cryostat in the liquid hydrogen tank, the power requirement—to bring the temperature down from minus 419.72°F. instead of ambient—can be

ehicles



LOCATION OF power/cooler in space vehicles is ahead of propulsion unit. Below is quarter-scale mockup of unit. The small tank holds LOX and under it are heat exchangers and turbines. The large tank holds LH_2.

reduced to a more acceptable ratio of 10/1 watts.

For fail-safe protection in a manned vehicle of the *Dyna-Soar* type, dual systems are provided, including twin turbines, alternators and overboard exhausts. The second system is not a standby. Both operate at half-capability and are able to carry the full load alone if necessary. Components include:

• **Tanks**—Thin-wall vacuum-jacketed tanks in a conventional approach to liquid hydrogen and oxygen storage. A specific mission such as *Dyna-Soar* would call for a 4-ft.-diameter hydrogen tank.

• **Heat exchangers**—These are the result of an extensive research program on hydrogen exchangers which AiResearch has been conducting for some time. They are of shell and tube construction.

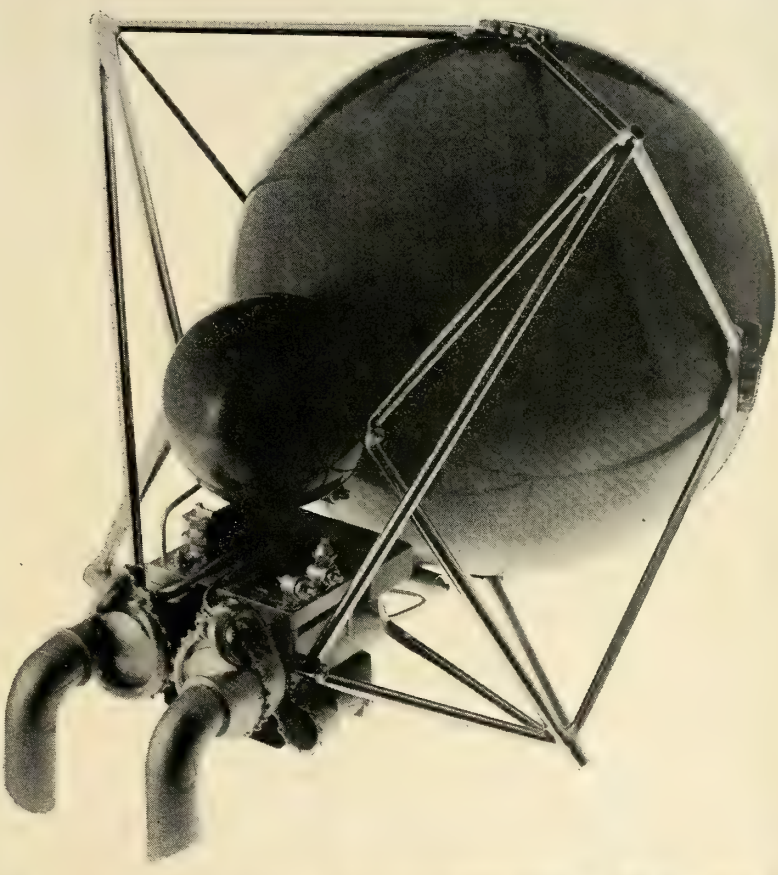
• **Combustors**—A simple small tube with a single spark plug. Oxygen is burned with the hydrogen to raise temperatures at the turbine inlet.

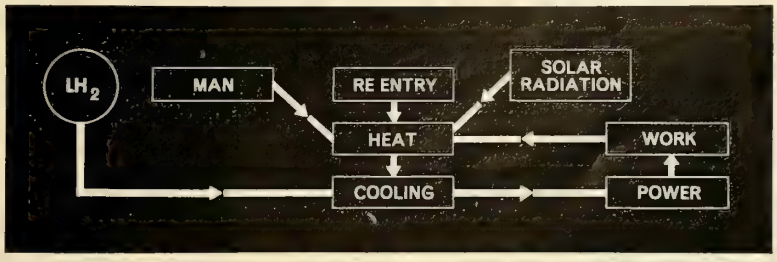
• **Turbines**—A multiple-entry turbine with axial blades. In this the hot gas is fed onto the turbine three times since, due to the large pressure ratio, the wheel cannot absorb the full energy in a single input.

"Since the fuel must be carried aboard, anything that can be done to reduce the fuel consumption by improving turbine performance becomes important in weight saving," Kimball explains. "But once you reach the point where cooling dictates the hydrogen flow, as in the manned vehicle, further improvement in turbine performance is not important."

• **Electrical equipment**—Since almost all space electronics employs a conventional 400-cycle operation, this probably will be provided although use of 3200-cycle power would permit direct driving of the alternator with the turbine, thereby eliminating the gearbox and sharply lowering weight.

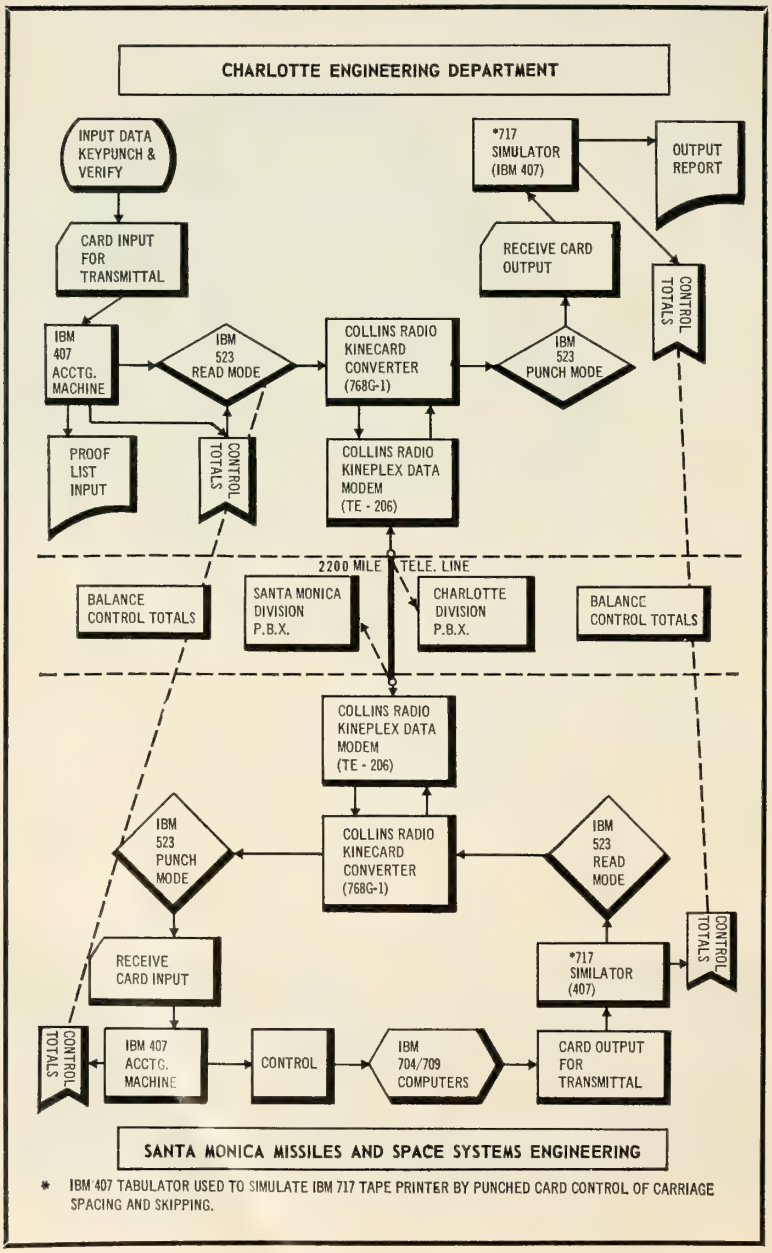
• **Hydraulic equipment**—A conventional 3000 psi system.





SYSTEM PROVIDES power and cooling for up to 14 days duration.

2200-mile Link Cuts Computer Price



* IBM 407 TABULATOR USED TO SIMULATE IBM 717 TAPE PRINTER BY PUNCHED CARD CONTROL OF CARRIAGE SPACING AND SKIPPING.

Douglas' coast-to-coast tie line costs 1/3 as much as building new facility

by Charles D. LaFond

SANTA MONICA—A 2200-mile data link recently installed for Douglas Aircraft Co., Inc., has given its Charlotte, N.C., missile plant an extensive computer facility at one-third normal cost. It's believed to be the first industrial use of a coast-to-coast high-speed card transmission system.

Formerly, computer service by the Santa Monica center was accomplished by time-consuming mail routing. The new system, supplied by Collins Radio Co., makes it possible to solve complex problems in from 4 to 7 days less time than before.

Douglas says the cost of setting up the system at each terminal, plus $10,000 a month telephone-line rental, is about 33% of the price of installing and operating a comparable computer facility at Charlotte.

• **Computer use grows**—As the computer industry strives to meet missile/space demands for smaller, faster, more flexible and efficient systems, it depends more and more on these marvelous tools to solve otherwise impossible problems.

The Douglas computer complex is typical of those at the big missile primes. Its 14 autonomous computer sections utilize 46 computers, including 17 major systems. (The other 29 equipments are general access types.)

Nearly 1000 computing personnel —including almost 200 analysts and programers—are needed to direct, feed, or operate these machines. Significantly, the company's Missile/Space Computer Engineering Sections employ half of this talent. Including the computer facilities with which they are associated, these two sections represent one third of Douglas' total ex-

penditure for computer service.

The stupendous tasks so often assumed by the nation's large missile prime contractors and various military and government agencies have brought about many such vast computer complexes.

This growth has not been haphazard; investment in such service organizations is dictated by equipment performance and cost in relation to need and available funds and manpower.

Since these machines are expensive, it is obvious that they must be kept busy. The drive to maintain a constant workload has brought about complicated and unusual intraorganization system configurations.

• **Busy tie line**—The Douglas company's unique coast-to-coast card transmission system has tied its Charlotte plant to the Santa Monica computer center, via the leased 2200-mile telephone cable, since March 1, 1960.

With Collins Radio Co.'s Kineplex card converters, data are transmitted at the rate of 100 cards/minute in one direction, 200 a minute in duplex operation.

In its work with the *Nike-Ajax, -Hercules,* and *-Zeus* missile family, the Charlotte plant frequently must relay problems to the West Coast IBM 704 or 709 computers for solution. Everything from missile trajectory calculations to thermal analysis, stress analysis, guidance and control studies and test data reduction has been handled by the computer center.

The long-distance system has been under a continuous heavy workload since its completion. The accompanying flow chart shows just what is involved in the Charlotte-Santa Monica transmission system and how equipments are associated.

Although the diagram tends to oversimplify, it should be noted that in the processing of each problem, the complete cycle back to originator requires 19 major tasks—and still effects a great time saving.

• **Typical problem**—Let's see how a typical problam is handled and exactly what time is saved:

Technical detail is urgently needed for a proposal. An aerodynamacist at the Charlotte plant must determine maximum-range trajectory for a new missile system—one similar in aerodynamic and propulsion characteristics to another missile previously simulated on a Douglas three-dimensional trajectory computer program. Principal differences are in propellant loading and payload.

The needed outputs are plots of proposed trajectory plus trajectory parameters and characteristics in the time domain. These data are needed by a staff artist within four days.

• **How it's solved**—The computer program requires processing the data in two phases: one pass requires a minimum of five solutions varying a control command parameter; the other, a single solution for complete trajectory output, using the control command valve for maximum range from the first five solutions and at least five additional solutions to establish unit effects of variations in aerodynamic and propulsion characteristics.

This means (1) transmitting the data for the first phase to Santa Monica, (2) waiting for return of the output before selecting the proper control command value, (3) transmitting the data for the second pass to Santa Monica, and (4) waiting for the computer output before beginning to prepare the final material.

Input values for the five solutions of the first pass are entered on the program data input loadsheets and submitted to the computing group at Charlotte on a Wednesday morning at eight o'clock. A standard job request form is prepared for scheduling and handling by computing.

In the computing group, a sequence number is assigned to the "urgent" request and the data on the loadsheets are transcribed to punched cards for transmittal to Santa Monica. After the data cards are proof-listed on an IBM 407 tabulator, which also accumulates control totals; the control totals are printed at the end of the listing. The listing is proof-read and the control totals are punched into a job trailer card. The data, now ready to be transmitted, consists of a transmit header, the data cards, and a control total card.

The data transmission operator at Santa Monica is called by phone. The operators complete their preliminary arrangements, the equipment is put in the ready status and transmission on the data is commenced. The data are sent in 100-card batches to expedite retransmission for error correction, should this become necessary.

Duplicate cards are produced automatically at the receiving end, listed and screened for input errors. These are then routed to the computer with a program, and they are processed. Results are again punched for transmittal and the information is returned at 10:00 A.M. to Charlotte, following listing, proofing, and the punching of a new control card.

After processing, the output is delivered to the originating engineer.

The aerodynamicist analyzes the first-phase output, selects the required value of control command parameter for maximum range, and enters it on loadsheets which have been completed except for the computer output. He submits the second-phase input at 8:00 A.M. Thursday to the computer group and the whole transmission-processing-transmission sequence is repeated.

Final results are returned to Charlotte at 10:30 Thursday morning. The aerodynamicist prepares his proposal material by Friday morning, with ample time for checking his work.

Comparison of Tie Line vs. Mail for Charlotte-Santa Monica Computer Solutions

Day	New Transmission System		Mail System	
	Date Submitted	Returned	Date Submitted	Returned
Wed.	8:00 A.M.	10:00 A.M.	8:00 A.M.	.....
Thurs.	8:00 A.M.	10:30 A.M.	.....	.....
Fri.	.....	.....	.....	12:00-4:00 P.M.*
Mon.	.....	.....	8:00 A.M.	.....
Tues.	.....	.....	.....	.....
Wed.	.....	.....	.....	12:00-4:00 P.M.*

*Depending on mail delivery.

• **Time comparison**—Before the data transmission system was installed, computing requests were handled by mail. The table compares handling times for the same job under the old mailing system and under the data transmission system. The gain is obvious and typical, according to Douglas—slightly over 1 day versus 1 week.

At one time, teletype and facsimile transmission facilities also were considered, but they proved to be inadequate, Douglas officials said, because of slower transmission rates, extra handling requirements, and overall increased job lag time.

Average card volume now is about 20,000/day. Full capacity for an 8-hr. shift is roughly 100,000 cards, according to Collins engineers. More advanced equipment will be added in 1961 to permit use of a Collin's magnetic tape-to-tape system for vastly increased volume and more rapid communication.

Top Reliability Sought in Minuteman Control, Guidance

Simplicity is keynote in Autonetics drive which demands that vendors steadily improve component performance

by Frank G. McGuire

DOWNEY, CALIF.—The integrated guidance and control system for the Air Force's *Minuteman* ICBM is a masterpiece of simplified design.

With emphasis on reliability through "pedigreed" parts and an uncomplicated marriage of mechanical and electronic subassemblies, Autonetics Div. of North American Aviation, Inc., is developing a G&C system that will work whenever needed.

In addition to incorporating guidance and flight control into a single, highly reliable system, nozzle control units for *Minuteman* combine hydraulics and electronics into one package. This is sealed upon leaving the Autonetics plant and requires no field adjustment.

Special features include:

• Elimination of external hydraulic lines through use of internally drilled channels.

• Employment of a common structure member for all four nozzle control units. This serves as heat sink and dissipater for the solid-state electronics, as well as a hydraulic reservoir.

• Use of etched and solid-state circuitry throughout. Amplifiers, modulators and similar subassemblies employ potted modules.

• Use of the missile guidance computer during ground checkout and test.

Developed by Autonetics, the nozzle control units have been successfully operated during silo tests at Edwards AFB, and have been delivered to all engine contractors in the program, for use in static tests. (Thiokol is producing the first stage, Aerojet the second stage, and both Aerojet and Hercules Powder Company have third-stage designs awaiting AF approval and contracts). The Autonetics system will be used on all stages of the missile.

The nozzle control units are a part of the missile flight control system, which also includes angular accelerometers for stabilization and angular sensors on the gimbal axes of the inertial guidance stable platform for attitude reference. A guidance computer package primarily performs the major computations of the guidance and control system.

During flight, each nozzle control unit governs deflection of an associated nozzle on each engine. Command signals from the computer are sent as DC voltages to the nozzle control units. These move the appropriate nozzle to direct the engine thrust vector.

Each nozzle control unit consists of a battery, hydraulic power supply, hydraulic servocylinder and associated electronics.

Hydraulic components and the amplifier assembly are mounted on a common structure which serves as a carrier for all the electronic assemblies and components of the nozzle control unit, as well as the hydraulic power supply.

In addition, it serves as a heat sink and dissipator for the electronics and hydraulic reservoir. No external hydraulic lines are used in this structural member, all hydraulic passages being internally drilled.

An effective cost-saving feature of the G&C system is that it uses the missile guidance computer and its associated circuitry to perform ground checkout and test functions for the entire system. This eliminates the necessity of designing and procuring separate ground support equipment. The computer itself is a high-speed, high-high-capacity, transistorized digital computer.

Principal Subcontractors

Beckman Instruments, an electronic unit; **Chance Vought Aircraft, Inc.-Elec. Div.**, electrohydraulic actuator assemblies; **Clary Corp.**, printer systems; **Corning Glass**, glass capacitors; **Daystrom Inc.-Pacific Div.**, displacement gyros; **Fairchild Semiconductor Corp.**, transistors; **Firestone Tire & Rubber Co.-Guided Missiles Div.**, program and monitor consoles (for testing flight control devices); **General Electric Co.-Irmo Div.**, foil tantalum capacitors; **Lear, Inc.**, north-seeking gyros; **Marquardt Corp.-Pomona Div.**, test consoles (for testing nozzle control units); **Motorola Inc.-Semiconductor Prod. Div.**, mesa transistors; **Pacific Semiconductors Corp.**, micro-diodes; **Potter Instrument Co.**, punched tape programmers; **Sprague Electric Co.**, solid tantalum capacitors; **Telecomputing Corp.-Cook Batteries**, silver-zinc batteries; **Texas Instruments, Inc.**, transistors; **Transitron Electronic Corp.**, diodes, silicon transistors; **Vickers, Inc.**, auxiliary power units; **Yardney Electric Corp.**, silver-zinc batteries.

• **Unprecedented reliability**—Autonetics's goal in this drive for extreme reliability is to raise component reliability levels by a factor of 100. This of course throws a heavy burden on the many vendors.

For example, Motorola's Semiconductor Products Div. is supplying Mesa transistors. These first production quantities must meet an estimated failure rate of less than 0.01% failure/1000 hrs. But ultimately Motorola must meet a failure rate of 0.0007%/1000 hrs. operation.

In its unprecedented effort to attain extreme reliability in the guidance and flight control system, Autonetics has been using closed circuit television to conduct classes on the production line aimed at educating its workers. An esprit de corps has been instilled in production personnel through repeated reminders of the vital nature of *Minuteman*.

Of the two million parts involved in the production, every one is serialized and a complete record is maintained of its test history. If an error is found in a complete or partially complete system during tests, the mistake can be traced back to the worker involved.

If the mistake is one of a series by that worker, a professional counselor talks with the employee and attempts to solve the problem by increasing his awareness of the possible consequences of such mistakes. A recurrent record results in re-training programs for the worker.

By the end of this summer, Autonetics expects to be using an IBM 705 computer to select parts from stock for assignment to various production line stations. In its efforts to minimize handling of parts, the firm has reduced the handling aspect to the lowest possible level. The parts are received mounted on boards which act as protective measures against damage.

Diodes are placed in "stabilized storage" where a carefully controlled trickle of current is passed through them for three months as a test of stability. A complete record of this test is maintained, and those diodes which vary beyond tolerable limits are rejected. Autonetics emphasizes that this is not a "burn-in" program for the components, but is instead a stabilized storage condition.

The company feels the reliability program on *Minuteman* electronics is rigid enough to qualify as the most advanced in Space Age electronics. The principal effort is to raise the mean time between component failures to as high a level as possible, in order to minimize repair and maintenance requirements on the missile while it lies dormant in its silo.

Navy Demonstrates Hydroskimmer Ship

A new high-speed over-water vehicle—with potential applications from missile launchers to aircraft carriers—was demonstrated by the Navy last week. Called the "Hydrostreak", the vehicle operates on an entirely new technological concept.

Such a craft could be built to almost any size and with a speed capability of 100 knots or more, according to Navy engineer. It could find use as an ASW craft or in any number of high-speed sea applications.

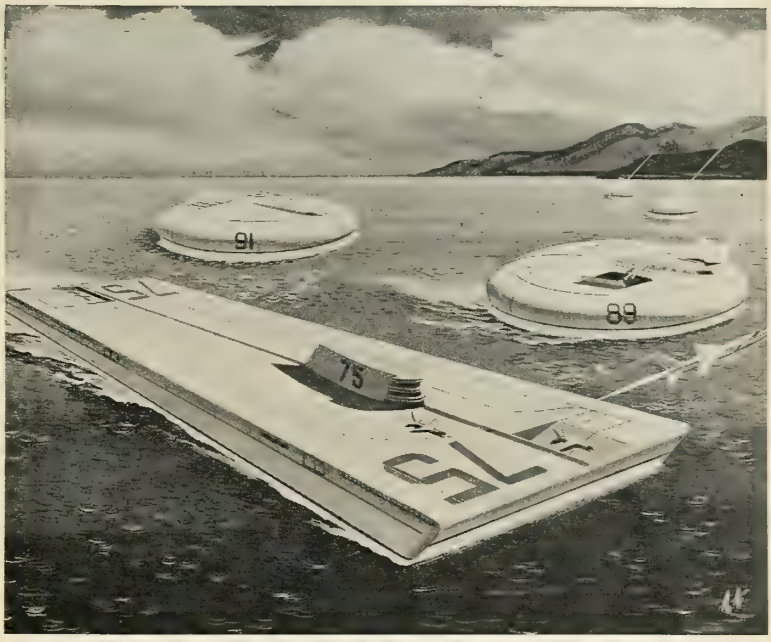
Hydrofoil ships—in which the Navy is currently showing great interest—are believed to be limited under the present state of the art to about 65 knots and 500 tons. There are those who feel that these limitations can be extended somewhat further. The hydroskimmer, however, could conceivably extend the operating parameters into an entirely new area—closing the gap between ships and aircraft.

Similar in some respects to air-cushion, or "ground-effect" machines, the hydroskimmer differs in the application of this principle. The craft uses a "water-wall" to confine the air cushion directly underneath the hull—and therefore requires considerably less power. The water is scooped up from the sea and pumped down in a sheet from nozzle bars at the forward and after ends of the vessel. The prototype craft uses only two water-walls, with solid fins on each side extending down into the water and forming the confining walls. Later models will use water-walls on all four sides.

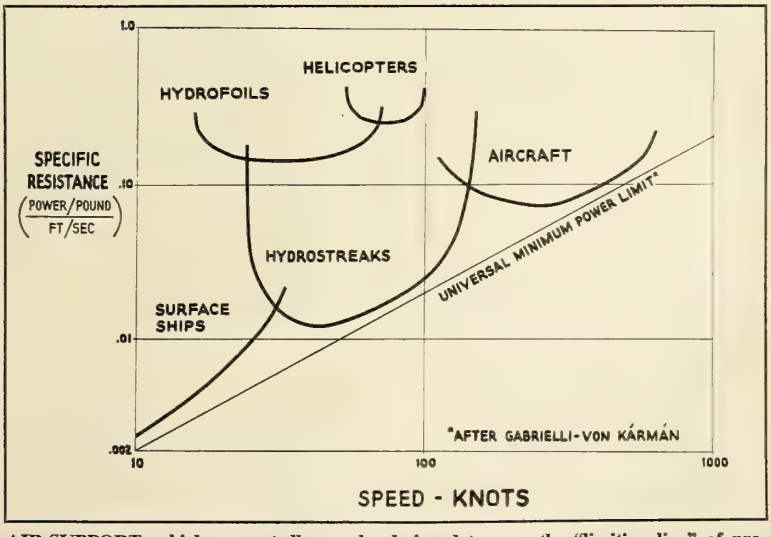
Propulsion for the prototype is furnished by two propellors driven by 80-horsepower outboard engines. A third engine drives a fan to provide the suspending cushion of air. Water jets, turbojets, or even aircraft propellers may be used to propel future models.

The water-wall principle and the experimental Hydrostreak were developed by Hughes Aircraft Division under a Bureau of Ships contract.

The Navy said that this was the first in a series of such craft being developed to evaluate various methods of supporting vessels on air cushions to overcome the limitations in speed and efficiency of surface-supported craft.



HUNDRED-KNOT over-sea missile launchers and 70-knot aircraft carriers are possible Navy applications of new hydroskimmer principle. The circular missile craft, as conceived by Hughes Aircraft engineers, would be 400 ft. in diameter.



AIR-SUPPORT vehicles reportedly can be designed to near the "limiting line" of propulsion system efficiency established by Gambrielli and Von Karman. The concept is considered highly efficient; more efficient devices are unlikely in near future.

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Drone Helicopter Drops Torpedoes on Radio Command

A pilotless helicopter carrying two dummy torpedoes for ASW work and controlled by radio link was demonstrated recently for the chiefs of naval operations of Latin American countries.

Gathering for a Key West meeting of the Inter-American Naval Conference, the participants saw a Kaman HTK drone sent from a control station aboard the USS Hazelwood to a target where, upon command, the drone dropped its missiles.

The company reported that the HTK has been flown by remote control by persons without pilot training and with only a few hours' instruction. The craft is easy to manage, according to Kaman, and "winch-down technique makes it possible to effect landing on pitching decks and has been accomplished in winds of more than 30 knots and with the ship rolling 25 degrees in each direction."

The company pointed out that in addition to carrying weapons, the drone could be used for bearing detection equipment for sub location, for testing for radioactivity in presumed "hot" areas, and for getting visual evidence of damage by way of a television link.

Survey Ship Pioneers Ocean Probing Equipment

Pioneering development of equipment and techniques for oceanographic investigation is being carried out aboard the Survey Ship Explorer (OSS-28).

The ship is cruising from Seattle to the East Coast via the Panama Canal, on the most comprehensive oceanographic expedition undertaken by the U.S. Coast and Geodetic Survey since the early 1880's, when the Coast Survey Ship Blake made surveys of great historical value. The expedition is supported in part by the National Science



ARTIST'S CONCEPTION shows torpedo-carrying capability of HTK drone helicopter.

Foundation. A dozen or more research organizations are participating.

Observations have been made at positions off the coast of Oregon by the Scripps Institution of Oceanography, cooperating with Oregon State College. At each station water samples were taken to study the distributions of salinity, dissolved oxygen, phosphate, and temperature. Other important data were collected to determine the oceanographic regime, or makeup. In addition, surface water samples were taken, and the suspended sediments will be studied to determine what becomes of Columbia River water once it enters the Pacific Ocean.

A magnetometer, provided by Scripps at San Diego, Calif., was towed behind the Explorer to record continuously the earth's magnetic field along the ship's course. This information, when studied in connection with documented data on bottom topography, will add to man's knowledge of the intricate magnetic field of the earth. If the magnetometer discovers unsuspected or unexplained magnetic "hills" or "valleys," the ship's plans are flexible—extra time can be taken to survey the area in more detail.

Scientists from the U.S. Navy Electronics Laboratory, San Diego, have brought along deep-sea camera equipment for photographing the ocean bottom off the West Coast of Central America. They will attempt to prove photographically whether or not the ocean bottom at this location is covered with 80 to 100% nodules of manganese, high in nickel and cobalt.

Lear Develops Watertight Servos for Ryan Q2C Drone

Electro-Mechanical Division of Lear, Inc. has developed unusual watertight servos for the Ryan Q2C drone, which allow it to be used even after being brought down on water.

Major watertight packaging problem was in the elevator and aileron servo actuators, part of the drone's automatic flight control system. The servos—which provide up to 15 cycles per second—had to be able to move freely within their housing, yet be protected from sea water.

The servos also had to withstand rapid pressure buildup during a 3000-ft.-per-minute descent from 60,000 ft. to sea level, violent shock on impact with water, total submersion in water and a rapid temperature decline on immersion, with attendant contracting of the metal.

Lear engineers used a single joint casting, sealed with an aluminum gasket using a molded rubber insert, protecting the output shaft with a double lip seal, hermetically sealing all connectors, and impregnating the entire casting to eliminate porosity.

Fast Braking

Fins Stop Sled in First Full Firing

Aerodynamic braking fins developed by the Northrop Corp. stopped a rocket-propelled monorail sled traveling 2688 mph in less than 25000 ft. at the Holloman AFB captive missile test track last week.

The finned sled was tested at peak velocity for the first time by firing all three of the system's single-stage solid *Javelin* rockets developed by the Grand Central Rocket Co.

Initial deceleration causes the fins to open about two inches. Then they are fanned out to full braking capacity by wind blast. The 23-in. fins are prevented from being ripped off by a hydraulic snubber cylinder which dampens initial shock.

The sled will be used to test components of inertial guidance systems, according to Lt. Col. Donald H. Vlcek, Chief of the AF's Missile Development center at Holloman.

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U.K. Skybolts Far From Operational

Watkinson says Britain will take part in all phases of development but won't manufacture whole missiles

LONDON—Defense Minister Harold Watkinson has warned Britons that it will take at least another full year of development work to determine whether the Douglas *Skybolt* air-launched ballistic missile project will prove successful.

Speaking on his return from the United States, where the Anglo-American deal on *Skybolt* was settled, Harold Watkinson made these other points:

• Britain is not yet heavily involved financially on the *Skybolt*. "We shall be spending money on developing the prototype environment (i.e. the equipment needed) to fit the *Skybolt* to the Vulcan Mark 2 bombers, and designing the warhead for the missile, but decisions about total cost, numbers and price per missile do not really arise at this moment, until we see much more clearly what the final result may be."

• Most of the work will be done by Douglas Aircraft, with British teams participating. Another British team will be in the Washington Weapons Research Projects Office, watching progress. Britain, in fact, will participate in every phase of the development of the missile, along with SAC.

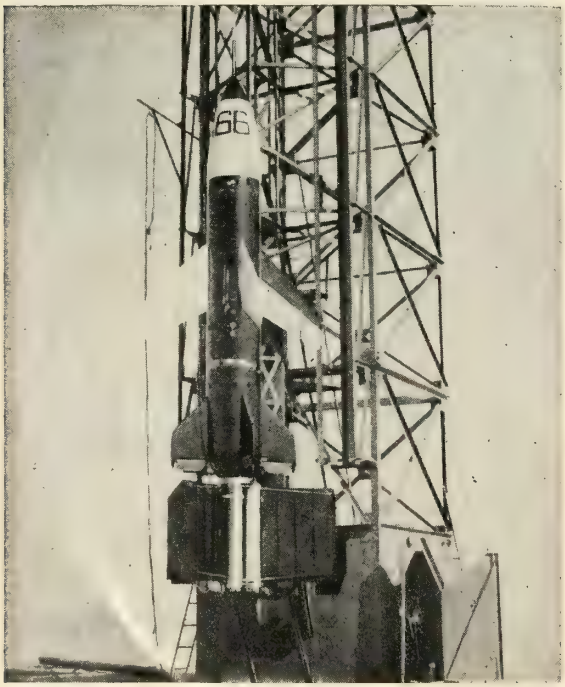
• In the meantime, Britain is accelerating development of the Avro *Blue Steel* guided bomb, which has "further development potentialities." It is not yet decided what missile will go on the Handley Page Victor bombers, according to Watkinson. He may decide soon to put another weapon onto the Victors—a British weapon, of which no details are yet available.

• Britain has already ordered some dummy *Skybolt* missiles in order to help it start its work. Britain will make its own warheads, and may also make some other parts of the missile, but there is no intention of making the whole missile in Britain under license. "That is exactly what I want to avoid doing," says Watkinson.

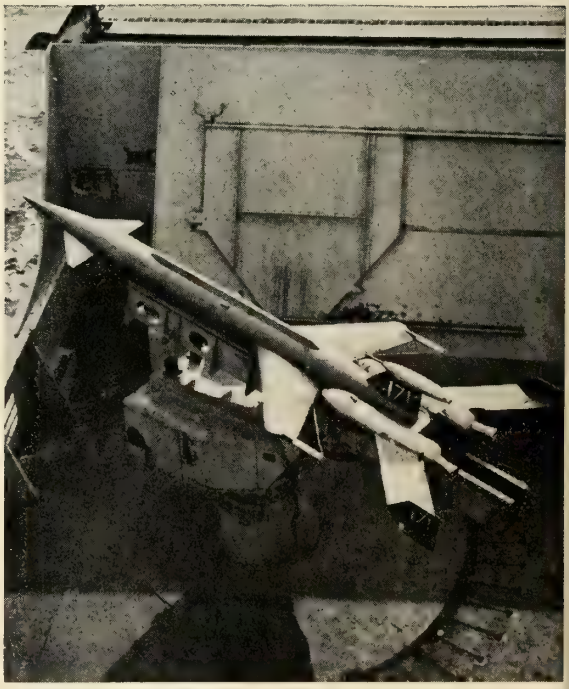
• During his U.S. trip, Watkinson also studied the *Polaris* Fleet Ballistic Missile, and is keeping a continuing watch on its development. So far, no decision has been taken on Britain buying *Polaris* as well as *Skybolt*, but this move may be in the cards for some future date.

British public reaction to the Anglo-American *Skybolt* agreement has been generally favorable. In general, it is thought to be common sense for the two countries to join in developing the missile and thus make the most of the investment in manned bombers, provided the weapon does fulfill all expectations.

Solid-boosted French Missiles



SUD AVIATION'S S.E. *4100* **surface-to-air missile was recently declared operational. The weapon has six solid-fueled boosters.**



FRENCH NAVY'S *Maruca,* **the fleet's most versatile test missile, is a ship-to-air weapon using four solid S.E.P.R. boosters.**

names in the news

Dr. Edward B. Doll: Vice president of Space Technology Laboratories, Inc., appointed director of the company's Systems Engineering Division, with overall responsibility for *Atlas, Titan* and *Minuteman* systems engineering and technical direction.



DOLL

G. Denton Clark: Named manager of the RCA Missile Test project at Cape Canaveral involving range instrumentation acitivities operated by the firm's service company.

Michel J. Fliegler: Appointed chief engineer, Potentiometer Division of Analogue Controls, Inc. Was formerly head of the potentiometer branch of Ketay Dept., Norden Division, United Aircraft Corp.

C. K. Fulton: Elected sales manager of Missile Defense Equipment in General Electric's Heavy Military Electronics Dept.

Maj. Gen. Eugene P. Mussett (USAF-ret.): Named site integration manager for The Martin Co. at the *Titan* ICBM base, Ellsworth Air Force Base, Rapid City, S. Dakota.

Ronald Toms: Formerly director of Wiancko Aeronautics, joins Electro-Optical Systems, Inc., as a senior scientist in the Fluid Physics Division.

James M. Beggs: Named manager of Westinghouse Electric Corp.'s new weapon control department, organized to centralize responsibility for all aspects of the weapon control subsystem of the Navy's new *Typhon* fleet anti-air warfare system.

John C. Christian: Named manager of Ford Motor Co.'s Defense Products Group's newly established Boston office. Was formerly manager of marketing for Space Technology Operations at Ford Motor Co.'s Aeronutronic Division and prior to that staff consultant, market development, at Hughes aircraft Co.



CHRISTIAN

Claude A. Brosterhous: Joins Ford Motor Co.'s Aeronutronic Division as assistant manager of systems test and prototype fabrication for tactical weapon systems operations. Was formerly chief engineer, Coleman Engineering Co.

Melbourne A. Forrest: Named a vice president of Burns and Roe, Inc. He will continue being responsible for the firm's operations in power, nuclear, and industrial facilities, in addition to defense and aeronautical projects.

R. S. Saye: Appointed project engineer for *Thor* systems at Douglas Aircraft Co., succeeding **H. M. Thomas,** named *Saturn* program manager. Other *Thor* project appointments are **D. E. Brimley,** assistant chief project engineer; **H. J. Heckman,** project engineer, field station testing; and **W. H. Hess,** project engineer, missile ground support equipment and contract requirements.

A. E. LeVan: Elected vice president-research and development for American Machine and Metals, Inc. Was previously in charge of research and development at the company's U.S. Gauge Division.

Dr. Wayne Masters: Holder of 15 U.S., patents, named manager of the Antenna Laboratory at Melpar, Inc. Was previously with Boeing Airplane Co. where he supervised the Antenna and Solid Dielectrics Research Groups, and prior to that was an advanced development engineer with RCA.



MASTERS

Pacific Semiconductors, Inc., elects **Lawrence T. Lindgren,** vice president, manufacturing; **Dr. John W. Peterson,** vice president, research and development; and **Sidney L. Spiegel,** vice president, marketing.

Paul S. Dove: Former manager of Allen B. DuMont Laboratories, Inc.'s Washington, D.C. office, joins the Washington staff of Stromberg-Carlson Division of General Dynamics Corp.

Dr. Emanuel R. Piore: Elected IBM's vice president-research and engineering. Prior to joining the firm in 1956 was vice president in charge of research for the Avco Manufacturing Co.

Joseph L. Morgan: Appointed to the newly created position of advertising and promotion manager, Remington Rand Systems Division, Sperry Rand Corp.

Robert J. Lodge: Elected manager, engineering test, for the Rocketdyne division of North American Aviation, Inc., replacing **W. J. Cecka,** appointed assistant to the president in charge of Rocketdyne Specialty Products.

Joseph Stanley: Appointed engineering manager of Meletron Corp., succeeding **Jim Slough,** assuming the duties of Quality Control manager.

Carl C. McCallus: Elected director of marketing for U.S. Relay-Electronics, a division of American Safety Razor Products Co. Was formerly sales manager of the Electro-mechanical division of Hoffman Electronics Corp.

E. H. Livingston: Former American Bosch Arma Corp. contracts marketing manager, named marketing manager-radar at The Crosley Division, Avco Corp. Electronic Systems and Equipment Operation.

Charles J. Disser: Former chief electrical engineer for Telex, Inc., joins the staff of General Magnetics, Inc., as senior electrical engineer.

Kurt Ehrismann: Appointed chief product engineer at Filters, Inc., with responsibility for design and production of the company's complete line of relays.

James R. Conto: Named to the newly created post of vice president in charge of marketing for the Standard Rectifier Corp. Formerly served as general sales manager of International Rectifier Corp.

Charles C. Colozzi: Elected president of the United States Gasket Co., Plastics Division of Garlock Inc., succeeding **A. J. McMullen,** who resigned in order to devote full time as president and chief executive officer of Garlock Inc.

Ernest A. Laufer: Previously with Bell Aircraft Corp., appointed a senior electronics engineer at Hoover Electronics Co.

Dr. Victor J. Young: Elected vice president of Hazeltine Corp.'s Electronics Division. Before he joined the firm in 1949, Dr. Young was in charge of radar, undersea detection and recorder projects for Melpar, Inc. and the Sperry Gyroscope Co.



YOUNG

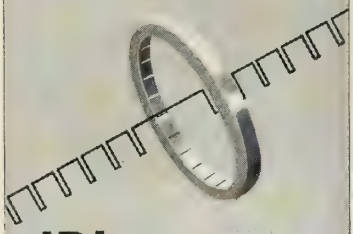
Leland E. Wells: Former director of engineering for Exide Industrial Division of The Electric Storage Battery Co., promoted to vice president-engineering of the division.

Dr. Chou H. Li: Former senior scientist at Shockley Transistor Corp., appointed head of the Materials and Techniques Research Group at General Transistor Corp.

James G. Wenzel: Named coordinator of antisubmarine warfare programs for General Dynamics Corp., replacing the late **Walter V. R. Vieweg.** Previously served as engineer with Convair.

Gerhard L. Hollander: Appointed manager of newly formed general-purpose computer department at Hughes Aircraft Co.'s ground systems group, was formerly section manager, systems management and control computer systems, Philco Corp.

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contracts

NASA

United Technology Corp., for design, fabrication and testing of three experimental conical solid-propellant rocket engines. Amount not disclosed.

$131,800—**Leon H. Perlin Co., Inc.**, Newport News, Va., for services and materials for modification of existing gust tunnel.

$106,926—**Doyle and Russell**, Norfolk, Va., for services and materials for auxiliary launching pad at Wallops Station.

NAVY

$23,600,000—**Raytheon Co.**, Waltham, Mass., for additional production of *Sparrow III* missiles.

$3,100,000—**Raytheon Co.**, Waltham, for continued research and development on the *Sparrow III*.

$2,082,215—**Aerospace Division, Boeing Airplane Co.**, Seattle, Wash., for construction of the Navy's first hydrofoil warship, a 110-ft. patrol craft displacing 115 tons and expected to be armed with advanced ASW missiles. **J. M. Martinac Shipbuilding Corp.**, Tacoma, Wash., will assist in construction of the vessel.

$580,000—**Aerojet-General Corp.**, for exploration of a "hybrid" rocket combining liquid and solid propellants.

$110,000—**Bulova Watch Co., Industrial & Military Products Division**, Jackson Heights, N.Y., for warhead fuzes for *Zuni* rockets.

$60,000—**National Engineering Science Co.**, Pasadena, for feasibility and design study related to large propellants and propulsion systems.

$47,900—**General Instrument Corp.**, Newark, N.J., for conducting a research program on semiconducting compounds for thermoelectric generator.

$44,580—**Ampex Data Products Co.**, Los Angeles, for magnetic tape recorder/reproducer system.

$43,142—**Power Generators, Inc.**, Trenton, N.J., for engineering services for development and certification tests of recovery system for *Polaris*.

$32,842—**Robert W. King Construction Co.**, North Hollywood, Calif., for construction of Project NERV launch support facilities, Point Arguello.

$27,284—**Stanford Research Institute**, Menlo Park, Calif., for feasibility study of optical cement for *Sidewinder* missile.

AIR FORCE

$3,600,001—**Olin Mathieson Chemical Corp.**, Baltimore, for propellants.

$3,500,000—**Union Carbide Corp.**, Lawrenceburg, Tenn., for facilities for research and development of graphite.

$1,511,210—**Fairchild Semiconductor Corp.**, for a silicon transistor reliability improvement program for *Minuteman*. Subcontract from **North American Aviation, Inc.'s Autonetics Division.**

$630,195—**Nortronics Systems Support Div., Northrop Corp.**, Anaheim, Calif., for ballistic cameras and ancillary equipment.

$412,718—**International Business Machines Corp.**, New York City, sequentializers and switching devices.

$250,000—**The Martin Co.**, Orlando, for GAM-83 guidance equipment for F-105D type aircraft.

$200,000—**Bohanan Manufacturing Co.**, Compton, Calif., for quick disconnects to be used on the *Atlas* silo program. Subcontract from **Convair.**

$122,328—**University of Utah**, Salt Lake City, for research on "pressure dependence of mechanical properties of metals and ionic and valence crystals."

$80,000—**Republic Aviation Corp.**, for test and development of leakproof connections or seals for fluid power systems used in future flight vehicles.

$79,601—**Hughes Aircraft Co.**, Culver City, Calif., for missile checkout equipment.

$47,400—**Massachusetts Institute of Technology**, for continuation of research on "study of interactions among burning fuel droplets and their effects on combustion stability and roughness."

$43,705—**Potter Pacific Corp.**, Malibu, Calif., for propellant loading control.

$42,845—**General Electric Co.**, Syracuse, N.Y., for electron tubes.

$41,000—**University of Delaware**, for research on "Oxidation of Metals and Alloys."

ARMY

Hogan Faximile Corp., a subsidiary of **Telautograph Corp.**, for a high-speed digital plotting recorder. Amount not disclosed.

$24,408,000—**Raymond International, Inc., Henry J. Kaiser Co., Macco Corp.**, and **Puget Sound Bridge & Drydock Co.**, for construction of *Atlas* launching sites near Plattsburgh, N.Y.

$8,777,222—**Radio Corp. of America**, Moorestown, N.J., for design, fabrication and delivery of one instrumentation tracking radar.

$2,070,346—**Airtemp Div., Chrysler Corp.**, Dayton, Ohio, for range finder.

$1,950,000—**Raytheon Co.**, Waltham, Mass., for engineering services on the *Hawk* missile system.

$1,150,557—**Chrysler Corp.**, Detroit, for the *Redstone* missile program.

$668,103—**H. B. Zachry Co.**, San Antonio, for *Hawk* training facilities.

$96,700—**Continental Technical Service, Inc.**, Dayton, for technical non-personal engineering services in connection with design, development and testing of rocket motors, airframes, launchers, guidance system and related equipment.

$95,752—**Douglas Aircraft Co., Inc.**, Santa Monica, for repair parts for *Nike-Hercules*.

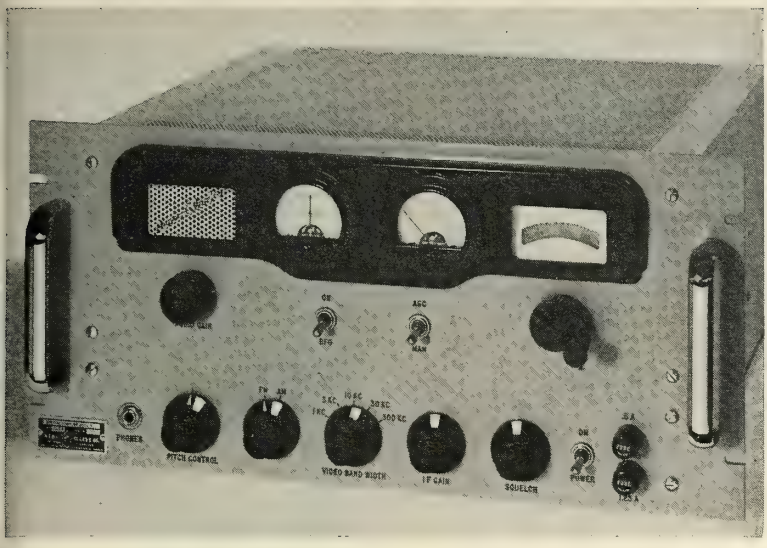
$59,121—**Building Mart**, El Paso, for *Nike-Zeus* facilities alterations.

$43,730—**Douglas Aircraft Co., Inc.**, Santa Monica, for *Nike* repair parts.

$40,240—**Packard Bell Computer Corp.**, Los Angeles, for components for high-speed digital simulator.

$37,829—**Rocket Power, Talco Div., Gabriel Co.**, Mesa, Ariz., for basic research entitled "thermodynamics of reactions involving the light metal oxides and propellant combustion gases."

$30,000—**Electro Optical Systems, Inc.**, Pasadena, for research and development on solar energy concentrators and their integration into space power systems.



Telemetry Line Introduced

Two new items and a new receiver series to fill out its line of special-purpose telemetry receiving equipment have been put on the market by Nems-Clarke, a division of Vitro Corp. of America.

These include type 1500 series VHF range receivers and a type 2501 special purpose receiver (all 55-260 mc), type PR-203 215-260 mc preamplifier, and a type PBS 10-push button switch.

The 1500 series receivers (7 types) are designed for FM, AM, and CW operation in the VHF range and for use in telemetering, missile monitoring, and other high-performance applications. Receivers offer high stability (AM output varies 7 db max. for input change of 40 db) and high sensitivity (4 μv produces 23 db S/N min. with 100-kc deviation, 1-kc modulation). Noise figure varies for the 7 receiver types: either 6, 11.5, or 13 db max. IF bandwidths similarly vary from 175-500 kc.

The 2501 receiver is AM-CW in 55-260 mc range. Standard 19-in. rack size, it is 8.75 in. high x 15 in. deep and draws 70 watts. Antenna and reference input impedances are 50 ohms nom., noise figure of 6 db max. at antenna input. Sensitivity: 2 μv 30% AM at 1-kc for 10 db S/N. Audio response ±3 db from 0.5 — 25 kc.

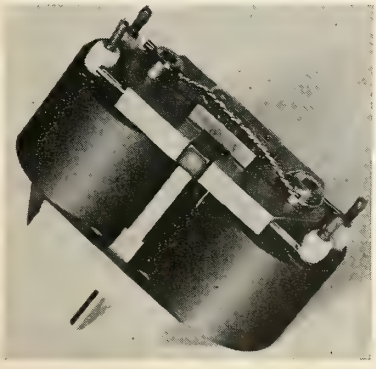
A weather-proofed, pressurized, PR-203 preamplifier eliminates moisture problems. Time losses up to 6 db decrease receiver sensitivity less than few tenths of a db. Offering uniform response within 3 db over frequency range, unit has improved receiver noise figure by from 3.5-4.5 db (assuming lossless lines). Gain is 22-db min. in pass band.

Circle No. 225 on Subscriber Service Card.

Polarized Torque Motor

A high-temperature, electromagnetic polarized torque motor with an operating capability up to 1250°F is now being produced by the Bendix-Pacific Division.

The unit is designed for continuous duty at elevated temperature. It provides a proportional output force and/or motion with input current up to 0.010 in. linear stroke, and a torque output of 0.017 inch pounds at 1200°F. Tests indicate an operating life of at least 20 hours under these conditions, including approximately 7 million full amplitude output motions.



double-throw switch is 5 amps at 30 volts dc. Switch weight is .006 lbs., operating force 3 to 5 oz., dimensions ¼ by ½ by ¾ in.

Circle No. 226 on Subscriber Service Card.

Single-Shot Epoxy Resin

A high strength one-component modified epoxy resin adhesive that permits easy application techniques and provides unlimited working life for bonding high-volume metal and plastic structural assemblies is now available from Adhesives, Coatings and Sealers Division, Minnesota Mining and Manufacturing Co.

SCOTCH-WELD Brand structural adhesive EC-1595, a one-component adhesive, contains a latent hardener which eliminates the need of accurately weighing and mixing a hardener with the base resin at time of use. The adhesive will not harden before curing operations are performed.

This adhesive provides metal-to-metal bonds, with shear strengths of 2500 psi at 75°F, maintains high strength over a service temperature range of minus 67°F to plus 300°F and exceeds requirements of MIL-A-5090B (Class A) and MIL-A-8431 (Type 1) specifications. It has high creep resistance under constant stress, exceptional adhesion to metals and plastics, and excellent resistance to water, 20% salt spray, hydraulic oil and aromatic fuel.

Circle No. 227 on Subscriber Service Card.

Mesa Transistor

A 30 mc amplifier Mesa transistor has been introduced by Motorola Semiconductor Products Division.

The 2N741, as it is designated, is a germanium PNP diffused junction transistor in a TO-18 (3-lead, .100 in. pin circle) package with collector connected to case. A vacuum bake-out at 200°C and a stabilization bake for a minimum of one week at temperatures in excess of 100°C help assure the stability of the device.

Circle No. 228 on Subscriber Service Card.

Semiconductor Furnace

A furnace apparatus for semiconductor preparation and growing single crystal materials has been introduced by Marshall Products Co.

The apparatus consists of two or more tubular furnaces, according to the material's requirements, mounted on a common axis. This permits zone refining, directional freezing or slow crystallization, seeding, and crystal

growing in the quartz work tube which runs through all furnace chambers.

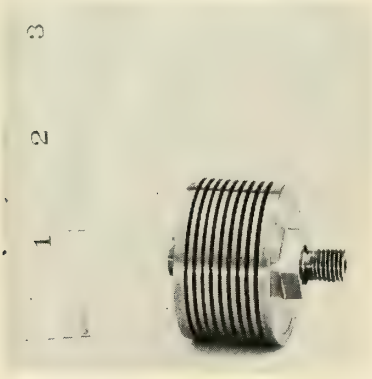
Each furnace is supplied with sufficient shunt taps to establish any reasonable temperature profile within the chamber. Sharp temperature gradients between adjoining units may be established by adjusting furnace spacing.

Once adjusted for the correct spacing, the furnaces can be driven as a unit on ball bushings along the support stand at speeds between 1/8 in. and 6 in. per hour as desired. Stroke length is limited only by the support stand chosen.

Circle No. 229 on Subscriber Service Card.

Cryogenic Sensory Bellows

A lightweight, sensory bellows for airborne applications has been made available by Hydrodyne. Its principal application to date has been in LOX pressure regulation, although it is also suitable for other applications.



It is fully machined, not formed, and designed for a maximum pressure differential of 100 psi and a temperature range of −450°F to +1000°F. The bellows are available in aluminum, stainless steel, nickel alloys, and other materials. Hysteresis is almost zero due to the machined bellows design.

The units are available in an infinite range of diameters and strokes.

Circle No. 230 on Subscriber Service Card.

'Explosion-proof Chamber'

An explosion test chamber designed for temperature operation to +200°F and altitudes to 100,000 feet is being manufactured by Itemco Inc. The explosive atmosphere is attained with propane gas or high octane gasoline.

The chamber body and door are certified at 300 psi operating pressure and 450 psi hydraulic test.

The facility is complete with temperature, altitude, and fuel mixture controls, relief valves which automatically compensate for altitude, and sampling chamber to check and prove the explosiveness of the fuel mixture prior to the operational test.

Circle No. 231 on Subscriber Service Card.

Container Relief Valve

A lightweight, highly sensitive low-pressure container relief valve, P7-637 is available from James, Pond & Clark, Inc. The P7-637 performs two functions: First, by maintaining slight internal pressure in the container, it prevents free breathing that would result in the condensation of moisture or the entrance of foreign material. Second, it maintains an equilibrium between external and internal pressures to prevent explosion or implosion of hermetically sealed containers.

The P7-637 features an exceptionally high flow capacity—with a 1 psi cracking pressure it will pass 50 scfm at an inlet pressure of 2 psi.

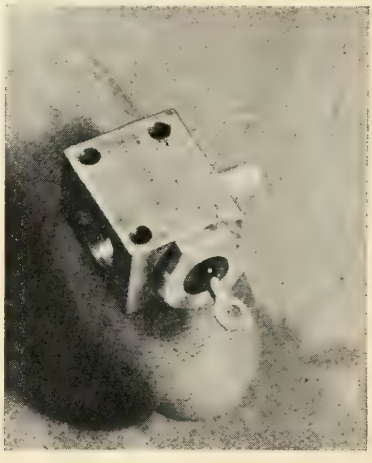
When closed, the P7-637 maintains a dead tight seal to retain a positive internal container pressure. The valve is suitable to protect airborne shipping containers as well as storage containers.

Circle No. 232 on Subscriber Service Card.

Subminiature Actuators

A low-cost family of ballistic actuators is now available from Propellex Chemical Division, Chromalloy Corp. Small, rugged, and with specific energy output, these units are ideal for subminiature applications.

Models have either push or pull action, in a range of predetermined strokes, and force outputs to 25 lbs. Various electric firing characteristics can be provided. The body of the unit measures 0.5 x 0.6 x 0.38 in. and weighs 4 grams without leads. It has a stroke of 1/16 in., and offers a force output of 3 lb. The actuator fires at 28 v, from an energy input of 15,000 erg.

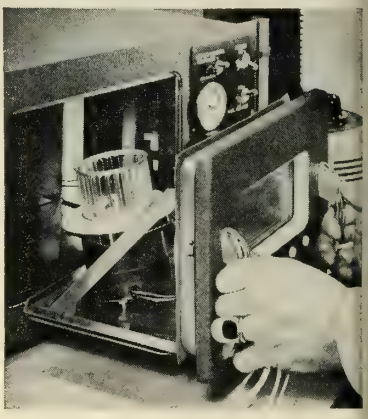


Circle No. 233 on Subscriber Service Card.

Rapid Cycle Chamber

Delta Design, Inc. has perfected an ultrarapid cycling chamber to expedite the testing of various electronic devices and components.

According to the firm, the chamber is capable of completing a hot-cold cycle within the −100°F to +500°F range in slightly less than 10 minutes, thereby materially reducing the time required for such environmental testing.



Circle No. 234 on Subscriber Service Card.

Optical Wedge Available

A simplified method for measuring displacement in vibration testing is available without charge from MB Electronics, a Division of Textron Electronics, Inc.

The "optical wedge" is a pressure-sensitive wedge-shaped sticker that can be affixed to a flat surface on the object under test. The long axis of the wedge should be exactly perpendicular to the axis of vibration. Then, as the wedge vibrates with the piece under test, two triangles will appear. Displacement is indicated on the scale directly below the point of the darkest triangle.

Circle No. 235 on Subscriber Service Card.

Sealed Tunnel Diodes

A series of germanium tunnel diodes, introduced by Philco Corp., are hermetically sealed and designed for low-level switching and small signal applications. Peak point current is closely controlled providing a peak to valley ratio of 8 to 1. Typical per-

formance shows peak voltage of 55 millivolts and a valley voltage of 320 millivolts.

The units exhibits low series inductance of one millimicrohenry and low series resistance of one ohm.

Measured frequency of oscillation is over 1500 megacycles. The new diodes are packaged in shortened, hermetically sealed transistor cases having thin bases and alloy contacts and featuring a specially designed outer tab of triangular configuration.

Circle No. 236 on Subscriber Service Card.

High Temperature Motor

The latest addition to the line of special motors at Airborne Accessories Corp. is the HM420 Type Hi Temp Motor designed for an ambient temperature range of −65° to +600°F. This motor was originally developed for Mach 3 aircraft but is now being offered to the electronics industry.

Nickel-clad copper wire windings are used, insulated by glass impregnated with a specially developed high-temperature additive. Similar problems have been solved in the case of bearing material, stator plating, soldering, etc.

Circle No. 237 on Subscriber Service Card.

Differential Voltmeter

A true differential DC vacuum tube voltmeter capable of 1% accuracy throughout the scale is being marketed by The Decker Corp. Model 410 unit features a zero center scale with full scale ranges of ± 0.3, 1.0, 3.0, 10, 30, and 100 volts DC, and a single input impedance of 20 megohms and 40 megohms differential. In transistorized circuitry the instrument readily provides off-ground readings without loading. The 410 also can be used as a unit cathode follower, having an open circuit gain of .85 which can be varied in definite steps by the input divider maintaining the input impedance with an output impedance of 1000 ohms.

Circle No. 238 on Subscriber Service Card.

Formable Ceramic Powders

Corning Glass Works has developed two ceramic powders that can be formed into shapes used in hot tooling —Corcast and Cortamp.

First applications will be as tools, jigs and fixtures in the aircraft and missile industry, where shaping of exotic metals requires great heat and pressure.

Users of the powders form the shapes they want—when and where they desire. No separate firing is required. Bonding occurs in use. Temperature capabilities go up to approximately 2500°F and 4000°F.

Circle No. 239 on Subscriber Service Card.

Epoxy Casting Compound

A non-burning, self-extinguishing, flexible epoxy casting compound has been developed by the laboratory of Hysol Corp.

Hysol 15-032 is a two-component, filled epoxy casting system recommended for use on transformers and other electronic and electrical parts.

"Non-burning" under ASTM D635-56 T and "self-extinguishing" according to MIL-I-16923C and MIL-T-27A tests, Hysol 15-032 Flame-Out Epoxy Casting System is also flexible and can be used as embedding material when required to meet thermal shock conditions.

A section of the cured material snuffs out immediately upon removal from the flame.

Circle No. 240 on Subscriber Service Card.

Readout Timing Devices

A line of precision stepping devices (Series 18200) featuring digital counter or dial readout and variable settings has been introduced by The A. W. Haydon Co. Units are designed to perform monitoring, indicating and/or control functions.

Included in the new stepping line are predetermined and remotely settable pulse counters and interval timers. These operate only on the number of pulses received, not incremental changes in voltage or phase angle. With accurate power supply, switching precision is equal to the pulse source itself. Haydon's new units are suitable for application in automated production equipment, military and commercial control systems and laboratory timing devices.

Circle No. 241 on Subscriber Service Card.

Stainless Welding Wire

Stainless steel welding wires for use with the submerged arc welding process are now being marketed by Air Reduction Sales Co.

Chemical composition of the stainless wires rigidly conforms to the A.W.S. and A.S.T.M. standards for corrosion-resisting and chromium nickel steels. These rigid standards provide close control of the amount of ferrite in the weld deposit.

Automatic stainless steel welding wires are available for use with 308, 309, 310, 347 and 502 stainless, in 25 and 50 pound coils. Each coil is carefully thread-wound to facilitate unwinding, and a constant controlled tension is maintained during coiling to assure a neat coil that will support itself and keep its designed shape and dimensions.

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editorial . . .

More Money for Samos and Midas

After much backing and filling, Congress finally is on the road to increasing the funding of *Samos* and *Midas,* the reconnaissance and early warning programs.

Although both projects were admittedly proceeding at minimal paces, Congress first added, then took away and finally added again—leaving the final decision up to a conference between the two houses.

The chronology of the effort went like this:

On April 6 the Air Force asked for $26.4 million for *Midas* and $35 million for *Samos-Discoverer,* a total of $61.4 million.

On May 18 Deputy Secretary of Defense James Douglas testified that these funds were sufficient to finance both programs and that DOD needed no more money. At the same time he added the programs were "at minimum."

Early in June the House looked over the programs and added $54 million.

A little later in June the Senate Defense Appropriations Subcommittee cut off this $54 million.

And a little later still, on June 11, Mississippi's Senator John Stennis in full committee moved successfully to add $83.8 million for *Samos* alone, thus restoring the $33.8 million House addition for *Samos* plus $50 million—but not restoring the $20.2 million House addition for the closely-related *Midas* and *Discoverer* programs.

That is the way the matter stands until conference between the Senate and the House. It is reasonable to predict that some addition to the two programs will be made.

The next point is whether or not the Administration will make use of the money to speed up the programs. Congress can give and Congress can take away, but Congress cannot force the Defense Department to use the money.

In light of the facts that the *Midas* could double our warning time on the launching of an enemy ballistic missile, and that *Samos* would make archaic all previous forms of reconnaissance, including the U-2, it would seem to most observers that speed in their development is essential.

Americans On IAS Program

Two Americans, one a scientist and one an international or perhaps interplanatory attorney, will participate in symposia at the International Astronautical Society meeting this August in Stockholm. And both symposia are of considerable interest to us.

Dr. Fred Singer, professor of physics at the University of Maryland, will conduct a panel on the use of small rockets for space exploration —actually in an effort to urge smaller nations to enter the space field in this manner. Since most of these smaller nations do no rocket manufacturing of their own, they would have to purchase them on the world market.

Attorney Andrew Haley, former president of the IAS and general counsel for the present meeting, will participate in a panel on the "Sovereignty of Outer Space," a topic which, in the light of the recent U-2 incident, has a particular significance for all Americans.

Clarke Newlon

Advanced hot gas systems delivered by AiResearch

FOR OUTER SPACE, ATMOSPHERIC AND UNDERWATER STEERING



AiResearch is now in production on two greatly simplified hot gas steering control systems: a reaction control system for outer space flight stabilization and a hot gas actuator control system for terrestrial steering (in the atmosphere and under water).

Both systems eliminate any need for pumps, heat exchangers, accumulators and other apparatus required in earlier control systems. And both systems utilize hot gas, operating off either the main engine or a separate fuel source.

The gas in the outer space reaction control system is fed into a set of nozzles which imparts spin to the missile to stabilize its flight through space.

In the terrestrial hot gas actuator control system the gas is fed into an on-off controlled linear actuator which moves the fins controlling the missile's attitude in the atmosphere or under water. This system also utilizes a concept developed from the AiResearch hydraulic "printed circuit." This approach eliminates complicated plumbing, thereby decreasing the weight and increasing the reliability of the system.

AiResearch is a pioneer, leading developer and manufacturer of hot gas systems and other nonpropulsive power systems for atmospheric, underwater and outer space missions. Your inquiries are invited.

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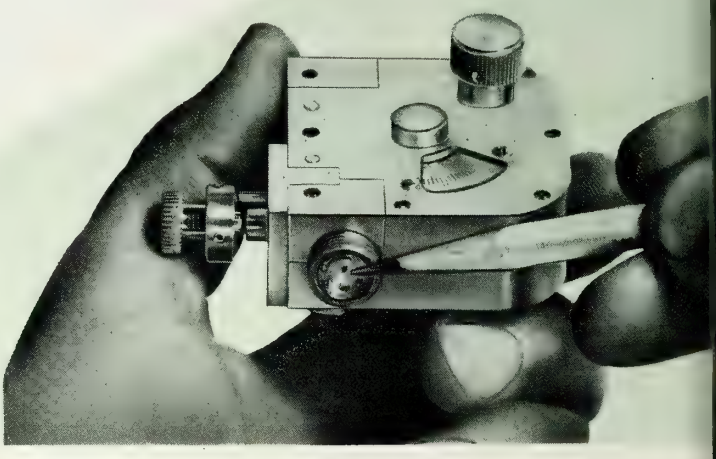
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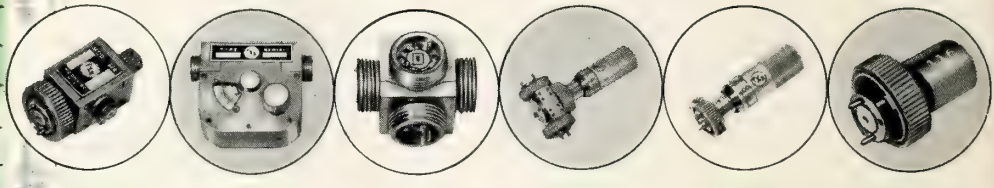
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JUNE 27, 1960

missiles and rockets

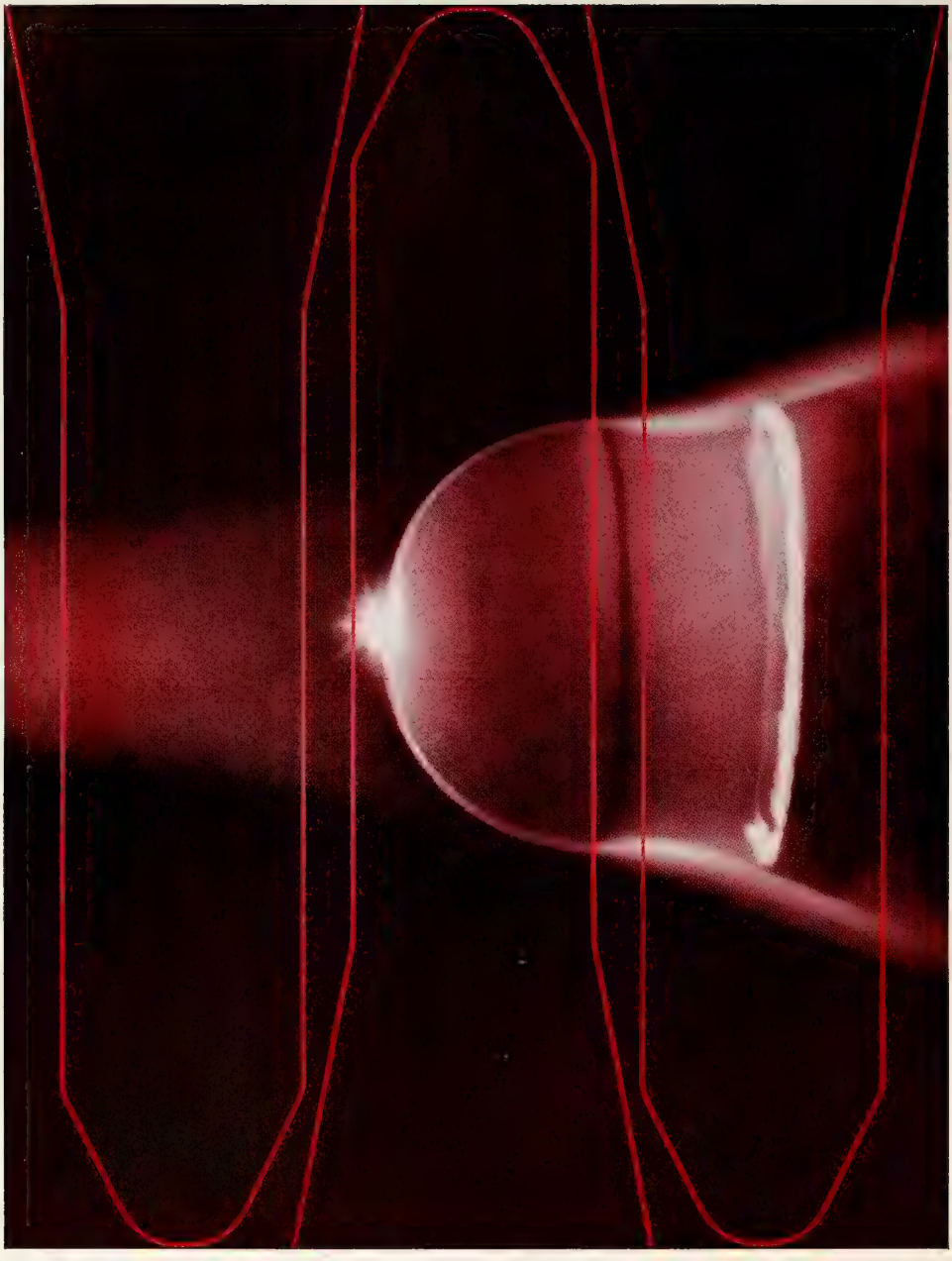
THE MISSILE/SPACE WEEKLY



ASROC—Navy's Newest ASW Weapon

SPECIAL REPORT: Revolution in Drones . . . 19

AN AMERICAN AVIATION PUBLICATION



Blasting new materials to make missile nose cones. The first ICBM nose cone ever to be recovered after flight was protected by a new, high-temperature material. Its name: Avcoite. Its construction: specially reinforced ceramic. Avcoite was the first of a family of new heat-shielding materials. They were developed for re-entering nose cones and satellites by Avco's Research and Advanced Development Division. Newest addition to this materials family is Avcoat, a plastic heat-shield here ablating smoothly in a hydrogen-oxygen jet simulating satellite re-entry temperatures.

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Expanding the Frontiers of Space Technology in

GROUND SUPPORT EQUIPMENT

Ground support equipment development at Lockheed Missiles and Space Division has encompassed an unusually broad area, ranging from the problems involved in the unique water environment of the Navy POLARIS FBM to the more conventional land-launched missiles and satellites.

Thus, the Division is involved in the design, development and operation of shipping, handling, assembly, checkout, erection and launch control units and systems in all their mechanical, electrical and electronic aspects.

Electrical and electronic equipment designed by the Division includes items tailor-made to checkout missile subsystems before flight; the major portion of electrical equipment used at the launch pad; the complex equipment needed to receive and record telemetry flight data; and such mechanical ground handling equipment as fuel handling and transfer units, transporter erectors, handling dollys and trailers, mobile servicing and handling units, and rolling stations. One such special digital comparator system checkout known as ACRE/Flight Test, developed by Lockheed, saves from 10 to 15 thousand man hours in final checkout of each missile, allowing complete checkout in approximately one-fourth the time needed by other methods.

Excellent opportunities are available at Lockheed in this rapidly growing field for personnel experienced in mechanical, electrical and electronic design; packaging; instrumentation; digital computer programming and analysis; modification and checkout; ground handling equipment; controls and communication; circuitry; prototype fabrication; test; and air conditioning.

If you are experienced in one of the above areas, or in related work, we invite your inquiry. Write: Research and Development Staff, Dept. F-29B, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.



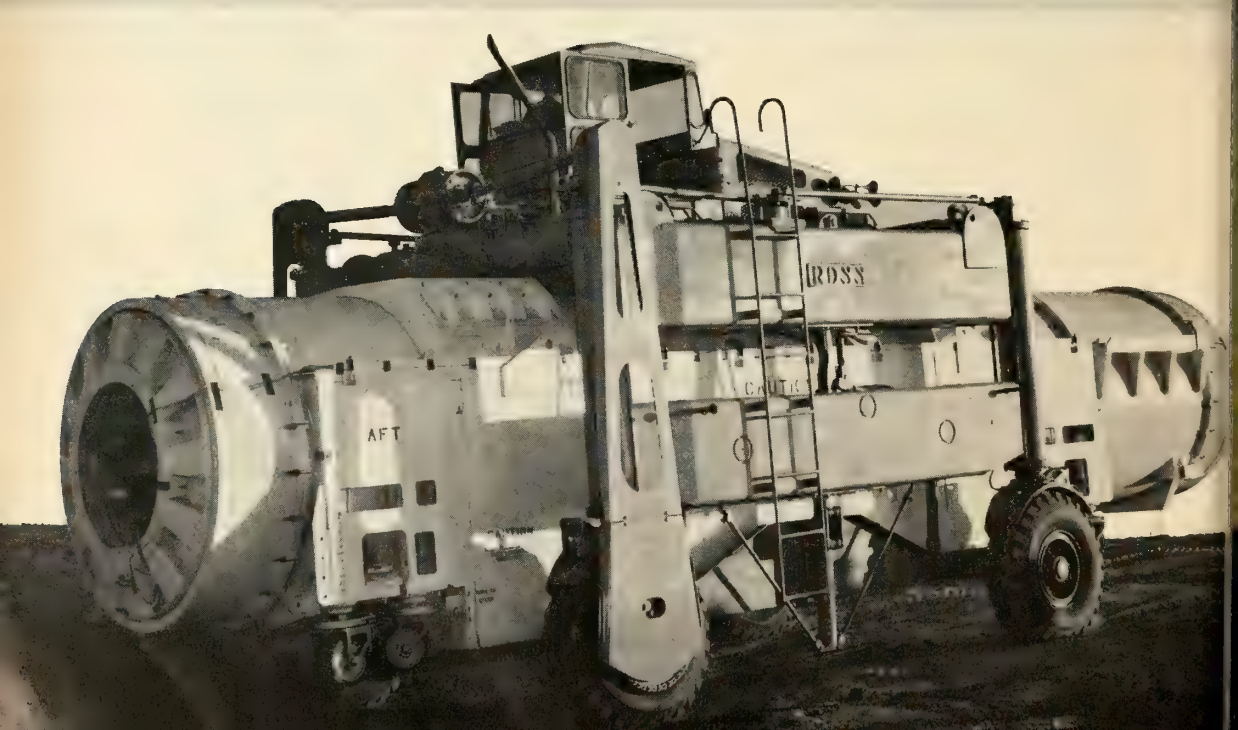
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missiles and rockets

June 27, 1960 Volume 6, No. 26

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THE COVER

ASROC poised ready for loading into a launcher aboard USS Norfolk. The Minneapolis-Honeywell missile is now officially operational. See report on p. 9.



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VERSATILE SD-2 SURVEILLANCE DRONE SYSTEM BY AEROJET

Designed for night and day battlefield surveillance, the Army's improved SD-2 Surveillance Drone System is an all-weather eye in the sky. In situations of general or limited warfare, the SD-2 provides the field commander with up-to-the-minute information on enemy activities. A product of Aerojet's Aeronautical Division at Downey, California, this versatile drone system features greatly improved performance and mission capability. Advanced flight testing is taking place at the Army's test station near Yuma, Arizona.

The current model carries the Army's latest sensory devices, including radar, infrared, photo transmission equipment, and high speed cameras. Stability in flight is excellent, making camera stabilization unnecessary and reducing system complexity and cost. Flight of the vehicle and subsequent recovery by parachute are remotely controlled, or supplemented by an on-board programer.

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ROUND THE CLOCK SURVEILLANCE

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WASHINGTON

Samos—How Soon?

Target date for an operational Air Force *Samos* reconnaissance satellite at present is understood to be late 1963. However, COUNTDOWN is told by highly-reliable congressional sources that additional funds could shorten the development time by as much as a full year. This is still a long wait for a replacement of the sidelined U-2.

Operational Subroc Near

The Navy now expects to deploy *Subrocs* aboard the new nuclear-powered attack submarine Thresher by early next year. The Goodyear antisub missile will be launched from submerged killer submarines, fly from the water and plunge back again on enemy subs at ranges of 30 miles or more.

Fencing the Question

Management of the U.S. satellite detection "fence" will be assigned to the North American Air Defense Command, according to Washington rumors. Such a decision would resolve the Air Force-Navy battle for control. But it still would leave up in the air responsibility for research and extension of the system.

V-Bombers over Florida

RAF V bombers will join SAC bombers and tankers in R&D test launchings of the Douglas *Skybolt* down the Atlantic Missile Range. The British and U.S. planes involved in the tests will be based at Eglin AFB, Fla. The British are buying 100 *Skybolts* at $560,000 per copy.

Bigger Bang for Polaris

The Navy is considering the possibility of boosting the punch of the *Polaris* warhead. Presumably the bigger-megaton wallop would be designed for the advanced 2500-mile *Polaris* now under development.

Eavesdropping the Candidates

Sen. Stuart Symington is assuring friends that he will get the Democratic presidential nomination—IF Sen. Kennedy doesn't.

INDUSTRY

Off to the Field

Under ARDC's reorganization much of the technical staff at headquarters in Andrews AFB, Md., is being shifted to field commands where its skills will be put to more direct use. One office already has been pared from eight to one technical man.

Storable Survey

Coming soon—a contract award from Edwards AFB, Calif., for a complete survey of storable liquid propellants. Every major propulsion company is said to be hot on the trail of this one. The winner presumably will have an in on all future AF switches to storables.

Rectifier Prices Halved

General Electric's slash in rectifier prices is expected to chain-react in the semiconductor industry. Cuts are in three lines: 10 and 16-amp silicon-controlled rectifiers—47% off; 10% amp inverter series—51% off. All are used extensively in power supplies for electronics and control distribution systems, plus a variety of commercial uses.

New Interest

The new Celanese Corp. rocket venture—Amcel Propulsion Inc.—is expanding its interests to include storable liquid fuels and composite solids, in addition to its work in double-based solids. Heading up the research staff is Dr. Clayton Huggett, former research director for Rohm & Haas at Redstone Arsenal and later at Philadelphia.

No Target for Zeus

Army officials are still looking for targets with which to test the *Nike-Zeus* AICBM. They say the *Zeus* is ready but no full-scale missile or reasonable facsimile is available to try it on.

INTERNATIONAL

GE-Nord Sign SS-11 Pact

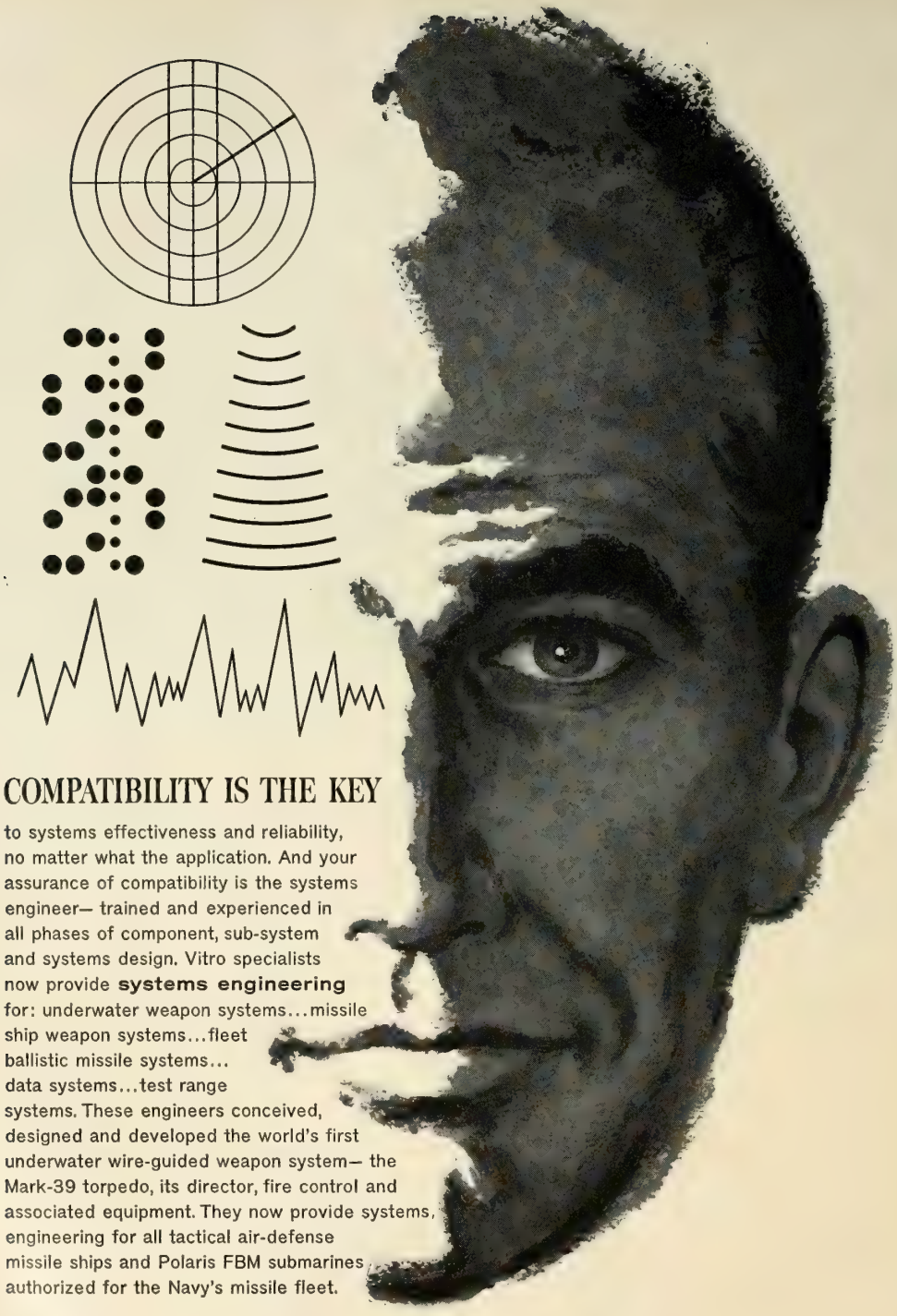
General Electric and Nord Aviation have signed a 10-year agreement giving GE a license to produce *SS-10* and *SS-11* wire-guided antitank missiles in the U.S. The agreement (M/R, May 2, p. 44) is expected to prelude a substantial buy of the missiles by the American Army.

Swedish Falcons

Sweden is getting ready to produce air-to-air *Falcon* missiles under a licensing agreement with Hughes Aircraft.

Franco-Italian IRBM

SISPRE of Italy is being approached by SEREB of France on the design of an IRBM. The two organizations also are discussing the possibility of joint production of an American missile under license.



COMPATIBILITY IS THE KEY

to systems effectiveness and reliability, no matter what the application. And your assurance of compatibility is the systems engineer— trained and experienced in all phases of component, sub-system and systems design. Vitro specialists now provide **systems engineering** for: underwater weapon systems...missile ship weapon systems...fleet ballistic missile systems... data systems...test range systems. These engineers conceived, designed and developed the world's first underwater wire-guided weapon system— the Mark-39 torpedo, its director, fire control and associated equipment. They now provide systems engineering for all tactical air-defense missile ships and Polaris FBM submarines authorized for the Navy's missile fleet.

SCIENTISTS AND ENGINEERS: JOIN THIS TEAM.

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ASROC Becomes Navy ASW Haymaker

Some 150 ships to get missile during next few years; first public evaluation exercise shows high capability

by James Baar

ABOARD THE DESTROYER LEADER NORFOLK—The trim *ASROC* antisubmarine missile is to become the new big punch of the Navy's ASW forces.

A total of 150 destroyers and cruisers are scheduled to be armed with *ASROC*'s within the next few years.

Navy missile experts disclosed the plan this last week as they officially declared the *ASROC* operational. They called the 15-foot Minneapolis-Honeywell missile the greatest ASW weapon to be developed in the last decade.

They conceded that a few adjustments were still needed. But they said the problems were nothing that would prevent proceeding into full production.

ASROC's already are prepared to go to war aboard the Norfolk and the destroyer Peary. Soon they are scheduled to be installed aboard the new destroyer leaders Preble and Dewey.

The missiles will be deployed aboard more than a dozen additional destroyer leaders, at least several cruisers, and a large number of newly rehabilitated destroyers by 1962. An informed source says that with sufficient financial backing the deployment of *ASROC*'s can be pushed at the rate of three a month.

Total installation costs are expected to be about $270 million—$1.8 million per ship. The missiles themselves cost about $22,000 each.

• **Potent and available**—*ASROC*'s deployment places on U.S. surface warships for the first time a weapon considered capable of effectively meeting the coming threat of the fast deep-diving nuclear submarines that Russia is reported to be building.

The Navy has other potent ASW weapons such as *SUBROC* under development. But these are not considered anything that would rapidly outmode *ASROC*—and they suffer from the failing of not being immediately available to fill the Navy's gaping ASW defenses.

ASROC's most important feature—its effective range—is secret. However, the missile is estimated to be capable of destroying a nuclear submarine at ranges up to about eight miles, compared to the 900-yard range of *Weapon Alfa*, the ASW rocket-boosted depth charge.

• The range of the *ASROC* missile can be increased considerably to match expected increases in the effective range of the *ASROC* system's submarine detection sonar—Sangamo Electric's SQS23.

• The effectiveness of *ASROC* can be increased by making its payload more potent—an improved homing torpedo or a nuclear depth charge.

"Just as is it's amazing," one former destroyer commander said. "You ought to see the faces of submarine skippers when we smack them at these ranges. They never heard of anything like it."

No major world power other than the United States has developed an ASW weapon considered to approach *ASROC*. The closest Russia is reported to have come is a rocket roughly comparable to *Alfa*.

All NATO countries have received information on *ASROC* and some—particularly Britain—are expected to be interested in buying it.

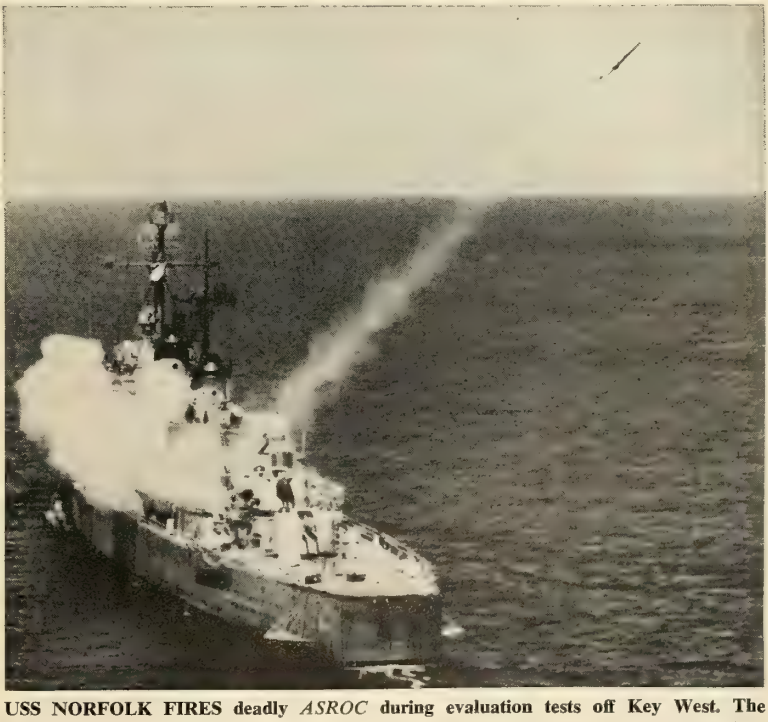
• **Premiere**—The Navy publicly revealed the capabilities of *ASROC* for the first time in a day-long evaluation exercise in the Atlantic some 50 miles southeast of Key West, Fla.

Navy crewmen of the USS Norfolk launched a total of four *ASROC*'s against the submerged nuclear-powered submarine Skate.

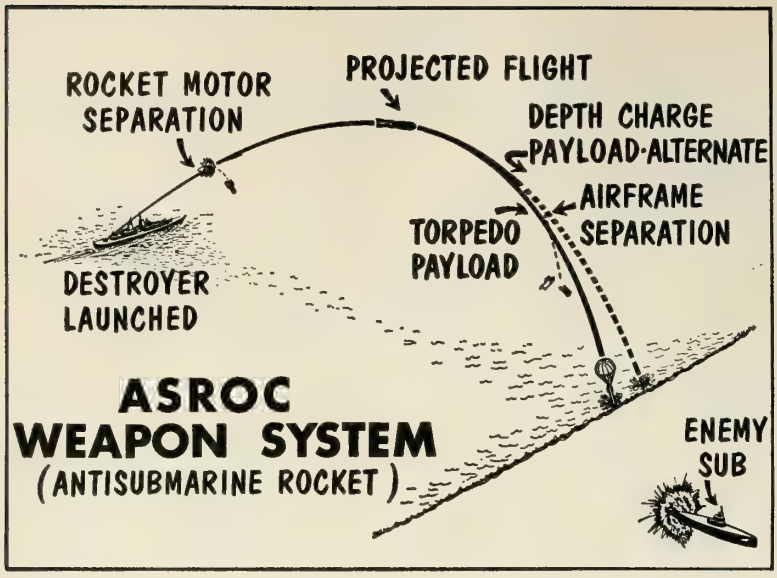
The Skate made three runs on the 7200-ton Norfolk as she cut through the warm southern sea with the destroyer, The Sullivans, trailing at her stern. Navy helicopters taking part in the evaluation tests hovered in the area.

On the first and second runs—both described as short-range tests—the *ASROC* sonar obtained fixes on the Skate at ranges of about 2500 yards.

Each time an orange *ASROC* roared into the hot June sky in seconds. The solid-propelled booster separated with a flash of flame about five second later and the warhead—a General Electric Mark 44 torpedo—arched toward the sea. About two seconds before it hit, an airframe fell away like



USS NORFOLK FIRES deadly *ASROC* during evaluation tests off Key West. The now-operational missile is unofficially estimated to be effective up to eight miles.



a banana skin and a small parachute shot out, slowing the torpedo's fall.

The Mark 44, the Navy's most advanced operational homing torpedo, shed the parachute and a protective nose covering as it entered the sea and began searching for the Skate.

• **Two for four**—Navy evaluators said preliminary reports showed the torpedo would have hit the Skate the first time if the torpedo had not automatically ceased operating as planned. They said it appeared to miss the second time.

The Norfolk fired two *ASROC*'s at the Skate when the submarine made its third run. This time the range was more than 4000 yards.

The two inert Mark 44's were not preset to cut off this time. Navy evaluators said early information indicated that one hit the submarine and the other may have.

Development of *ASROC*—A direct descendant of the defunct Navy missile program called *Rat*—began in 1956 under the direction of the Navy Ordnance Test Station and an industry team headed by Minneapolis-Honeywell.

The missile itself is powered by a single-based solid propellant developed by the Navy during World War II. The same booster can easily be coupled with the Mark 44 torpedo or a depth charge casing made by Minneapolis-Honeywell.

ASROC Fact Sheet

Name:	**ASROC (contraction of antisubmarine rocket)**
Dimensions:	**Length, 15 ft.; missile diameter, 1 ft.; overall diameter, 2½ ft.**
Weapon Weight:	**Approximately 1000 lbs.**
Speed:	**Nearly Mach 1**
Developed by:	**Naval Ordnance Test Station, China Lake and Pasadena, Calif., technical direction of development program.** **Minneapolis-Honeywell Regulator Co., Ordnance Div., Duarte, Calif., and Hopkins, Minn., prime contractor**
Principal Subcontractors:	**Librascope Div., General Precision, Inc., Glendale, Calif., fire-control and attack console.** **Universal Match Corp., Armament Div., St. Louis, launcher.**
Sonar Detection:	**Sangamo Electric.**
Payload:	**GE, torpedo; Minneapolis-Honeywell, depth charge.**
Development Cost:	**About $65,000,000.**

• **Backstopping control**—The fire control system—a development of the Librascope Division of General Precision—is one of the first to use a digital computer on shipboard. The system is housed in a control room below the launching deck.

The control room is manned by two fire control men, two sonar men and an officer. They launch the *ASROC*'s from there once the ship's captain has thrown a fire switch on the bridge.

The only other crewmen needed to operate the *ASROC* system are two gunnery mates who visually monitor launchings from a control room directly behind the launcher. A gunnery mate can launch a missile from his post should a breakdown occur elsewhere.

• **Fast reloading**—The launcher—developed by Universal Match—is unique. It resembles a modified pepper box gun.

Eight square shafts in rows of four hold the *ASROC*'s ready at all times for launching. Each pair of two shafts can be elevated separately and the entire box-shaped launcher can be swung in an arc of about 300 degrees.

Small doors cover the front end of each shaft. A plastic-coated disc protects the rear of each shaft from rain and the sea.

The doors are opened several seconds before a launching. The plastic-coated discs are blown out by the launching blast.

The launcher can be reloaded swiftly and extra *ASROC*'s will be stored on larger ships in light aluminum shipping containers. Reloads can be easily provided for smaller vessels from supply ships.

• **"Very satisfied"**—More than 200 test launchings were conducted during the development of *ASROC* before it was turned over to the Navy for evaluation this spring.

ASROC's were successfully launched from a platform moving at 30 knots at the NOTS test area at China Lake, Calif. Dummy payloads were launched into water at Morris Dam, near Azusa, Calif. Other dummy payloads were dropped from airplanes into a hydrophone range off San Clemente Island in the Pacific.

The Navy's evaluation tests through June included only *ASROC*'s carrying the Mark 44 torpedo. A series of tests with depth charge-carrying *ASROC*'s is planned next.

"We're very satisfied," one Navy test officer said. "What we're doing now is looking for trouble spots and working the thing so that we can say to a skipper—'Buster, here's your system. Here's what it will do.' "

The consensus among the test officers was that *ASROC* can do plenty

Two Satellites Orbited in One Shot

A navigational satellite system to give pin-point accuracy to *Polaris*—firing submarines last week took a major step toward its 1962 operational date with the first simultaneous orbiting of two satellites—one of them *Transit IIA*.

A third R&D navigational satellite —the *Transit IIB*—is expected to be launched in three to four months. It will carry the same basic instrumentation, but will be placed in a different orbit (20-25° angle of inclination to the equator).

Transit IIA, launched June 22, involved an almost perfect orbital injection and equipment response.

Transit IIA Statistics

LAUNCH VEHICLE 2-stage Thor-Able Star: 79.3 ft., 52.5 tons at lift-off. **1st stage:** 160 sec. burning time. **2nd stage:** 300 sec. total burning time (285 sec. initially, 18 min. coast, then restart for final injection into orbit). **Total weight in orbit:** 1500 lbs.

TRANSIT IIA **Size:** 36-in. dia., 223 lbs. **Orbit:** apogee, 563 statute mi.; perigee, 400 statute mi.; inclination, 65 degrees ($2^{1}/_{2}$ degrees low); period, 101.5 min.; approx. life, 50 yrs.; operating life, 5 yrs. (designed).

INSTRUMENTATION: 2 ultra-stable oscillators (54 or 325 and 162 or 216 mc); infrared scanner (measures spin-rate); digital clock (for precise timing); galactic-noise receiver (Canadian-3.8 mc); antenna, spiral silver paint. **Power:** silicon solar cells—2 circumferential banks; Nickel-cadmium storage batteries.

RADIATION SATELLITE **Size:** 20-in. dia., 42 lbs. **Orbit:** slightly higher and slower than Transit IIA; operational life, 1 year. **Instrumentation:** transmitter AM/FM-108 mc carrier, 10 channels; command receiver (to kill xmtr.); antennas—4 rigid tubes, spring-erected; two ion chambers for radiation measurement (Lyman-alpha and X-rays below 8 Angstroms). **Power:** silicon solar cells—6 patches, total 936 cells; 12-volt storage battery (9-cell).

Transit IA, a partial success, failed to orbit Sept. 17, 1959, when the third stage did not ignite. It did, however, reach planned altitude.

Transit IB, launched last April 13, was a complete success and is still transmitting data. Besides proving feasibility of the Doppler navigation-aid concept, it successfully demonstrated (1) injection and separation of the piggyback dual-satellite using a dummy second payload, (2) the despin action of its flying weights, and (3) the restart capability of Aerojet-General's *Able-Star* second-stage rocket engine.

• **Siamese satellites**—Housed within the second stage, the 3-ft. dia. *Transit IIA* was connected to a 20-in. sphere by a cable, clamp, and set of explosive bolts. The smaller satellite, developed by Naval Research Laboratory, Washington, to measure solar radiation, was separated from the second stage with the *Transit* vehicle after orbital injection. Shortly afterward, the exploding bolts effected separation and a spring propelled it upward and away from its bigger cousin.

Being in a higher orbit, its angular velocity is slower—separation rate is about 1 ft./sec.

• **Three-pronged experiment**—Although this is primarily a continuance of the navigational-aid satellite research program directed by Johns Hopkins Univ.-Applied Physics Lab. for the Navy, two other experiments are being conducted.

To perfect Doppler navigation, which is the basis of the *Transit* concept, NRL devised the smaller payload. Accuracy of Doppler measurements is affected by ionospheric perturbations and radiation intensity.

Instrumentation in the piggyback capsule will measure the Lyman-alpha hydrogen resonance line and the X-ray spectrum below 8 Angstroms. These are the only ionizing radiations penetrating the earth's atmosphere believed degrading to radio propagation.

Included within *Transit IIA* instrumentation is a receiver for measuring galactic-noise. This package was developed by the Defense Research Telecommunications Establishment (DRTE) of Canada.

The Canadian equipment will be shut down in one week when satellite spin is stopped by releasing despin weights.

• **Operational system-1962**—If all goes well, the operational *Transit* system will use four satellites, two at 22° and two at 67° inclination with each pair located on either side of the orbital path.

It is hoped that a 0.1 mile accuracy can be obtained with the operational satellites.

Shipboard equipment for use with the navigation system is now in parallel development. In mass production, eventual cost estimates vary from $2-4 thousand per ship, said the Navy.

Titan II to be static-fired in Silo

An entirely new testing procedure will be attempted with the storable liquid-fueled *Titan II*. The larger follow-on version of the *Titan* will be static-fired in its silo.

First in-silo static tests are scheduled later this year at Vandenberg AFB. Disclosure of this first attempt to run an ICBM's engines underground came after the Air Force awarded an initial $8-million contract last week to The Martin Co. for *Titan II*.

No design details of the *Titan II* silo have been disclosed. However, the one at Vandenberg—now virtually complete—has a double-ring configuration. The exhaust of the missile, which stands inside the inner ring, is deflected to the outer ring and vents above ground. This is a considerably simpler approach than earlier-suggested U-shaped silos which involved the digging of a separate vent tunnel.

If the in-silo static firing proves successful, it will mean that the Air Force would be able in wartime to reload the *Titan II* silos and fire more than one shot, although as yet no provision has been disclosed for reloading any ICBM launching pads. Combat missilemen could also use them for on-base training.

Principal features of the *Titan II* missile—expected to be operational in 1963—will be:

• A propulsion system being developed by Aerojet-General using storable hypergolic propellants (nitrogen tetroxide and a 50-50 mixture of UDMH and simple hydrazine).

• An all-inertial guidance system being developed by the AC Spark Plug Div. of General Motors.

• A greater payload capacity allowing for flights of 9000 miles or more, or heavier payloads.

The switchover to storable propellants eliminates fueling and "topping-off" operations during launch, and allows the missile to be fired from its underground silo. The *Titan* must be elevated to the surface for launching.

Possibility of enemy jamming is diminished by use of the all-inertial guidance system, though such systems thus far have not attained the accuracy of the radio-inertial system in present use.

The contract gives a permanent place to *Titan* in the nation's missile deterrent force. Mishaps in testing the first *Titan* series earlier this year had brought demands for the program's cancellation in favor of the *Atlas*.

The advanced *Titan II* will be deployed in the seventh *Titan* squadron and thereafter. So far, sites for two squadrons of *Titan II* have been announced at Davis-Monthan AFB, Tucson, Ariz., and two squadrons at McConnell AFB, Wichita, Kan.

Air Force Claims It Will Double Research Spending

Smarting from charges that it is allowing basic research to wither on the vine, the Air Force has produced figures to show that it will double spending in this area to $70 million by FY 1965.

Despite the figures, however, some question persists over whether the money would go into increased basic research or, through some semantic twist, actually be channeled more into applied research.

At the core of the controversy is the Air Force's Office of Scientific Research. Long the center of pure research sponsored by the Air Force, OSR has been made one of the operating elements of the Air Research and Development Command's newly organized Research Division. This, in the eyes of some OSR scientists, amounts to downgrading their function.

OSR Commander Col. A. P. Gagge recently protested in a memorandum the withdrawal of 10 technical vacancies, which reduced his staff to 89. He called this an indication that "a decision has been made to curtail AFOSR's responsibilities and that a new future for it is in the planning."

Adding to the dispute is a somewhat blurred line between "basic" and "applied" research, and apparently different interpretations by some Air Force officials of what direction each should take.

• **Tied to management**—In FY 1960 the initial basic research request was $34 million. This was increased to $43 million, largely through additional support for a hi-gauss magnet research facility. The 1961 budget calls for $42.1 million—a $7-million increase over the original request for this current year.

Maj. Gen. William Canterbury, commander of the Air Force Research Division (AFRD), said the Air Force plans to fund the division at a $70 million level by 1965 regardless of whether the overall AF budget is increased. As to the function of AFRD, Canterbury said it is regarded as a "management tool for all basic research in USAF, no matter where it is done, and for applied research that is not specifically tied to a weapon system."

He added that "if a piece of basic research is tied to a development, then the development command may do it —or the work can be sent to AFRD," in effect giving AFRD cognizance over all AF basic research.

"We're doing research of potential application to USAF, regardless of what it is," said Brig. Gen. Benjamin Holzman, Canterbury's deputy. He said AFRD was not trying to stop any basic research, but was working to avoid duplication.

The division, established Jan. 15, is the direct result of recommendations by a group of scientists which studied ARDC for two years. The study, headed by MIT Prof. Guyford Stever, advocated not only the reorganization of ARDC—much of which has been effected—but the raising of research to a division level to make it as important as weapon system development.

AFRD has five operating elements: OSR at Washington, D.C.; electronic and Geophysics Research Directorates, both at ARDC's Cambridge, Mass., center; the Aeronautical Research Laboratory at Wright Air Development Division, Dayton, Ohio, and the European Office in Brussels, Belgium.

• **AFRD to coordinate research**—The largest element in terms of funding is OSR, which will be getting $22.5 million for FY 1961. This office awards contracts entirely on the basis of evaluating unsolicited proposals coming largely from scientists in universities or non-profit organizations. Guide lines for such contracts are set up for AFOSR by research planning objectives.

The other operating elements, except the European Office, do mostly in-house research. The contracts they give are solicited, are relatively small in number, and are for support research.

The coordinating work of Headquarters AFRD will be one of its most important functions, Canterbury said. For example, his division has been given management responsibility for USAF sounding rocket programs. "Now, before any rocket is sent up we shall make sure that we have spoken to all our scientists about it. Then if any of them have a worthwhile experiment to put in the rocket it will be included."

Asked if he contemplated any important changes in the operating elements of AFRD, Canterbury said, "we couldn't make any major program changes now even if we want to. We've not been in business long enough."

AFRD Research Funding by Operating Elements
(IN MILLIONS OF DOLLARS)

Operating Element	FY '59	FY '60*	FY '61 (est.)
Electronic Research Directorate	5.126	9.003	3.5
Geophysics Research Directorate		2.909	3.2
Office of Scientific Research	20.683	22.322	22.6
Aeronautical Research Laboratories	7.478	6.840	7.5
All others	1.298	2.448	5.3
	34.585	43.522	42.1

* Includes FY '59 augmentation of $8.2 million for High Gauss Facility.

Unions Settle With Some Firms But New Strikes Loom

The battle by missile industry machinists for more money, extended unemployment benefits, and cost of living increases ended for certain companies last week and threatened to close down others.

A look at the labor map at week's end showed:

• A tentative agreement has been negotiated for Convair's 26,000 International Association of Machinists employees at San Diego, Palmdale and Pomona, but agreement is still to be reached with Convair's off-site IAM employees at Vandenberg and the operational *Atlas* missile sites;

• Tentative agreements are also subject to IAM and United Auto Worker member votes at Douglas;

• The strike deadlock at Lockheed's Missile and Space Division reached an impasse last week when the company's latest offer was booed down by its 10,000 IAM employees.

• 38,000 United Aircraft IAM and UAW employees are still out at the company's plants in Connecticut.

• Boeing IAM employees in four states have voted to strike and have turned down the company's latest offer.

• UAW employees at Chance Vought and Bell Aircraft held one-day strikes last week and threatened to go out again "unless management offers improve."

Minuteman 3rd-Stage Fight Centers on Casing Materials

The *Minuteman* third stage competition last week shaped up as a battle between two advanced rocket case materials—titanium and fiber glass reinforced plastic.

Aerojet-General announced it has successfully fired a development model of the *Minuteman* third stage with a titanium chamber—the first time, Aerojet said, that a titanium case has been successfully demonstrated in a full-scale solid propellant motor.

Aerojet and Hercules Powder Co. are competing for the third stage—the last major contract in the *Minuteman* system. Hercules is developing a unit packed in a plastic case, similar to the Hercules-Allegany Ballistics Lab third and fourth stages in the *Scout* which uses double-base propellant.

It was learned that Aerojet is using an alpha-beta titanium alloy containing 6% aluminum and 4% vanadium. Welding details were not disclosed but it is believed the case has only circumferential welds—none longitudinally.

The Air Force financed the Aerojet titanium chamber program, which was done in-house in conjunction with Space Technology Laboratories.

Aerojet used a polyurethane composite propellant—describing it only as a "high-energy solid propellant meeting *Minuteman* specifications." The unit is light enough to be handled by two men. The additional cost of titanium is more than offset by increased range and payload possibilities, Aerojet said.

Plastic cases save even more weight than titanium and have apparently had the edge in the competition in recent weeks. However, titanium supporters have been pointing out that plastics tend to distort under moist conditions—a possibly important factor if the missile is to be stored underground for long periods.

Aerojet Protests Award of NASA Rocketdyne Contract

The National Aeronautics and Space Administration is studying a protest by Aerojet-General Corp. over the recent award of a $44-million liquid hydrogen engine contract to Rocketdyne Division, North American Aviation.

Meanwhile, it was learned that copies of the protest—in a letter from Aerojet President Dan A. Kimball to NASA Administrator T. Keith Glennan—have been given to members of the House and Senate committees on space.

A NASA spokesman said the agency will reply to Aerojet in due course.

Aerojet noted that NASA has contracts with Rocketdyne for development of the 1½-million-lb.-thrust F-1 engine, supply of the H-1 *Saturn* booster engines and Project *Rover* nuclear rocket component hardware, in addition to the 200,000-lb.-thrust liquid hydrogen-LOX engine contract awarded June 1. An Aerojet source said NASA officials have already indicated that Rocketdyne eventually will be awarded a contract for development of a nuclear engine.

Rocketdyne declined comment on the protests.

Goddard Staff Begins Move to New Headquarters

The vanguard—a particularly apt simile—of the staff of Goddard Space Flight Center has moved into its big new headquarters in the Washington suburb of Greenbelt, Md.

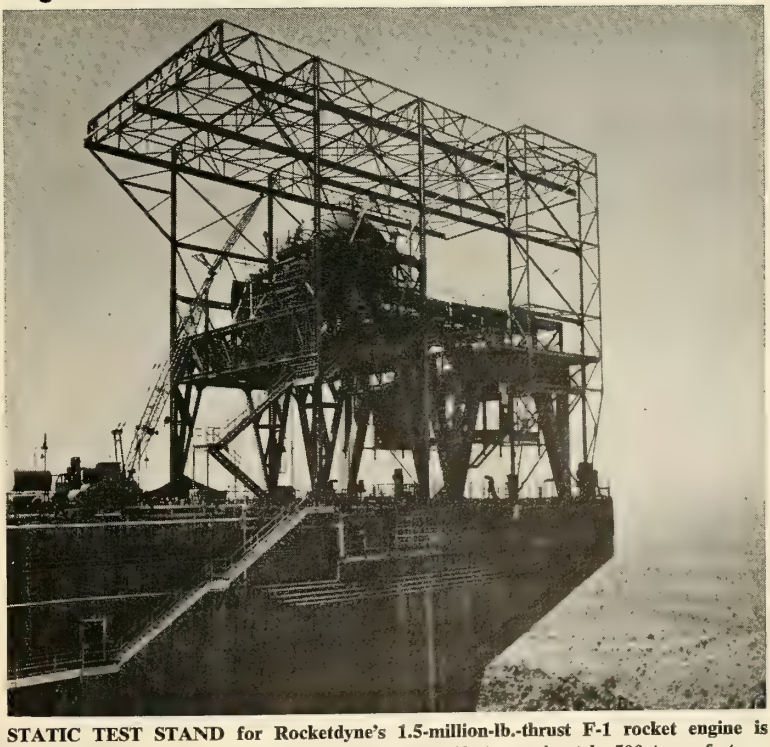
About 30 technicians have begun operating two computers in one building of the Goddard Center, a major division of the National Aeronautics and Space Administration. The bulk of the agency's staff, now scattered in several locations in Washington, will begin moving into the center in late summer, when the first two of six buildings are fully ready for use.

The Goddard center, which was formed by NASA around a nucleus of the Navy's old *Vanguard* group, is responsible for developing payloads for NASA's sounding rocket and satellite programs. It will be the data center for all space programs. Goddard also supervises the manned space flight program.

Goddard has a staff of 1200 at present. The NASA FY 1961 budget calls for an increase up to 2000. Activities now are at the Naval Research Laboratory and the Naval Receiving Station in Washington and a rented building in Silver Spring, Md.

The first two buildings at Greenbelt will be completed and the staff will move in the latter part of August. Two IBM 709 computers are already in operation in one of these buildings. Two more computers—the complex IBM 7090s—are to be installed shortly.

Huge Test Stand Forms



STATIC TEST STAND for Rocketdyne's 1.5-million-lb.-thrust F-1 rocket engine is nearing completion at Edwards Air Force Base, Calif. Approximately 500 tons of structural steel were used in the massive framework built by Kaiser Steel. First test firings are scheduled for early next year. Aerojet-General, A-E prime for the project, says the stand will ultimately accommodate 6-million-lb. engines.

Douglas Cites Drop in Plant Area

Plant area required in the aerospace industry to fill defense orders has dropped 50% since 1957—from 60 million to 30 million square feet—and is expected to be cut in half again over the next three years.

This dramatic reduction has been caused by the shift in emphasis from aircraft to missiles and satellites, sharply increased combat capability of aircraft still being produced, and the advent of nuclear weapons, according to Deputy Defense Secretary James H. Douglas.

In a recent speech before the Board of Governors of the Aerospace Industries Association at Williamsburg, Va., Douglas said that efforts to move toward controlled arms reduction are also bringing "new elements of uncertainty into defense and industry planning."

"There are no ready answers to the problems that industry faces," he said. Industry and the Pentagon "are caught up . . . in a series of moving equations, for which the solutions will depend on circumstances and factors that are still unresolved."

But Douglas said he was confident that industry would be able to make the necessary adjustments. He said DOD would help to "minimize" the effects.

To illustrate the problems, the defense official cited these additional statistics:

- In 1953, the Air Force alone accepted nearly 6000 aircraft; the total for all services was nearly 11,000. In 1959, production declined to less than 3000 for all services, while production is estimated at 2200 this year.
- Total DOD spending increased from about $35.5 billion in FY '55 to $41 billion in FY '59; aircraft and missile expenditures increased by nearly $2.2 billion. But aircraft expenditures, which in 1955 totalled $8 billion compared with less than $1 billion for missiles, in FY '61 will amount to only $6 billion as against $3.5 billion for missiles.
- With aircraft becoming more costly and missile expenditures increasing, producers of electronic and other advanced equipment have received a bigger share of aircraft and missile procurement dollars.
- Aeronautical products export have declined from about $1 billion in 1956 and 1957 to $750 million in 1959. Britain's efforts to encourage consolidation of its aircraft industry will in some degree increase U.S. industry's problems with competition both home and abroad.
- If consolidations or merger should be necessary to retain essential U.S. aerospace skills and capacities DOD will have a "real interest in exploring the probable effects of any such proposals."

mergers and expansions

REMINGTON RAND UNIVAC has formed a Reliability Engineering Dept. to centralize its reliability efforts. Some 50 component, circuit and failure analysis engineers and statisticians will work in the department under the direction of G. A. Raymond, former assistant project manager for one of Univac's navy computers.

ALLIS CHALMERS MFG. CO. has purchased 50% of the common stock of Consolidated Systems Corp., Monrovia, Calif., from Bell & Howell's Consolidated Electrodynamics Corp. The firm will be operated jointly by Allis Chalmers and CEC.

DACO INSTRUMENT CO. has acquired the Motoroid Division of Leetronics, Inc. . . . Wilcox Electric Co. of Kansas City has formed a Magnetics Division . . . Kelvin Electric Co. has sold its Magnetics Division to Datafilter, Inc., both of Van Nuys, Calif.

TENS CORP., (The Electro Nuclear Systems Corp.) of Minneapolis has completed initial financing with public sale of 650,000 shares of stock. TENS will engage in R&D and manufacture of systems and equipment for government and industry, particularly in automation, data processing, weapons and missile systems, medical and nuclear electronics.

TELEX, INC. has purchased Aemco, Inc., Mankata, Minn. manufacturer of components for the electrical and electronic industries. Telex earlier this year acquired Ballastran Corp., Ft. Wayne, Ind., and a one-fourth interest in Electro-Logic Corp., Venice, Calif.

OHIO SEAMLESS TUBE has contracted for a factory structure to house its new welded tube mill at Shelby, Ohio. The 460-ft. long building is scheduled for completion Oct. 31.

MINIATURE PRECISION BEARINGS has opened a sales office in Redwood City . . . The DeVilbiss Co. has integrated its subsidiary, De Vilbiss Metal Fabricators Co., making it a division of the company.

GENERAL ELECTRIC will add another 260,000 sq. ft. of office, engineering and manufacturing space to its transistor and tunnel diode facilities in Electronics Park within the next few months. This will bring GE's Syracuse facilities for manufacture and sale of transistors and related electronic components to 450,000 sq. ft.

POLARAD ELECTRONICS CORP. has added a 100,000 sq. ft. building to its Long Island City production facilities, bringing its total plant area to almost 250,000 sq. ft.

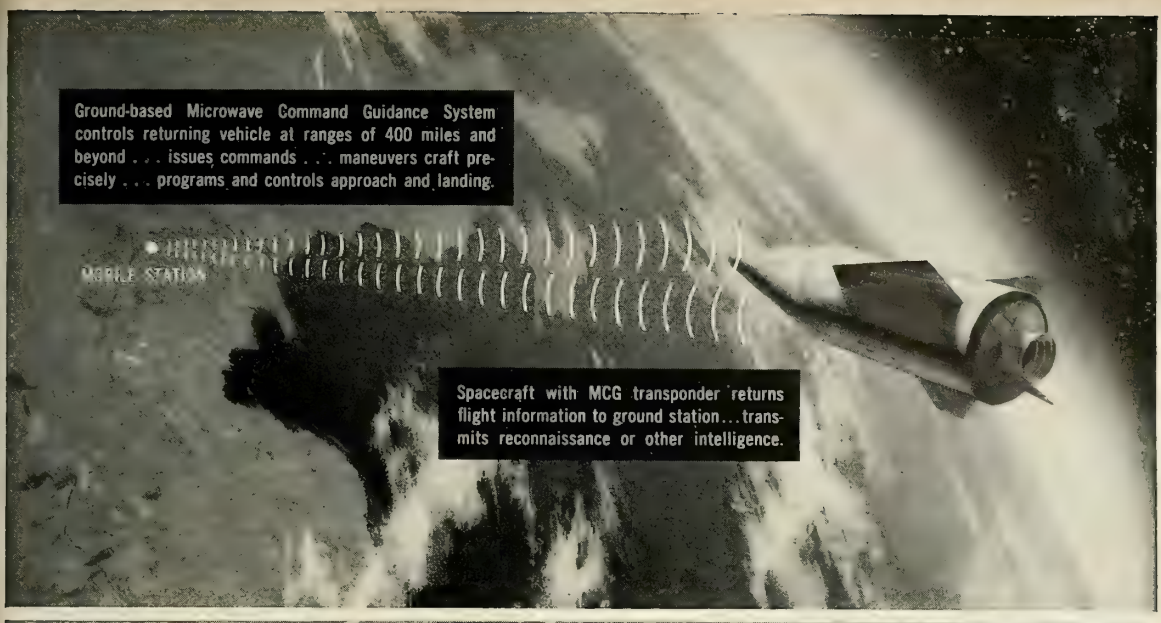
APPLIED PHYSICS LABORATORY of Johns Hopkins University, has contracted to construct a two-story, $310,000 building to house experimental radar equipment and scientific research staff. The building will be used for experimental evaluation of APL-developed search and guidance radar and weapons direction finding equipment for BuWeap, Navy Dept. Completion of the building is scheduled for late October, 1960. It will be located in Howard County, between Washington, D.C., and Baltimore, Md.

financial

IMC Magnetics Corp.—Net sales for the fiscal year ending Feb. 29 rose 43½% to a record high of $4.4 million. Profits dropped to $25,841 from $105,589. Company spokesmen attribute this to large-scale investment in R&D and a 100% expansion of IMC's Westbury plant. Current backlog nears $2 million.

Northrop Corp.—Sales and profits slipped somewhat for the nine months ending April 30. Net income was $5.31 million compared to $5.35 million for the same period in the previous year. Sales amounted to $170.7 million, compared to $195.8 million for the corresponding 1959 period. Northrop President Thomas V. Jones reports an upward trend this fiscal year.

Dynatronics, Inc.—The three-year-old firm predicts gross revenues for the current fiscal year of $2.7 million, nearly $1 million more than in 1959.





How Sperry Puts Spacecraft "On Instruments"

SPERRY 50 YEARS 1910 1960

One of the big questions in returning spacecraft to earth—how to "steer" with precision—is being answered by Sperry. Sperry's Microwave Command Guidance System, developed with the Air Force, will fly any kind of vehicle remotely 400 miles and beyond, exercising levels of precise control far beyond the ability of a skilled pilot.

Sperry Microwave Command Guidance can establish the optimum approach path and provide accurate landing control. It issues high-speed commands, monitors performance, plots course, transmits intelligence in both directions. It can control any reconnaissance vehicle, as well as returning spacecraft, and is ideal for test-range instrumentation applications.

Already proven in remote control of supersonic vehicles, MCG is a compact, mobile package in an air-transportable van . . . can also "go airborne" to avoid terrain problems and extend range. Write for system information pertinent to your project.

SPERRY PHOENIX COMPANY, *DIVISION OF SPERRY RAND CORPORATION, PHOENIX, ARIZONA*



ARMY'S SD-1 RACKS UP 31 MISSIONS ...READY FOR 31 MORE!

At the Army Electronic Proving Ground, Fort Huachuca, Arizona, tough little SD-1 drones from Radioplane perform mission after mission training troops in the tactical use of drone aerial surveillance. Under the direction of the U.S. Army Combat Surveillance and Target Acquisition Training Command, they are launched and return with photo intelligence within minutes. The SD-1 serves our tactical organizations in the U.S. and overseas in Europe and the Far East.

Reliability is the keynote in Radioplane design whether the product is a tactical SD-1 drone like "Repeater," a target missile, or a landing system for a space vehicle.

PILOTLESS AIRCRAFT
FOR AERIAL SURVEILLANCE
FOR TARGET TRAINING
FOR WEAPON SYSTEM EVALUATION

RADIOPLANE
A Division of **NORTHROP CORPORATION**
Van Nuys, California, and El Paso, Texas

Circle No. 12 on Subscriber Service Card.

Technical Countdown

ELECTRONICS

Explorer VII Channel Fails

Failure of a multiplexer has made signals on one of four channels from *Explorer VII* unreadable since June 13. The malfunction cut off data on solar far UV and soft X-rays, heavy cosmic radiation and operation of a solar cell. Three channels still in operation are carrying information on other cosmic radiation, radiation balance and temperature. Meanwhile, NASA has issued its promised *Explorer VII* telemetry code in a publication (TN D-484) available to scientists around the world.

24-hr. Satellite Study Nears Completion

General Electric has substantially completed research into the feasibility of communications satellites. Aimed ultimately at the 24-hour satellite, the study conducted for the Army covered five major areas: satellite electronics, reliability, environment, noise sources, and anti-jamming.

New Radar Scans Electronically

A computer-controlled radar being built by Bendix will be able to track simultaneously space vehicles and low-altitude aircraft. Multiple electronic search and track beams eliminate conventional mechanical scanning. The ESAR (Electronically Steerable Array Radar) is being built for ARPA and the Air Force under a $4-million contract.

Two for the Price of One

Successful orbiting of the 223-lb. *Transit IIA* included first practical use of a piggy-back secondary satellite. The smaller 42-lb. sphere contains solar radiation measurement devices. The feasibility of orbiting dual payloads was proved out with *Transit IB* in April, when the vehicle was separated from a simulated second satellite.

Performance Up, Cost Down

New high-speed, solid-state digital computers not only outperform previous systems—they save money. When the second of a pair of IBM 7090's is installed at Marshall Space Flight Center, Huntsville, they will replace three machines, require only one shift, and cost $50,000 a month less. (See story p. 34.)

PROPULSION

Plastic Key to Success

A plastic insert in its steel nozzle has contributed greatly to success of the Army's *Pershing* test program. *Pershing*'s single nozzle is believed to be the largest under current development.

9-Foot Apache Flies High

The new Thiokol/New Mexico State Univ. *Apache* sounding rocket carried a 35-lb. payload to almost 40 miles altitude in a test earlier this month. Gross weight of the 104-in.-long, 6¾-in.-dia. motor is 223 lbs.

MATERIALS

Super Strength Steel Due Soon

Designed specifically for missile cases, super alloy MX-2 will be made available soon by its developers, Scaife Co. Pressure vessels fabricated from the new steel have been hydrostatically tested up to 280,000 psi burst pressure without failure. The cobalt-modified alloy has two to three times the strength of normal construction steels but is easily rolled, deep drawn, welded and machined. (See story p. 31.)

Lunartics on Water Wagon

Solar energy may provide water for future moon explorers, according to Dr. Jack Green of North American Aviation. Water can be extracted from volcanic rock through heat supplied by focusing the sun's rays through a Fresnel lens. The process presumes existence of volcanic lunar rock.

"T-1" Castings License Issued

Alloy Steel & Metals Co., has obtained a license from U.S. Steel to produce "T-1" steel castings. Possible applications include GSE and missile launch systems where strength and light weight are necessary for airlift operations.

Helium Plant Fabricator Error

The Navy's mobile liquid helium plant was built by Air Products Inc.—not Air Reduction Inc., as reported in TECHNICAL COUNTDOWN, June 6.

ASW ENGINEERING

New Technique Saves Sonobuoys

Sonobuoy manufacturers are wondering what the "Circling-Line" sonar-search concept will mean to their market. The Navy, trying to limit use of expendable gear, has Douglas Aircraft's Johnsville Lab developing the technique, in which a patrol aircraft lowers the sonobuoy on cable, makes a complete listening circle, retracts gear and moves to another area. With correct turn radius and speed, the sonobuoy remains virtually motionless.

Ike Supports New Ocean Study

The White House has announced support of an intensive IGY-type oceanographic study of the Indian Ocean. The National Academy of Sciences will direct the four-year program. Up to 20 vessels (Navy-supplied) and 350 scientists will participate. A basic research program, it should give the Navy welcome information (ocean-floor charting, shoal locations, current variations, and meteorological data).

Need for New ASW Aircraft

Data retrieval still is a serious problem for ASW aircraft forces. Fleet personnel have healthy respect for the existing S2F and P2V and their successors S2F-3 and P3V, but still higher performance craft are needed. They're looking toward a turbo capable of 4-hour patrol duty and speed bursts up to 400 knots.

FIREBEE:



AMERICA'S NO. 1 JET TARGET

The Ryan Firebee is America's most widely used jet target missile. It keeps more men, missiles and weapons systems combat-ready than all other jet targets combined. The Firebee is fast (over 500 mph)...high-flying (up to 50,000 feet)...reliable (30 minutes-a-flight average)... durable (up to 20 flights).

The Firebee is operational, "off-the-shelf" hardware. It is the exclusive target used in the Air Force's Project "William Tell" Weapons Meets. The Firebee is the most realistic stand-in for "enemy" aircraft ever developed to test men and weapons.

Now an even more advanced version of the Firebee is in production at Ryan. The Q-2C Firebee, already on order by the Air Force, has flown at Mach .95 speeds and 59,000-foot altitudes.

RYAN OFFERS CHALLENGING OPPORTUNITIES TO ENGINEERS

RYAN BUILDS BETTER

AIRCRAFT · POWER PLANTS · ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

A Special M/R Report

Drone Market Undergoes Drastic Transition for Future

- *Future missile and satellite weapon systems probably will include target drones as part of the complete package—a drastic change from today's separate procurement.*
- *Research is now under way by the services on whole new families of target drones.*
- *Pressure is on to reduce the unit costs of both surveillance and combat drones.*



IMPROVED SD-2 successfully flown on first attempt.

Directory of U.S. Drones Starts on p. 22

A LITTLE-RECOGNIZED revolution is taking place today in the American market for airborne and space-travelling drones.

With the increasing dominance of missiles and the relative decline of military aircraft, the drone market is going through a radical transition that should be completed by the mid-60's.

By then the Armed Services expect to have four great new families of drones:

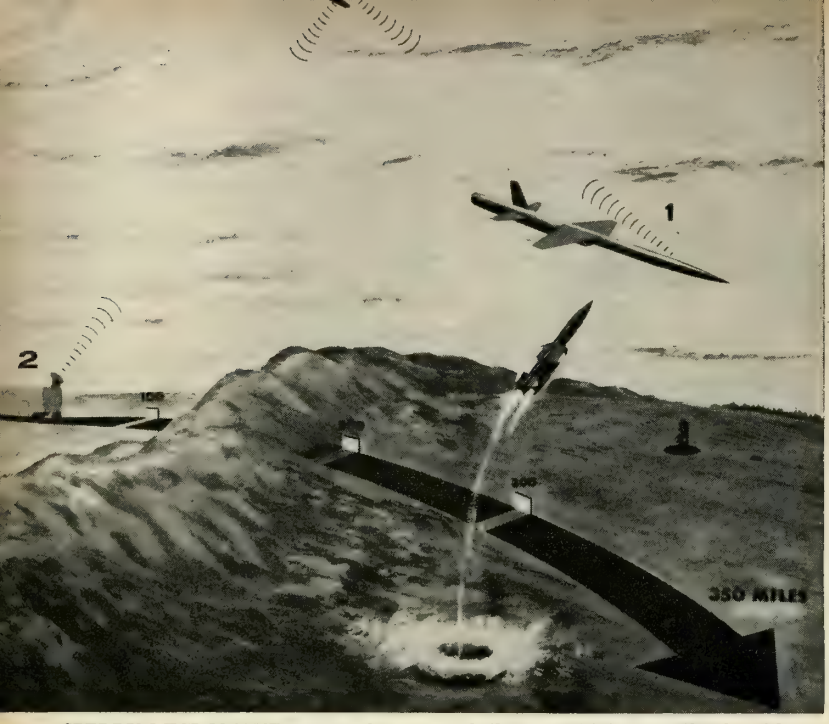
- The missile target drone for testing both tactical and strategic antimissile missile systems and for training AICBM crews. These drones will be needed not only to provide targets for such land-based systems as *Nike-Zeus* and *Mauler* and sea-based systems such as *Typhon,* but for space-based systems now on drawing boards.
- The spacecraft target drone for testing antisatellite and antispacecraft systems that will be needed to combat such enemy systems as reconnaissance satellites and other military space vehicles.
- The surveillance drone for a wide variety of reconnaissance missions.
- The combat drone for the dissemination of chemical and biological agents.

Although considerable work has already been done in all of these areas, major development of the systems needed is still ahead. Such systems call for new materials, smaller and more effective electronic systems and propulsion systems that must be improved in a number of ways.

Above all, the military services are pressing for a reduction of cost.

In recent years, the rising cost of drones has made their use in many cases almost prohibitive. Many drone experts doubt that this trend can be reversed in the field of missile and space drones, but they are optimistic about reducing the cost of surveillance and combat drones.

The FY 1961 military budgets for



SPERRY MICROWAVE command system: missile target (1) is controlled by airborne director (3), which relays the microwave signals from ground director station (2).

drones clearly reflects the changes that are taking place.

The three military services plan to obligate about $100 million, a $30 million drop from last year. This is mainly attributable to a hiatus caused by a decline in production of drones for aircraft and the beginning of the full development of the drone systems of the future.

• **Costly sophistication**—The Navy money for powered aerial targets including expensive support equipment jumps up $4.4 million in the next fiscal year to a total of $25.3 million. Oddly enough, this money will buy only half the number of targets bought with lesser amounts of money in either FY '58 or FY '59. Reason is that the Navy is asking for more sophisticated and thus higher-priced vehicles.

Emphasizing this point, a Navy spokesman pointed out that his service's training targets have risen from a cost of a few thousand dollars each to between $70,000 and $100,000. Price tags on targets to test out weapon systems now read as high as $500,000 per vehicle. In some instances, there is as yet no adequate target and the Navy must use analytical means to find out the performance of a weapon system.

"This trend will continue," added the Navy spokesman. "Within the next five to ten years the number of targets we buy will keep lessening, but the total cost for the vehicles and supporting equipment will go up because of our need to simulate realistically a manned aircraft threat."

There has been talk in the Navy that money might be saved if the aerial targets used for training its personnel were replaced by analog computers. Most line officers believe, though, that no analog computer can adequately simulate the field environment. These men say that the psychological conditions that exist in the field and the seemingly trivial incidents that arise, like a man tripping over a wire, are all essential experience that a computer can never give a man.

• **AF sees new target needs**—The Air Force will be spending about half as much in FY '61 as they did in FY '60. This is a drop of nearly $28 million. Reasons given are: (1) The programs for air-breathing targets have advanced to a point where development money can be cut. (2) Because of AF emphasis on ballistic missiles, the air-breathing weapons and their targets will get less consideration.

This cut in money has been called a "leveling-off" process. As one AF colonel put it, "We're going to have to simulate aircraft for a long time to come and to do this we're going to continue needing appropriate targets." Hence it is expected that the $26-million FY '61 figure will remain more or less steady for the next few years.

Plans of the AF indicate a future requirement for ballistic targets, and could involve substantial amounts of money. These will be targets for missile defense systems and for aerospace defense systems. Money has already been spent on studies, which may develop into R&D ones in the near future.

• **Part of weapon system**—A new trend for funding targets for weapon system evaluation is becoming apparent. For example, funding of an AF advanced target for R&D work will probably fall under the budget for the weapon system that the target is evaluating. This is a change from the way such targets are financed now, independent of the weapon system. However, the new method is in line with a June 1958 OSD memorandum to the three service Secretaries.

The directive calls for each service to examine its targets used for R&D work to see whether they are good enough to do the job at hand. If not, then a target should be developed to suit the needs, even if this means making a new target for each weapon system. The memorandum directs that money for the targets be included in the missile system budget.

This means that for highly sophisticated weapon systems, a parallel development might be that of its target. Important is that the OSD memorandum calls for no change in handling training target requirements which "will continue to be justified under the present procedures and budgeting methods."

• **Army target & drone money to rise**—The Army will be spending almost $40 million in FY '61 for powered aerial targets and combat surveillance drones. This is considerably more money than either of the other two services are spending. It is also a figure that will probably go much higher during the coming years. Three factors indicate more money will be spent:

(1) Since 1957, $88 million has been spent for the RDT&E work on combat surveillance drones *SD-2*, *SD-4* and *SD-5*. An advanced version of the *SD-2* was successfully test-flown last April, and the first flight of the *SD-2* took place in May. The *SD-4* is scheduled for flight testing early this fall. Production contracts are anticipated for each of these birds, which after the initial R&D vehicles are delivered, should significantly raise the FY '62 funding over the FY '61.

(2) With the Army's responsibility for point defense against missiles goes the responsibility to get aerial targets to simulate missiles. For example, the *Jupiter* was recently modified for a mission as a target for evaluating the *Nike-Zeus* weapon system. Although the project is now under review, this does not change the eventual need for tar-

gets for antimissile missiles. Using the missiles themselves is felt to be much too expensive.

(3) The Army is only now beginning to tap the enormous potential of the combat surveillance drone. Although the fact is not being given much publicity, the Army Chemical Corps Research and Development Command is very much interested in using such drones as carriers in chemical and biological warfare. For the past year, the Command has been consulting with industry about the possibilities for such use and has been encouraging studies of the problem.

Four functions are required of a surveillance drone. (1) To give timely and accurately the coordinates of potential targets. (2) To detect enemy intrusions of the battlefield. (3) To detect all nuclear detonations in the battlefield, hostile or friendly. (4) To transmit intelligence to the field commanders fast enough to do some good, in most instances, immediately.

Beyond these standard missions, the surveillance drone system may be used to gather weather and terrain data and then enlarged to include missions such as: weapons carrier, decoy, enemy harassment, countermeasures, short-range observation, air-sampling, supply and communication.

Other possible applications are mapping, training, system exercise, weapon evaluation and research.

• **Targets by appointment**—A trend that is gaining high favor in the Army is for manufacturers of targets to contract to put their vehicles in the sky where and when the Army wants them. In this way, the service gives the entire problem of target presentation to the manufacturers.

Lockheed, operating under one such contract, is making presentations with its *Q-5* for weapon system evaluations; Radioplane is making presentations with its *RP-76;* and Beech, with its *KDB-1*.

The advantage of this service is that the military does not have to train personnel in the special skills needed for target operation and maintenance. Thus the Army can assign personnel to the primary duty of testing systems and shooting down targets instead of to the supporting activity of target presentation.

There are significant economies for the Army, according to Radioplane project engineer Jack Pfarr. One instance given is that the engineers responsible for target presentations are permanent and experienced employes, residing in the area in which they are working. Thus they do not have to be trained every few years, as would be the case with military personnel in view of their turnover, they are not paid per diem, and they have usually grown up with the systems.

The Army likes the idea so much that the Redhead and Roadrunner competition for target drones, which is being processed now, will probably include in the resulting contract some provisions for contractor operations.

On the other hand, neither the Navy nor the AF are encouraging these services. The Navy feels that there is no room on its ships nor money for a near-permanent staff of civilians. The AF takes a similar stand in saying it does not want to pay for civilian technicians to reside at overseas bases. Yet the Navy and AF leave the door open for contractors to arrange to present their targets over domestic bases.

• **Which propulsion system best**—There are four basic propulsion types being used in targets and drones. These are the piston engine, the turbojet, the ramjet and the rocket. Each has its domain, depending on the use to which the craft will be put, and each domain is fairly well defined.

The main technical argument involves—as it has for a number of years in other circumstances—the question of whether in the rocket field the solid or the liquid propulsion system is best.

Where relatively long-duration, low-speed and low-altitude performance is required, the piston engine is apt to be chosen. Examples are Radioplane's 160-knot *SD-1*, which uses a McCulloch engine; and Aerojet-General's *SD-2*, which uses a Lycoming engine.

For relatively long-duration missions but ones with moderate speeds and altitudes, the turbojet with or without afterburning is a likely candidate. Examples here are Republic's *SD-4* and Fairchild's *SD-5*, each powered by Pratt & Whitney's J60 engine. This is a small, high-performance powerplant

(Continued on p. 30)

Annual Funding for Aerial Targets And Combat Surveillance Drones

ARMY

(in millions of dollars)

Aerial targets, powered (Does not include support equip.)	FY '58	FY '59	FY '60	FY '61 (est.)
Procurement	10.0	9.0	31.1	28.5
RDT&E	. . .	3.0	4.7	0

Combat surveillance drones (Does not include support equip.)	FY '57	FY '58	FY '59	FY '60	FY '61 (est.)
Procurement	15.6 →			5.5	↑ 11.0 ↓
RDT&E					
SD-1	? →				
SD-2	10.0 →				
SD-3	? →				
SD-4	30.0 →				
SD-5	48.0 →				

NAVY

(in millions of dollars)

Procurement and RDT&E (Including all support equip.)	FY '58	FY '59	FY '60	FY '61 (est.)
Aerial targets, powered	20.6	20.2	20.9	25.3
Tow targets	7.5	3.0	5.4	7.8

AIR FORCE

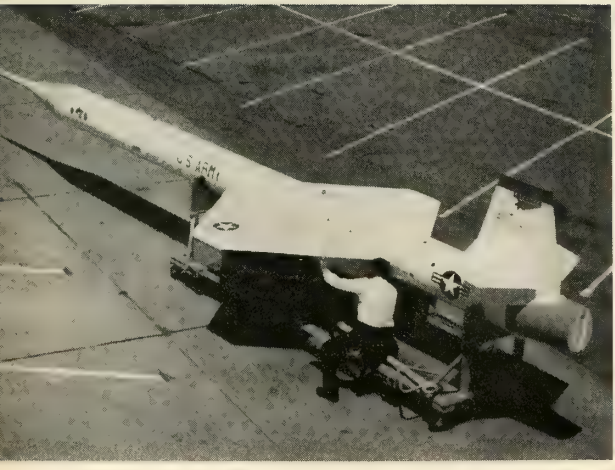
(in millions of dollars)

Procurement and RDT&E (Does not include support equip.)	FY '58	FY '59	FY '60	FY '61 (est.)
Aerial targets, powered	40.2	46.7	53.9	26.0
Tow targets	. . .	. . .	7.0	. . .

Aerial Targets and Combo

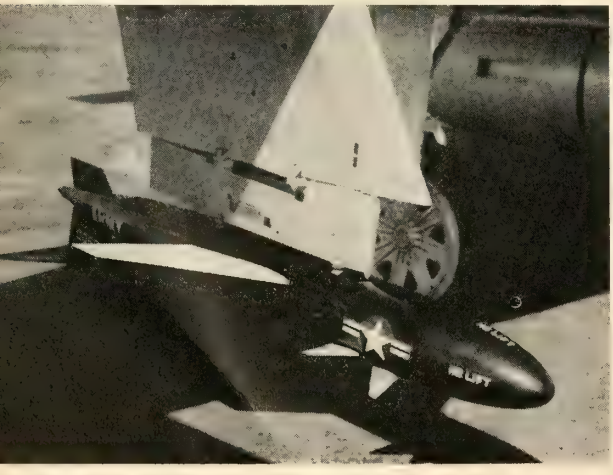
DIRECTORY

28	CT-20	29	OQ-19E	23	SD-4 (Swallow)
29	CT-41	28	Q2-C (Firebee)	23	SD-5
24	KDB-1	22	Q-5 (Kingfisher)	24	XKD2B-1;WS462L
24	KD2R-5	22	RP-76	29	XKDT-1 (Teal)
24	KD2U-1	29	RP-77D	28	XQ-4B
24	OQ-19B	23	SD-1		
24	OQ-19D	23	SD-2		



Q-5 (Kingfisher)

RP-76



ARMY

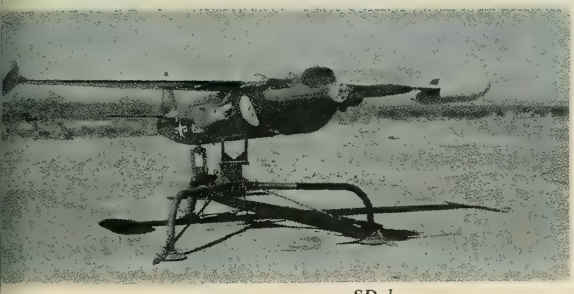
Q-5 (Kingfisher)

Manufacturer Lockheed Aircraft Corp.
Mission Target for surface-to-air weapon system evaluation
Status In inventory
Speed Mach 3 at 80,000 ft.
Altitude 80,000 ft. operational
Endurance 9 to 11 min. after climb to 60,000 ft.
Launch Air-launched from B-50
Propulsion Underwing boosters until Marquardt ramjet takes over
Recovery Parachute and landing spike
Flight Control Programed and command control override
Span/Length/Height (ft.) 10/39/1.7
Gross Weight, without payload 7600 lbs. plus
Augmentation Luneberg lens passive radar
Notes Derived from Air Force X-7A system

RP-76

Manufacturer Radioplane
Mission Target for surface-to-air weapon system training
Status In production
Speed Mach 0.9 at 40,000 ft.
Altitude 40,000 ft. operational
Endurance 8 to 9 min. at 40,000 ft.
Launch Air-launched from fighter-type aircraft bearing external store pylon
Propulsion Aerojet-General 53ONS-35 end-burning solid-propellant rocket engine
Recovery 2-stage parachute
Flight Control Programed and command control override
Span/Length/Height (ft.) 5/9.7/1.5
Gross Weight, without payload 300 lbs.
Augmentation Luneberg lens passive radar
Notes Production contract for 400 craft

urveillance Drones



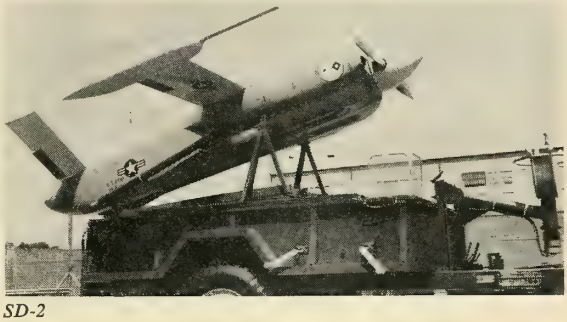
SD-1

SD-1

Manufacturer Radioplane
Mission Combat surveillance
Status In production
Speed 160 knots at sea-level
Altitude 15,000 ft. service
Endurance 40 min. at sea-level
Launch Zero-length
Propulsion McCulloch 4-cylinder 2-cycle air-cooled engine driving a 44" dia. propeller
Recovery Single-stage parachute
Flight Control Proportional command control system
Span/Length/Height (ft.) 11.5/13.4/2.6
Gross Weight, without payload 430 lbs.

SD-2

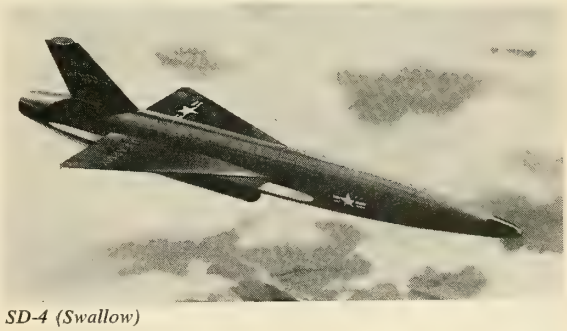
Manufacturer Aerojet-General Corp.
Mission Combat surveillance
Status Advanced flight testing
Speed, est. 300 knots at sea-level
Altitude, est. 5000 ft. operational
Launch Zero-length with two rocket assist boosters
Propulsion Lycoming IMO-360-B1B air-cooled 4-cylinder, 225 hp. engine
Recovery Parachute
Flight Control Programed and command control override
Span/Length/Height (ft.) 13.3/16.1/3.6
Gross Weight, without payload 992 lbs.
Notes Improved version of SD-2 was successfully flight tested in April, 1960



SD-2

SD-4 (Swallow)

Manufacturer Republic Aviation Corp.
Mission Combat surveillance
Status Under development
Launch Zero-length with Thiokol rocket booster
Propulsion Pratt & Whitney J-60 turbojet rated at 3000 lb. sea-level static thrust
Recovery Parachute plus landing bags
Flight Control Programed or controlled by mobile ground or airborne command
Notes Craft scheduled for early fall, 1960 flight testing



SD-4 (Swallow)

SD-5

Manufacturer Fairchild Engine and Airplane Corp.
Mission Combat surveillance
Status Under development
Speed High subsonic
Launch Zero-length
Propulsion Pratt & Whitney J-60 turbojet rated at 3000 lb. sea-level static thrust
Recovery Parachute plus landing bags
Flight Control Programed and command control override
Span/Length/Height (ft.) 24/36/8
Notes Craft was successfully test-flown in May, 1960

SD-5

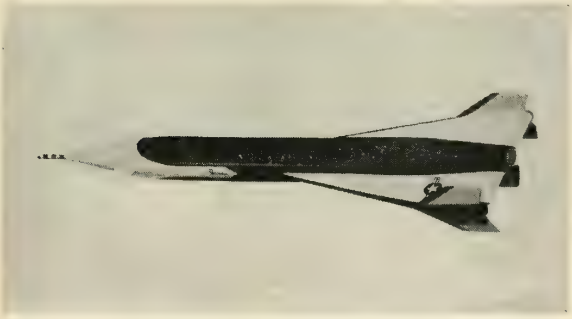


Additional ARMY targets:

- **KDB-1, under Navy listing**
- **OQ-19B, under Air Force listing**
- **"Notes," in Air Force listing of Q-2C**



KDB-1



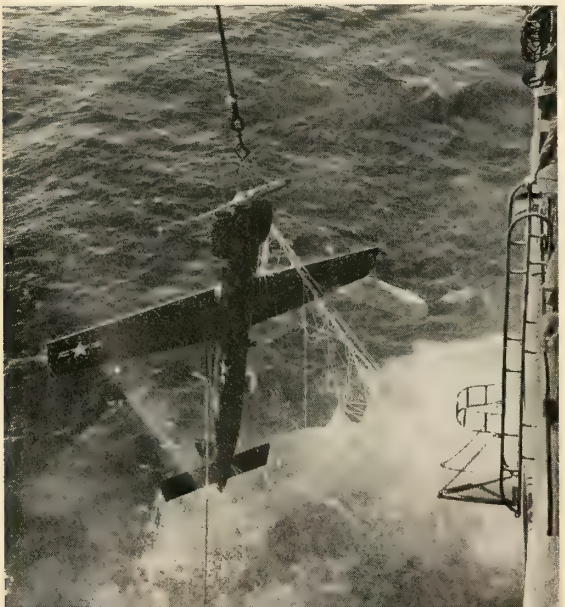
XKD2B-1; WS462L



KD2U-1

Additional NAVY targets:
- KD2R-5, under Air Force listing
- "Notes," in Air Force listing of Q-2C

KD2R-5



NAVY

KDB-1

Manufacturer Beech Aircraft Corp.
Mission Target for air-to-air and surface-to-air weapon system training and evaluation
Status In production
Speed 275 knots at 25,000 ft.
Altitude 40,000 ft. service
Endurance 60 min. at 25,000 ft.
Launch Zero-length with JATO, or compressed-air catapult
Propulsion McCulloch 6-cylinder, 2-cycle supercharged air-cooled engine driving a 52" dia. propeller
Recovery Single-stage parachute
Flight Control Command with automatic stabilization
Span/Length/Height (ft.) 12.5/13.5/3.5
Gross Weight, without payload 600 lbs.
Augmentation Reflectors in wing pods and tail cone for radar tracking
Notes Craft also being used by Army

XKD2B-1; WS462L

Manufacturer Beech Aircraft Corp.
Mission Target for air-to-air weapon system training and evaluation
Status Under development
Cognizant Services XKD2B-1, Navy; WS462L, Air Force
Speed Mach 1.5 and Mach 2.0 at 70,000 ft.
Altitude 70,000 ft.
Endurance 5 min. at 70,000 ft.
Launch Air launched from fighter-type craft
Propulsion Liquid rocket made by Rocketdyne
Recovery Self-destruct
Flight Control Programed system with automatic stabilization
Span/Length/Height (ft.) 3.25/12.8/1.4
Gross Weight, without payload 560 lbs.
Augmentation Installations for radar and infrared reflectivity
Notes Arranged as a Navy-Air Force joint venture. Operational in 1962.

KD2U-1

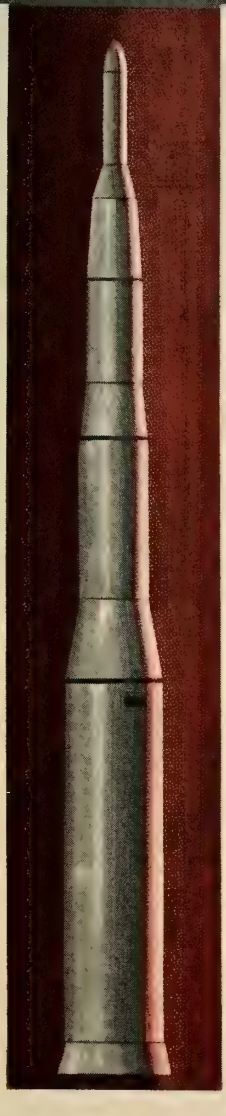
Manufacturer Chance Vought Aircraft, Inc.
Mission Target for air-to-air and surface-to-air weapon system evaluation
Status In production
Speed Mach 2 class at 60,000 ft.
Altitude Over 60,000 ft. operational
Launch Rail using rocket booster
Propulsion G. E. J79-3A turbojet with afterburner
Recovery Airplane-type landing with parabrake
Flight Control Programed and command control override
Span/Length/Height (ft.) 20.5/57.5/12.5
Gross Weight, without payload 21,000 lbs.
Augmentation Compatible with standard systems
Notes Converted from Regulus II design; in operational use by Navy and Air Force

AIR FORCE

OQ-19D; OQ-19B; KD2R-5

Manufacturer Radioplane
Mission Target for surface-to-air missile and gunnery training
Status In production
Cognizant Services OQ-19D and OQ-19B, Air Force and Army; KD2R-5, Navy
Speed 193 knots at sea-level
Altitude 23,000 ft. service
Endurance 60 to 90 min. at sea-level
Launch Ground launched and can be fitted for air launch; except KD2R-5, which can be ground-launched only
Propulsion McCulloch 4-cylinder, 2-cycle air-cooled engine driving a 44" dia. propeller
Recovery Single-stage parachute
Flight Control OQ-19B, command control with automatic stabilization; OQ-19D, command control; KD2R-5, proportional command control with automatic stabilization
Span/Length/Height (ft.) 11.5/12.2/2.6
Gross Weight, without payload 327 lbs.
Augmentation Two wing-tip radar reflector pods are optional on OQ-19B; are standard on KD2R-5; are not provided for on OQ-19D
Notes Thousands of these craft have seen service in U.S. and abroad





SEALED IN A SECRET SILO

Somewhere in a wasteland, the Air Force Minuteman will keep its lonely vigil all through a thousand nights. Buried and untended, it must be ready to spring to life if the button is ever pushed.

Minuteman poses a real challenge to the New Reliability—reliability which must guarantee successful firing at any moment in the far future. Each of the missile's systems, each of its thousands of electronic components, must function perfectly at that given moment. For once the missile is lowered into its silo, no human hands again need touch it.

The Minuteman's critical guidance and control system has been entrusted to Autonetics. We are proud to be a member of this United States Air Force missile team.

Once again America's defense force reaps the harvest of Autonetics' pioneering. A decade of experience with major projects has given Autonetics a unique capability in systems management—and in meshing its work with that of other companies in building modern weapon systems.

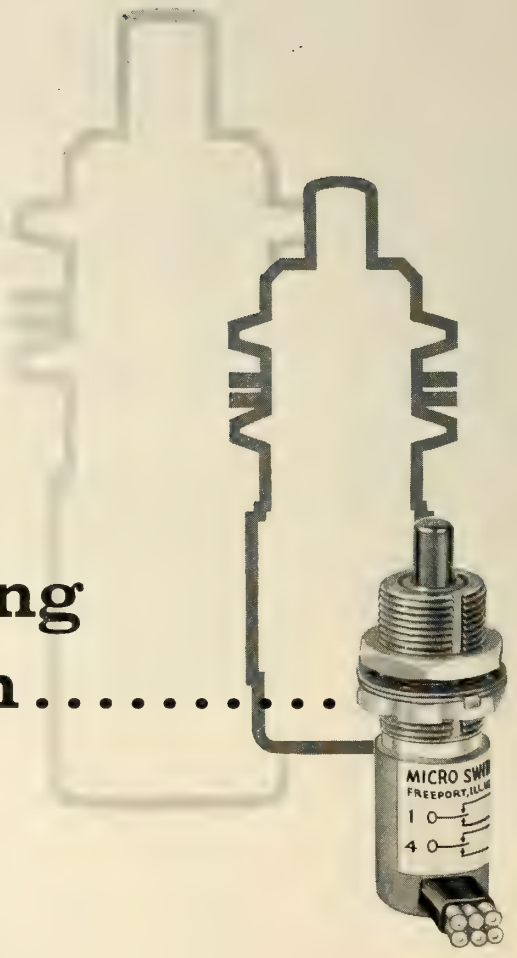
Guidance Systems by Autonetics

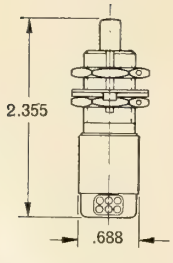
DOWNEY, CALIFORNIA

A DIVISION OF NORTH AMERICAN AVIATION, INC. REGIONAL OFFICES: WASHINGTON, D.C. AND DAYTON, OHIO

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402EN SEALED SWITCH

Operating Force	6-12 Lbs.
Pretravel	.040 In. Max.
Differential Travel	.020 In. Max.
Overtravel	.250 In. Min.

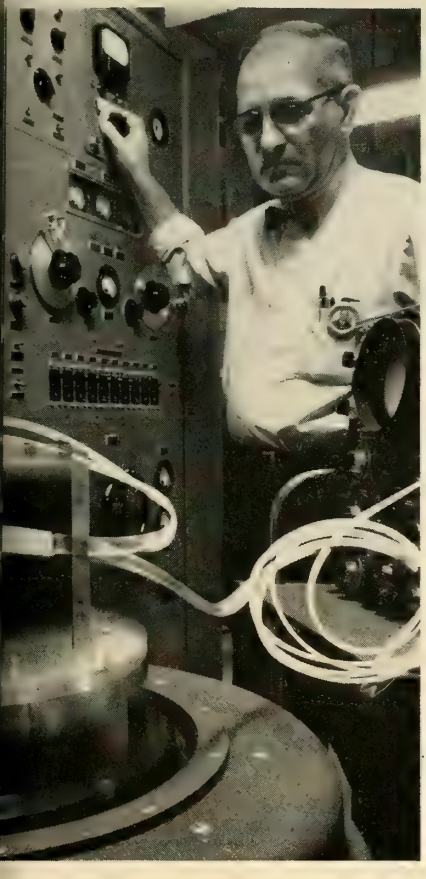
Electrical rating at 28 vdc: resistive, 7 amperes; inductive, 4 amperes.

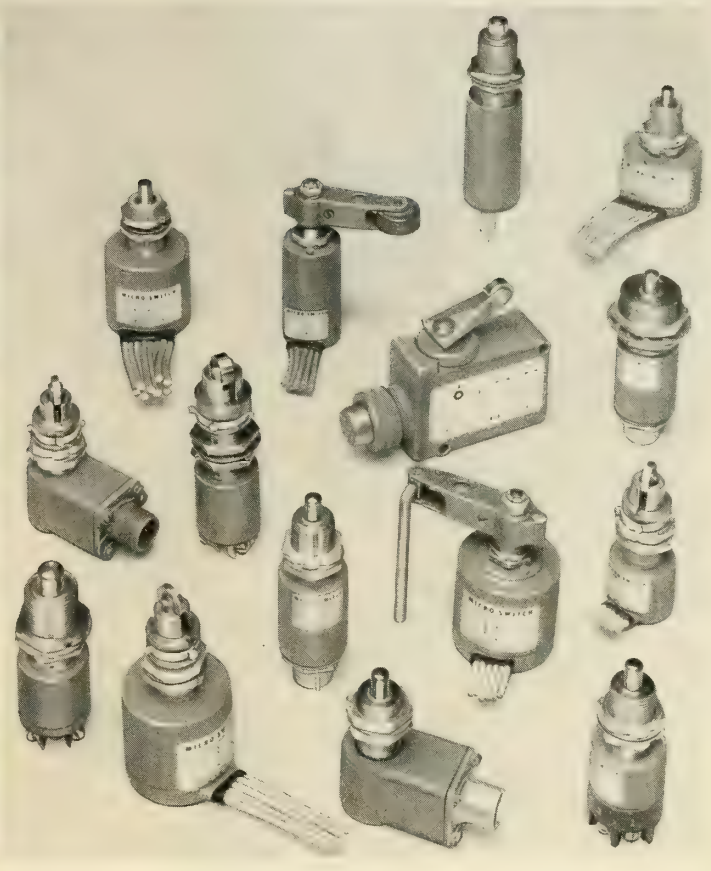
New 402EN—smallest two-circuit sealed environment-free switch available—The new reduced diameter of the MICRO SWITCH 402EN makes it possible to "tighten up a notch" on component designs, save both space and weight. This plunger-actuated sealed environment-free switch contains two sub-subminiature basic switches, for two single-pole double-throw circuits—yet measures only .688" in diameter.

It is fully enclosed and sealed against changes in atmospheric conditions. An "O" ring seal on the actuator shaft, plus glass-to-metal terminal seals and potted leadwire termination seals keep dust, water and air from entering switching chamber. An ice scraper ring on the actuator shaft removes ice or mud that might cause jamming or binding. The new 402EN meets immersion test requirements of MIL E-5272A Procedure 1.

For more information on this new unit, check the Yellow Pages for the nearest MICRO SWITCH branch office or write for Data Sheet No. 171.

MICRO SWITCH Precision Switches





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Does the testing and quality control behind that switch really guarantee the precision and reliability needed? MICRO SWITCH has the largest test laboratory of its kind where tests simulate actual operating conditions exactly —heat, shock, altitude and other conditions that affect switch performance.

In production, MICRO SWITCH tests vital materials literally by the inch to be sure they will perform as required. Throughout the manufacturing process the most precise quality control in the switch industry is used to safeguard the precision and reliability of these switches.

MICRO SWITCH manufactures a complete line of sealed switches for aircraft and missile applications. This specialized engineering experience is also available for recommending special switch designs for particular components. Ask the nearby MICRO SWITCH branch office or write for the new Catalog 77 which describes sealed environment-free switches for airborne applications. Check your switch requirements with MICRO SWITCH to be absolutely sure of precision and reliability.

MICRO SWITCH . . . FREEPORT, ILLINOIS
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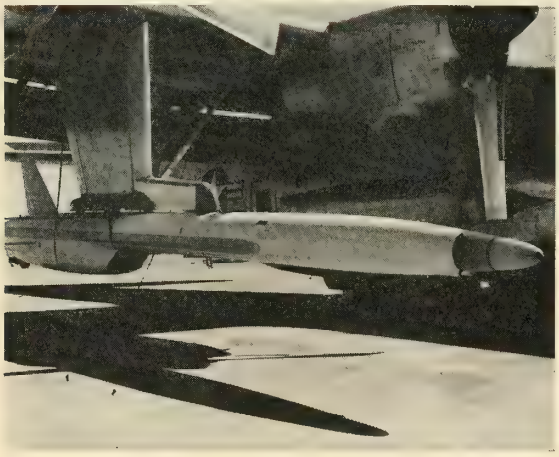
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MICRO SWITCH Precision Switches

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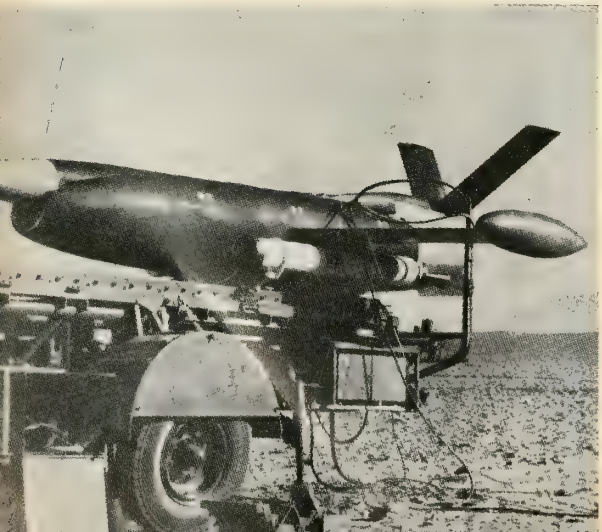


Q-2C (Firebee)



XQ-4B

CT-20



Q-2C *(Firebee)*

Manufacturer Ryan Aeronautical Corp.
Mission Target for air-to-air and surface-to-air weapon system training and evaluation
Status In production
Speed 545 knots at 60,000 ft.
Altitude 50,000 ft. operational
Endurance 76 min. after climb from 15,000 ft. to 50,000 ft.
Launch Zero-length ground launch capability with RATO, or air-launched from GC-130 or P2V-5D type aircraft
Propulsion Continental J-69-T-29 turbojet rated at 1700 lb. sea-level static thrust
Recovery Parachute
Flight Control Command control and automatic stabilization system
Span/Length/Height (ft.) 12.9/22.9/6.7
Gross Weight, without payload 2060 lbs.
Augmentation Radar return by broadband traveling wave tube amplifiers
Notes Q-2C is advanced version of Q-2A and KDA Firebee series, which has wide use in all services

XQ-4B

Manufacturer Radioplane
Mission Target for air-to-air and surface-to-air weapon system evaluation
Status Under development
Speed Mach 2 at 70,000 ft.
Altitude Over 70,000 ft. ceiling
Endurance 17 min. after climb from 36,000 to 70,000 ft.
Launch Air launched from GC-130 or similar aircraft
Propulsion G. E. J85-5 turbojet with afterburner
Recovery 3-stage parachute plus flotation equipment
Flight Control Sperry microwave command
Span/Length/Height (ft.) 13/35/6
Gross Weight, without payload 3300 lbs.
Augmentation Radar return by broadband traveling wave tube amplifiers
Notes Drone is follow-on of Q-4 series

Additional AIR FORCE targets:
- KD2U-1 and WS462L, under Navy listings

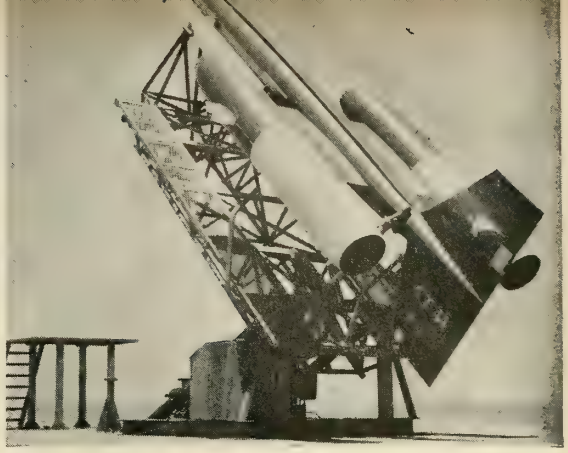
COMPANY-SPONSORED AND FOREIGN

CT-20

Manufacturer Nord-Aviation; U.S. sales through Bell Aircraft Corp.
Mission Target for air-to-air and surface-to-air weapon system training and evaluation
Status In production
Speed Mach 0.85 at 33,000 ft.
Altitude 46,000 ft. maximum
Endurance 60 min. at 33,000 ft.
Launch Rail with two rocket-assist boosters
Propulsion Marbore (Turbomeca) turbojet engine rated at 880 lb. sea-level static thrust
Recovery Parachute
Flight Control Command with automatic stabilization
Span/Length/Height (ft.) 11/18/2.2
Gross Weight, without payload but with boosters 1470 lbs.
Augmentation Radar reflectors
Notes 350 targets delivered to France, England, Italy and Sweden, and Nord is filling order for 100 more

CT-41

Manufacturer Bell Aircraft Corp. under license from Nord-Aviation
Mission Target for air-to-air and surface-to-air weapon system training and evaluation
Status Under flight test in France
Speed Mach 2.7 at 80,000 ft.
Altitude 80,000 ft. operational
Endurance 14 min. at 70,000 ft.
Launch Zero-length with two solid rocket boosters
Propulsion Two wing-tip ramjets, Sirius II
Recovery Parachute
Flight Control Command with automatic stabilization
Span/Length/Height (ft.) 11.9/32.2/7.6
Gross Weight, without payload 2865 lbs.
Augmentation Luneberg lens passive radar
Notes Quantity production scheduled for 1961. Target compatible with U.S. range requirements



CT-41

OQ-19E

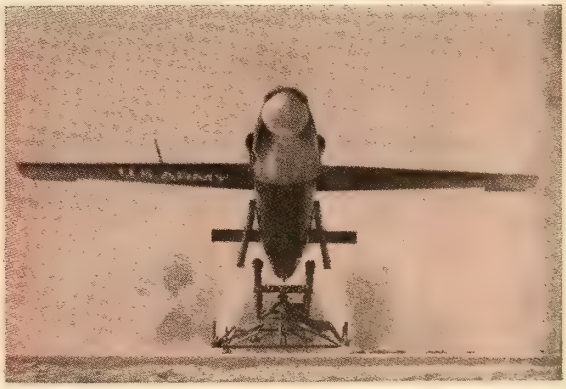
Prime Contractor Radioplane
Mission Low-altitude target for surface-to-air weapon system training and evaluation
Status Under flight evaluation
Speed 222 knots at sea-level
Altitude 25,000 ft. ceiling
Endurance 60 min. at sea-level
Launch Ground launched and can be fitted for air launch
Propulsion McCulloch 6-cylinder, 2-cycle air-cooled engine driving a 47" dia. propeller
Recovery Single-stage parachute
Flight Control Command or proportional command system with automatic stabilization
Span/Length/Height (ft.) 11.5/12.5/2.6
Gross Weight, without payload 405 lbs.
Augmentation Two wing-tip radar reflector pods are optional



OQ-19E

RP-77D

Manufacturer Radioplane
Mission Target for surface-to-air missile and gunnery training
Status Under flight evaluation
Speed 350 knots at 40,000 ft.
Altitude 40,000 ft. operational
Endurance 60 min. after climb to 40,000 ft.
Launch Zero-length using Loki or Falcon rocket boosters
Propulsion Boeing 502-10F free-turbine turboprop; 52" dia. propeller
Recovery 3-stage parachute
Flight Control Proportional command control and automatic stabilization system
Span/Length/Height (ft.) 17.5/14.9/5.2
Gross Weight, without payload 1000 lbs.
Augmentation Two wing tip radar reflector pods
Notes Craft can be used for combat surveillance missions



RP-77D

XKDT-1 (Teal)

XKDT-1 (Teal)

Manufacturer Temco Aircraft (Rocketdyne)
Mission Target for air-to-air weapon system training
Speed Mach 0.95 at 50,000 ft.
Altitude 55,000 ft.
Endurance 8.5 min. at 45,000 ft.
Launch Air launch from carrier-based swept-wing fighter aircraft
Propulsion Dual thrust solid propellant rocket motor
Recovery Expendable
Flight Control Programed and automatic stabilization
Span/Length/Height (ft.) 4.9/11.8/1.9
Gross Weight 350 lbs.
Augmentation Radar reflectors
Notes Craft is first successful solid-propellant rocket-powered target



(Continued from p. 21)

weighing only 436 lbs. and developing 3000 lbs. of thrust, a thrust-to-weight ratio of 7.

Another example of turbojet use is G.E.'s J79 with afterburner, which drives to Mach 2 the *KD2U-1*, a Navy target made by Chance Vought. Weighing 3200 pounds, the J79 provides 15,000 lbs. of thrust.

Where high-speed flight of at least seven to eight minutes at high altitude is wanted, the ramjet must be considered. There has been some criticism of this powerplant, laying to its door problems of flameout and inflexible operation.

Proponents of the ramjet, such as Lockheed who makes the *Q-5*, say that the "relative" inflexibility of the ramjet results in high reliability and low cost. "Besides," a company spokesman counters, "a target drone designed to perform all possible combinations of missions will degrade the performance . . . where it will not really be satisfactory for any mission."

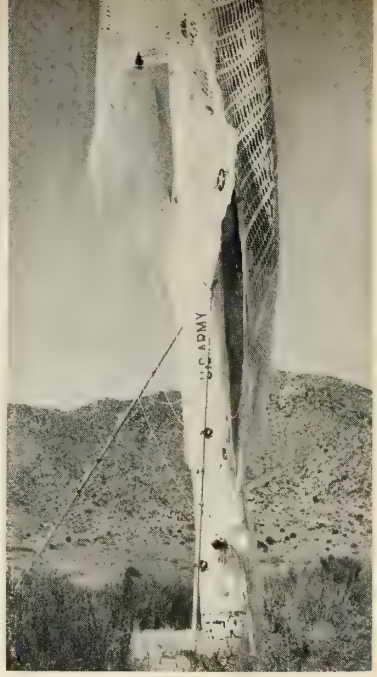
• **Programing a solid rocket**—The advantages of the rocket engine are well-known, high speed at any altitude but performing best with increasing altitude.

An advanced solid-rocket propulsion system, proposed by Rocketdyne's Solid Propulsion Operations at McGregor, Tex., uses a variable area rocket nozzle to give versatility to programing high-altitude, supersonic aerial targets.

For low cost and high performance, the propulsion system uses an ammonium nitrate propellant similar to that used in Temco's "*Teal*" target. For the *Teal*, a unique solid propulsion system was used in which a "boost" disc of fast-burning propellant was bonded to the slower burning "sustain" phase. The extra burst of power needed to get the drone away from the launching aircraft and up to cruise speed was thus designed into the propellant charge.

Addition of the variable area nozzle lets technicians program a variety of target missions together with launches at varying speeds and altitudes. Activation of the nozzle during flight can also be done by command control.

The scheme for liquid rockets powering targets, according to Thiokol's Reaction Motors, is to use "simple, inexpensive modular powerplants." A major feature of such a system is said to be its adaptability to meet most target mission requirements. By using one of three basic off-the-shelf thrust chambers or by merely "plugging in" extra chambers and components, the company says that any thrust level or flight profile can be had.



DRAPED in its parachute, the *Kingfisher* digs its landing spike into the ground.

In a performance envelope for its liquid-rocket powerplants, the company shows available thrust ratings with single-chamber configurations ranging from 15 to 320 lbs. at 100 psia chamber pressure; and from 50 to 530 lbs. at 300 psia chamber pressure. Two-chamber or three-chamber configurations extend the thrust to 960 pounds at 100 psia and 1590 pounds at 300 psia.

• **Firebee looks like B-52**—Augmentation, the technique of making aerial targets look in some aspect like the weapon being simulated, will always fall short of its intended purpose. Perhaps this comes from an engineering theorem which states that the only model that acts like a full-scale system is one that is identical to the full-scale system.

The familiar augmentation techniques to simulate a radar echo, of corner reflectors and Luneberg lenses, are systems usually compatible with most aerial targets. However, the disadvantage of the reflectors and lenses are that they give only a mono-static response to the inquiring radar.

Although these passive devices are relatively inexpensive, and show high degrees of reliability, their inability to provide the bi-static response needed for semi-active homing systems gives merit to the traveling-wave tube. According to Ryan Aeronautical Corp., which built a system around such a tube, the device can give a 22-foot long *Firebee* the average radar "echo" size equal to the AF's B-52 or the Russian's "Bison" bomber. One disadvantage of the tube is that it is not a cheap item, compared with other radar simulation means.

Another augmentation system using the traveling wave tube, a system that can also be used for target identification and tracking, is the Sperry Echo Enhancer, the "SEE" system. This is a wide-band microwave amplifier which re-radiates an illuminating radar signal with high fidelity. The amplifier gain can be adjusted with external attenuators to simulate the radar echo area desired. Radar illumination can be cw, pulse or doppler. All these can be applied simultaneously, says Sperry, with no appreciable interaction. The system has proved effective at speeds exceeding Mach 2 and at altitudes above 50,000 feet.

• **City mapped at Mach 1**—The effectiveness of a surveillance drone can be no better than the sensitivity, accuracy and versatility of its complement of sensors. For this reason, the number of sensors being used and considered for combat surveillance is long and includes optical aids, photography, television, passive and active infrared, radar, flash- and sound-ranging sets, and acoustic devices.

Here is an example of modern work in the sensor field being applied to drones.

The Motorola Military Electronics Division presently has a contract for developing side-looking radar for the *SD-2*. This extremely fast information-gathering radar system, when mounted in a drone, is able to map terrain and moving targets at drone speeds approaching the speed of sound. The system can map terrain at ranges approximating the diameter of a city from the flight path on either one or both sides of the drone.

As the drone flies along, the radar return signals from the narrow antenna beam are displayed on an intensity-modulated cathode ray tube. The single-line trace on the cathode ray tube is optically imaged on photographic film. The film is moved at a speed proportional to the speed of the drone. The motion of the drone thereby develops a radar map of all the terrain along the flight path.

In order to map on both sides of the drone simultaneously, it is necessary to switch the transmitted power from one antenna to the other very rapidly. The Motorola Solid State Electronics department developed a high-powered microwave rf switch for this application. Development of this switch, according to the company, represents an advance in the state of the art as well as providing a valuable radar capability.

Earlier it was said that what the

Army field commanders want from their drones is battlefield information in time to do something about it. One sensor system that appears will give this is Fairchild Camera and Instrument Corp.'s "Photo Transmission System."

This system permits aerial photography from any type vehicle including satellites, rapid in-flight processing of the aerial negatives, opto-mechanical scanning of the negatives to convert light energy into electrical signals for driving a microwave FM data link, and transmission of the aerial negatives to a ground station.

The ground station demodulates the FM signal and displays it on a pair of direct-view monitors (storage tubes) and generates a positive transparency which is rapidly processed for immediate viewing.

The time delay between the actuation of the aerial camera taking the picture and the viewing of a positive transparency on the ground is less than two minutes. The aerial negative after processing has a photographic resolution of 40 lines/mm on 70 mm film.

• **Controlling beyond-horizon drones**—What gave us the aerial target and drone field was the automatic guidance and control capabilities developed for the craft. An important system now in production, and used in Radioplane's *XQ-4B,* is the Sperry Microwave Command Guidance System (MCGS), developed by the Sperry Phoenix Company.

The system consists of three major sub-systems: a Flight Control Central, a Transponder Set and an Air Director. The Flight Control Central and Transponder Set are used for vehicle control, track and telemetry out to 200 miles, limited only by radar line of sight.

The Air Director is used as a relay to extend the operational range out to 400 miles, thereby getting below the horizon control with respect to the Flight Control Central. The Air Director is also able to control the vehicle independently of the Flight Control Central. Chain station operation of Flight Control Centrals can be used to give unlimited range.

Motorola is currently developing a navigation, guidance and control system for advanced, high-speed combat surveillance drones, under contract with the Army Signal Corps. The system uses a combination of a low-frequency hyperbolic navigation system and a doppler navigator, and the computer necessary for combining information from these two systems to control the flight of a drone.

The proof of a weapon system is how close its missile comes to the target. To get this information, several companies have devised and marketed highly accurate systems, ones that measure relative trajectory between a missile and its target, relative velocity and miss distance, among other parameters.

One objection to the systems available, according to a Navy engineering director, is that all of them require a signal source in the missile. He says, "When we fire a missile we don't want to first have to take it apart and plant some piece of apparatus inside of it, no matter how small the piece is." He added that opening up the missile might also influence its performance, perhaps in some subtle way.

Among the prominent companies making the systems are: Aerojet-General's Ordnance Engineering Division, which developed the FIRETRAC, Firing Error Trajectory Recorder and Computer; the Ralph M. Parsons Company, which developed PARAMI, Parsons Active Ring-Around Miss Indicator; and Aircraft Armaments, developer of the MDMS System, Miss Distance Measuring System.

• **Mach 1.5 tow target devised**—An idea of the workings of a typical system can be gained form Aircraft Armaments engineer Philip Yaffee's description of the MDMS. It comprises three basic components: A simple transmitter in the missile, a receiver-recorder on the ground monitor station, and a transponder in the target aircraft.

The aircraft transponder is actually an airborne relay station, which receives a radio signal from the missile transmitter on one frequency and retransmits it to the ground receiver on a different frequency. The doppler effect is the basic operating principle. A recording of the doppler frequency shift of the missile signal as it approaches and then passes the target is made at the receiving station. This record provides precise data on the miss distance, the relative intercept velocity, and the time of closest proximity of missile and target.

One airborne device that solves a number of problems such as cost and guidance, is the tow target. A leading company in the field is Del Mar Engineering Laboratories, maker of the newly announced Mach 1.5 high-altitude RADOP (radar/optical) tow target system. Tow lengths up to six miles are said to be feasible at supersonic speeds through the use of this system.

The target is lightweight, containing a passive radar reflector assembly designed to give 360° coverage with a uniform radar return. It is equipped with flares to provide an infrared source, powder cartridges for visual augmentation, a command receiver to actuate these aids and provision for miss-distance indication equipment.

Missile Steel

Motor Case Alloy Announced by Scaife

A cobalt-modified low-alloy steel has been developed specifically for missile motor cases by Scaife Co., Pittsburgh, Pa., subsidiary of Wilson Brothers.

The alloy, MX-2, is reported to be two to three times stronger than normal constructional steels. MX-2 can be readily fabricated by rolling, deep drawing, welding and machining.

The new alloy also appears to have increased resistance to weaknesses originating from notch sensitivity and heat treating. Design requirements can be met with only one half to one third as much MX-2 as compared to other constructional steels.

Motor cases of the material reached a 0.2% offset yield strength of 225,000 to 235,000 psi in uniaxial tensile tests. Ultimate tensile strengths of 275,000 to 290,000 psi have been reached and in hydrostatic tests, the alloy withstood 280,000 psi burst pressure.

The new steel was discovered by two Mellon Institute scientists assigned to a Scaife research team. One nominal composition released by the company is in the lower cobalt range and includes carbon, 0.39%; manganese, 0.70%; silicon, 1.00%; chromium, 1.10%; molybdenum, 0.25%; vanadium, 0.15% and cobalt, 1.00%.

Scaife has filed patent applications in the U.S. and abroad.

• **Broad market**—MX-2 is expected to find applications in areas other than missiles. The company estimates that potential use in the steel industry alone will be in excess of $100 million annually.

More than $750,000 worth of the new alloy has been produced for prototype investigations.

Scaife Co. is a metal fabricator; its deep drawing presses have been producing missile cases for over seventeen years. Since the firm does not have the facilities to melt MX-2 on the anticipated production scale, a licensing program is being formulated. Royalty figures have not been settled for this program, but the range might run from 3% to 10%.

Solid motor cases for the *Falcon, Matador, Hawk, Nike-Hercules* and other missiles have been produced by Scaife with its reverse deep draw technique. The MX-2 alloy is the result of a concerted effort at Scaife and the Mellon Institute to develop a steel ideally suited to exploitation of this forming method.



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'Microcrazing' Enhances Castings

by John F. Judge

Details of a unique metal casting method, involving the phenomenon of "microcrazing," were revealed recently by the U.S. licensor, Shaw Process Development Corp., Port Washington, L.I., N.Y., division of British Industries Corp.

Smooth surfaces, close-dimensional tolerances and complex shapes—qualities that usually result from costly machining operations—are possible in the as-cast product.

The heart of the process lies in the structure of the Shaw ceramic mold—a microscopic network of cracks aptly termed "microcrazing."

The entire mold is composed of jagged ceramic particles separated by minute fissures, or air gaps. Fissure size is critical since it must be small enough to prevent entry of molten metal, large enough to permit thermal expansion of the particles and yet adequate for the proper venting of gases trapped during the casting process.

This structure is directly responsible for such improvements as;

- Thermal Shock Resistance—individual particles have room to expand without affecting neighboring particles.
- Dimensional Stability—The mold does not change size during casting due to a coefficient of expansion of practically zero.
- Resistance to Hot Tears—According to the firm, this problem does not exist.

In addition, there are no inclusions, the mold is free of gas, and heavy and light adjacent sections can be designed into it without fear of voids.

- **Mold formation**—Initially a variety of blended refractory powders are mixed with an ethyl silicate-based binder and a small amount of gelling agent. The slurry is poured over a wood, or plastic, pattern and allowed to harden to a strong, rubbery gel. After being stripped from the pattern, the mold is ignited—burning off all the volatiles and setting up the microcrazed structure. Immune to thermal shock, the mold is then baked at elevated temperatures, removing the last vestige of moisture, and sent to the casting area.

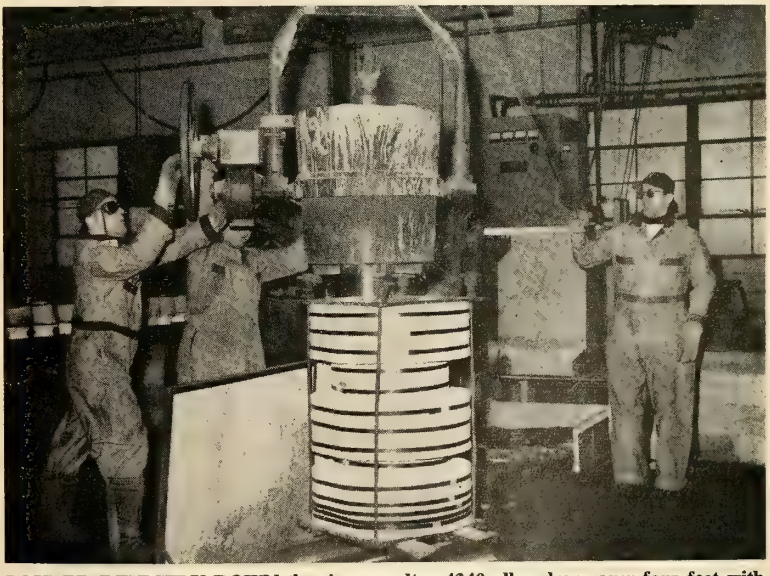
More than 100 foundries, precision casters and tool shops throughout the world are using the Shaw Process under license. Auto Specialties Mfg. Co. turns out first stage deflector nozzles for the *Nike-Hercules* through the Shaw Process. The firm also produces the second-stage nozzles in the same manner.

Gas inlet manifolds in Hastelloy B for the *Jupiter, Thor* and *Atlas* missiles are Shaw-cast by Lebanon Steel. The Watertown Arsenal is another licensee.

The process is a result of studies by two British scientist-brothers, Clifford and Noel Shaw. The Shaws were responsible for establishing the use of ethyl silicate as a binder for refractory molds—the foundation for the modern "Lost Wax" investment molding process. Their microcraze method is an improvement over the wax technique in that larger castings, closer tolerances and tooling cost savings are possible.

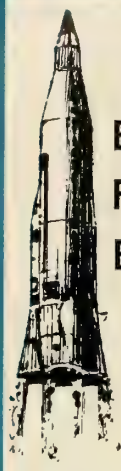


SECOND-STAGE NOZZLE for Army's *Nike-Hercules* ground-to-air missile is a Shaw-cast product.



POURED DIRECTLY DOWN the risers, molten 4340 alloy drops over four feet without causing wash in the thin sections of this nozzle casting at Auto Specialties Mfg. Co. The mold is composed of Shaw zircon faced cheek cores with a CO_2 grog backup.

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IBM 7090 Saves Money, Too

by Charles D. LaFond

HUNTSVILLE, ALA.—An often overlooked virtue in the newest of today's super-capacity computers is the fact that they not only enlarge operational capability—they actually save dollars.

It was with an eye on both of these attributes that scientists at the Army Ballistic Missile Agency here pushed so hard to obtain a pair of International Business Machine Corp.'s new solid-state Model 7090 computers.

Their efforts proved more than successful: the first two of 82 such systems obtainable during the next 11 months will be installed in the Computation Laboratory of the George C. Marshall Space Flight Center, located within Redstone Arsenal. (The Center, manned by Dr. Wernher von Braun's ABMA team, officially joins the National Aeronautics and Space Administration on July 1.)

First assignment for 7090's will be processing of test data and trajectory simulations for the *Saturn* space-vehicle booster.

Capable of making nearly 14 million logical decisions a minute, the IBM 7090 fully transistorized digital computer is considered the most advanced computational system which IBM has developed for general-purpose use. The first machine, dedicated at the Center on June 15 (M/R, June 20, page 17), is getting its final acceptance tests; the second will be installed in August.

The pair will replace two IBM 704's and one 709, both vacuum-tube computers until now regarded as highly advanced systems. Six times faster than its 709 predecessor, the 7090 is 7.5 times faster than the 704.

The desk-size machine employs over 50,000 transistors in its circuitry and a high-speed magnetic core memory. Data can be extracted from the 32,768-word memory in 2.18 millionths of a second.

• **Doubled output, same price**—Cost of each 7090 is roughly 25% more per month than for a 709, but a closer look at price vs. performance shows an entirely different picture. Rental for the three incumbent systems totals $180,000/month for a 24-hour operational day. The two 7090's will cost $130,000 for an 8-hour working day, and will accomplish the same amount of work as the replaced machines.

In time, if another 8-hr. shift is required, the additional cost will be 40% of the basic rental, or $52,000. The overall total then would be $182,000/mo., which is roughly the three-machine former cost. But total capacity would be doubled and there is still room to grow toward a third shift.

Finally, the Comp. Lab. personnel told M/R that a 70% savings also will be achieved with reduced power and air conditioning requirements.

• **Will level mountain of data**—The amount of data obtained at each static firing of the *Saturn* booster is overwhelming. Six to eight times greater than from any previous space program, information pours in from as many as 970 data channels. High-speed computers are the only answer to the problem of reducing and evaluating test results of this magnitude.

For example, Dr. Rudolph Hoelker, deputy chief of the Aeroballistics Lab. and a former member of Germany's Peenemunde rocket group, said that 20 years ago a simple V-2 missile trajectory calculation required 3-4 weeks and tied up 12 scientists. Today, using the new equipment and introducing many more factors, actual running time for a complete solution would be 30 sec.

Use of computers in studying test data and simulating flight trajectories has minimized guesswork in developing the *Saturn* booster. So much so that only 10 test flights, including four orbital, will be required before the 3-stage vehicle is designated operational.

• **New techniques introduced**—Two new system techniques will be used in operating the 7090 to increase efficiency and to aid operators and programers. Called SPOOK and FORTRAN, they are updated versions of developed computer procedures.

To better utilize the fast operating speeds of 7090, SPOOK (Supervisory Program Over Other Kinds) supervises, controls, and monitors a computing job permitting maximum effective use with minimum machine preparation.

An IBM-developed shortcut to programing, FORTRAN (FORmula TRANslation) "machine language" permits a programer to write a program without learning the language of the particular IBM computer. Consisting of 32 types of statements, it is a relatively simple language. The program, when complete, is processed by a FORTRAN translater. This changes it to an optimized machine-language program to which the computer will respond.



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Thirty contracts so far . . .

Air Force Outlines Broad Effort i

Los Angeles—The extent of the Air Force solar power program has been spelled out by Wright Air Development Division, which has about 30 contracts outstanding for solar power conversion devices and accessories.

The most active contractors appear to be Electro-Optical Systems, Inc., Sundstrand Turbo, AiResearch, General Electric, and Hoffman Electronics.

As part of its requirement to supply power for satellites used for communications, early warning, weather and navigation, WADD is investigating several methods of solar energy conversion to electrical power. Among them:

• Photovoltaic: represented by the solar cell system now in use on a number of satellites. This is the most reliable and efficient method we now have, according to WADD.

• Photoemissive: a direct conversion method which uses an anode to collect electrons emitted from a photoemissive surface when struck by sunlight.

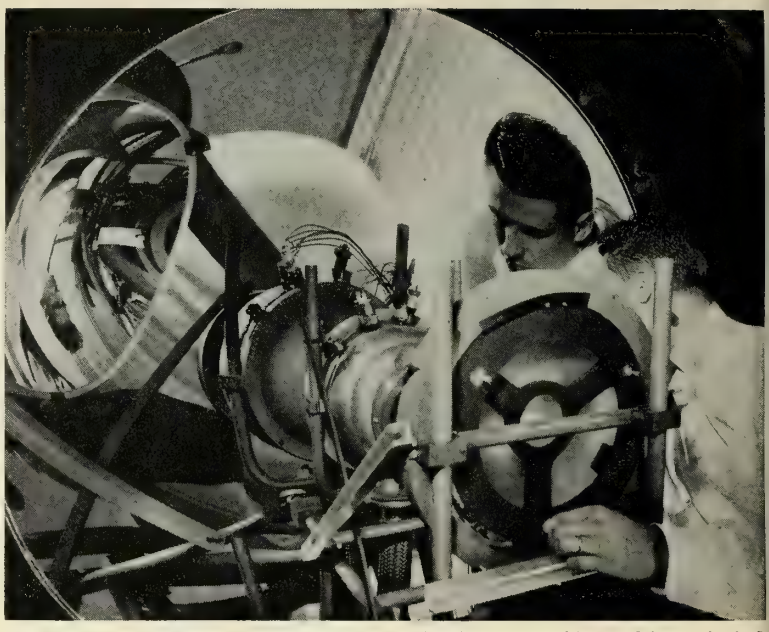
• Photolytic: characterized by the regeneration systems of fuel cells which operate on a chemical reaction due to photolysis.

• Solar-thermal: the collection of sunlight via a mirror and focusing system, which heats a boiler containing a working fluid. This in turn operates a turbine to generate electricity. A thermocouple arrangement would also fall into this category.

William C. Savage, Senior Research Engineer, Flight Vehicle Power Branch, WADD, told the American Rocket Society here that WADD's program aims to provide system engineers with sufficient data to permit attainment of objectives in advanced flight vehicles now being built.

According to Savage, the photovoltaic systems now being used represent the most reliable and efficient method of sunlight conversion, and additional development is expected to increase these advantages even further, although other avenues are being pursued.

In the photovoltaic field, Hoffman Electronics is developing a 500-watt silicon cell system capable of full orientation. One of the major disadvantages of previous systems was that constant orientation toward the sun was not practiced. NASA's *Explorer VI,* Savage pointed out, exhibited an overall efficiency of 1½%. A similar design, fully oriented, would have an efficiency of 6½%, or allow reduction of the required number of solar cells by 75%, without power loss, over an unoriented system.



SPECTRALLY SELECTIVE surfaces are studied in solar facility at Electro-Optical Systems, Inc., under AF contract, making use of concentrated solar radiation.

The Hoffman system will have a maximum deflection of ±10 degrees from the normal. The angular variation represents only a slight variation in power output. The system will be "kicked" from one limit to the other, coasting in a five-degree dead space. Studies have been conducted on low impedance and low friction slip ring type connections which permit movement of the paddles relative to the vehicle.

Liquid metal electrical connections were investigated by Hoffman, and it was found that a mercury ring contained in a circumferential groove inside a Teflon bearing, (working against a shaft made of metal which will not alloy with mercury), was feasible and would best satisfy electrical connection requirements.

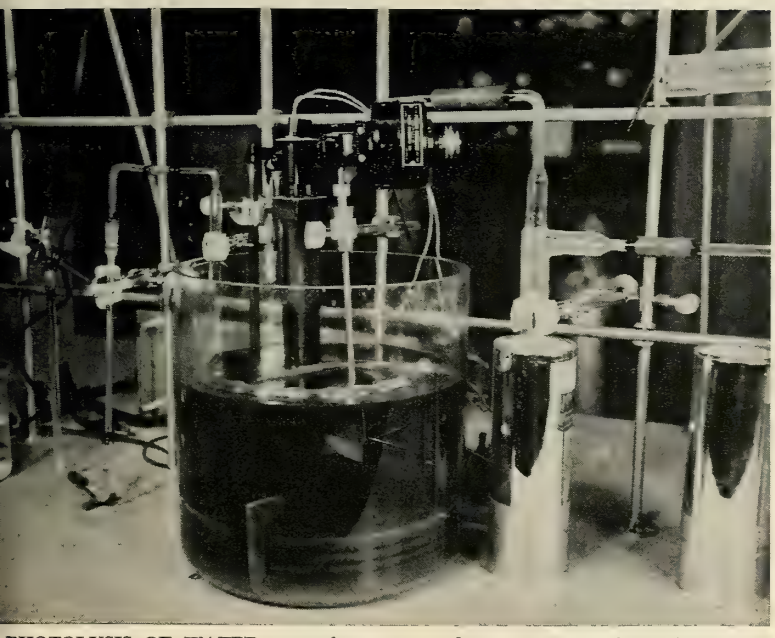
The company also studied mercury bearings, "but concluded that a loose fit of metal on Teflon and the mercury bearing would be best."

Conventional slip rings would have high frictional forces due to the requirement for added brush pressure under vacuum conditions. For the design contemplated, torque due to viscosity was calculated to be 10^{-4} dyne-cm for each liquid ring per centimeter length. The loss of liquid metal for a bearing shaft clearance of .006" was figured to be 0.7 kg./year.

• **Energy storage**—Cited as "one of the major areas for improvement in the solar power system, energy storage has gotten considerable attention from WADD, said Savage. Presently used nickel-cadmium batteries, although having the best cycle lifetime, are relatively poor—since for reasonable life the storage capability is estimated to be about one watt hr./lb. of battery for a 6000 cycle life having a 10% discharge/charge cycle. WADD is now establishing accurate design criteria for life under various charge/discharge cycles.

Tests are being conducted on fifty type F nickel cadmium batteries simultaneously, with an electronic solar cell simulator assuring charge conditions

olar Power Research



PHOTOLYSIS OF WATER vapor in presence of mercury vapor is carried out at Electro-Optical as part of WADD-sponsored research into solar energy conversion.

that accurately duplicate system operation.

Photovoltaic system design also considers the optimum series-parallel arrangement of cells in each subassembly to obtain maximum reliability. Savage pointed out that a static system can suffer a failure with a minimum reduction in performance, while a dynamic system failure usually results in total loss of usefulness.

• **Photovoltaic research**—The 6½% efficiency referred to above is based on silicon cells whose efficiency averages 8%. WADD has contracted with Westinghouse for development of 15% efficiency laboratory model silicon cells, and with Hoffman for investigation of manufacturing methods to produce high-yield 12% cells.

These improvements can be accomplished by reducing contact and sheet resistance, accurately controlling impurity diffusion, improving surface coating and cutting reflection losses.

In addition to the research on silicon cells, a similar program is under way at the Radio Corporation of America to study gallium arsenide. Indications are that the cost of this type of cell will be no less than silicon, and that it has greater brittleness. It does, however, offer higher potential efficiency, and can operate at higher temperatures.

Other high-temperature materials for photovoltaic applications are being investigated at Harshaw Chemical on cadmium sulfide cells. Efforts thus far have sought to determine the effect of impurities on cell efficiency and characteristics. Highest efficiency obtained in laboratory tests so far has been 7%. The material shows promise as a low-cost cell, when compared with a polycrystalline cell.

Shockley Transistor is making a theoretical analysis of the electrical and physical parameters applicable to the design of solar cells. Through this study, WADD hopes to determine the basic reasons why cells fall short of their theoretically predicted maximum performance.

Electro-Optical Systems has a contract for the reduction of cost per kilowatt and pounds per kilowatt through the use of light concentrators.

A standard light source and evaluation technique is being set up by Mount Vernon Research, which will closely simulate a 59000 black body or solar spectrum. Problems with noise, heat dissipation and protection of personnel from ultraviolet radiation are anticipated in this development program. At present, varying efficiencies are reported for the same cell, depending on the test technique used to measure characteristics.

• **Other methods studied**—Photoemission phenomena are being studied at RCA despite their anticipated low efficiency; low cost and potential advantages through use of light flexible structures may increase the method's attractiveness. RCA's program calls for selection of optimum materials, fabrication of three laboratory models and investigation of their characteristics.

Electro-Optical Systems and Physics Engineering and Chemistry Corp. are carrying out studies into the photolysis of water, using inorganic salts as sensitizers. WADD feels that the process, if carried out efficiently, may lead to a regenerative fuel cell, or may also result in a source of oxygen and hydrogen for other uses.

Present research is quite basic in nature, and primarily designed to demonstrate the phenomena. Electro-Optical is also investigating the photolysis of water vapor in the presence of mercury vapor.

In the solar-thermal field, WADD contractors are working on:

• A 500-watt solar thermionic system, supported by Advanced Research Projects Agency, being developed by General Electric.

• A 500-watt solar regenerative fuel cell, being developed by Sunstrand Turbo.

• A three-kilowatt Stirling cycle engine being supported by ARPA and under development by the Allison Division of General Motors.

• A Rankine cycle advanced working fluid turbine system, being designed by Sundstrand Turbo.

• Supporting programs on solar collectors, orientation, radiators, heat storage and zero gravity, under investigation by Electro-Optical Systems and several other contractors, whose final arrangements are still under negotiation.

Thermionic buttons are under study by General Electric, which is determining the characteristics of a 500-watt system through fabrication and test. One of the problems of the thermionic

system is its need for great accuracy of orientation; another is heat storage during periods spent in darkness. Orientation requirements are about $\pm 5^1$.

One method being considered for maintaining temperature of the thermionic buttons during darkness is to close an iris at the entrance to the black body cavity in which the buttons are located.

The 500-watt regenerative fuel cell being developed by Sundstrand Turbo is an attempt to minimize the energy storage problem. Thus far, little has been done to combine the regenerative chamber and the fuel cell, WADD says, because of low yield from the regeneration process and poor operation of a mechanical separator.

In Sundstrand Turbo's' design, nitric oxide and chlorine are combined for the production of power—with the resulting product of the cell, nitrosyl chloride, being decomposed by the action of solar energy into its original constituents.

It's hoped that the Allison solar power system, a three-kilowatt dynamic Stirling cycle engine, will have an efficiency of 23%, if the anticipated engine thermal efficiency of 34% is attained. This engine will use gaseous helium as a working fluid and operate between temperatures of 1250°F and 180°F. Thermal heat storage using lithium hydride will be used during periods of darkness.

Potentially smaller volume and lighter weight is expected from a 15-kw Rankine cycle advanced working fluid system being developed by Sundstrand Turbo. The advantages can be realized at an overall system efficiency of 15%, provided an adequate high-temperature heat storage system can be evolved.

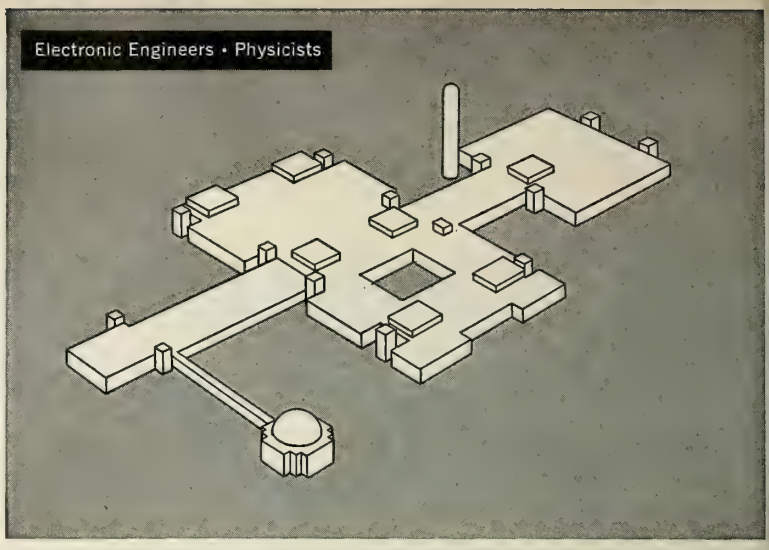
The emphasis in this project is to design components which will operate satisfactorily with the higher temperatures possible with use of such fluids as rubidium and potassium.

In addition to these, an advanced solar systems study, in the 1-to-30 kw range, is being undertaken by AiResearch, with the goal of optimizing weights, sizes, working fluids and cycles.

Using a mercury working fluid, Thompson Ramo Wooldridge is working on a contract to demonstrate a 1-kw solar power system. The solar power unit demonstrator (known as SPUD I) will operate on a Rankine cycle.

WADD's heat transfer group has underway projects covering problems of collectors, boilers, radiators, heat storage, and zero gravity.

Tests to investigate the zero gravity problem are being conducted aboard Air Force aircraft, and on some missile flights.



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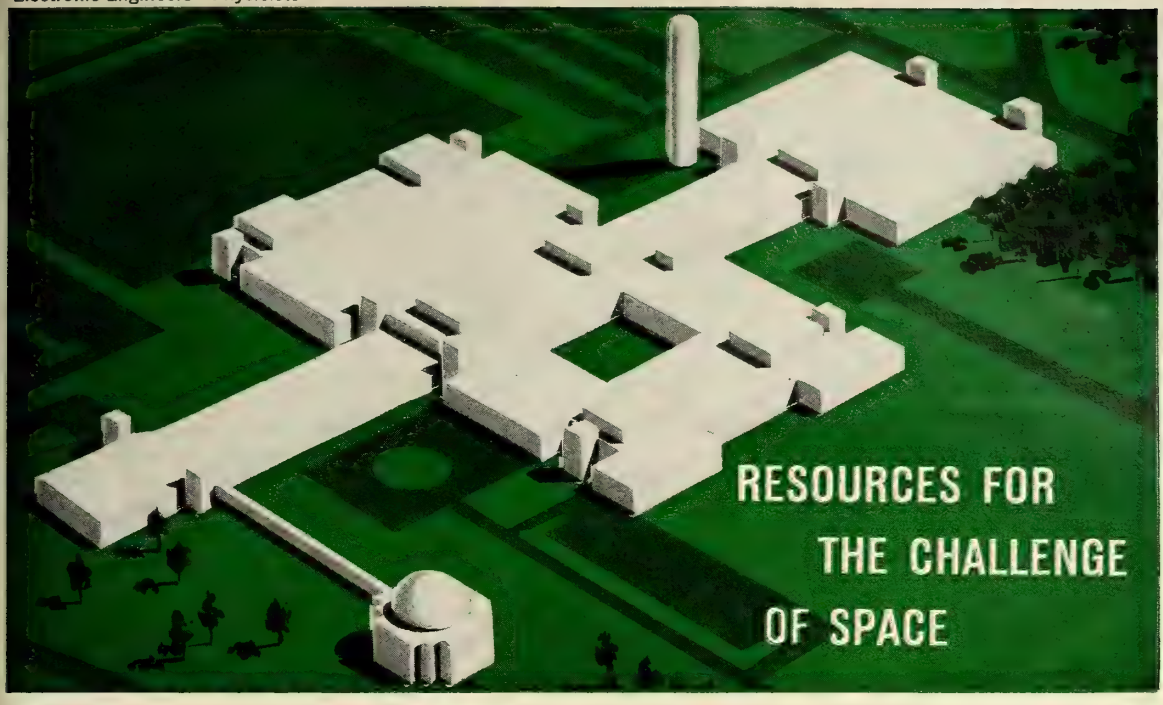
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Check additional openings listed to the left, and write to Mr. Thomas H. Sebring, Div. 73WZ.

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Solid Aging Study to Up Reliability

by Frank G. McGuire

MENLO PARK, CALIF.—The aging of solid propellants is being studied at Stanford Research Institute in a program that may play a key role in major missile systems.

At present, reliability of solid-propellant motors can be guaranteed for less than five years, although it is hoped that *Polaris* and *Minuteman* motors will be useful for longer periods. Reliability is considered "relatively" certain for 10 years; knowledge is lacking about the proper functioning of solids beyond a decade.

SRI points out that it's tough to predict the reliability of a weapon system when its primary propulsion unit is a more or less unknown factor.

Much basic research and development work is being done to determine the reliability after storage of such missiles as *Minuteman, Polaris* and *Skybolt*, but there are no conclusive answers yet, according to Stanford spokesmen.

• **Money-savings**—With knowledge of "life" or condition, SRI feels, it should be possible to set up a general program for selective replacement of solid-propellant motors in stored missiles to insure maximum reliability.

The researchers say that the program, based on non-destructive testing of each motor, would cost less than a total replacement program—based on entire production runs after a fixed aged period—and would guarantee a higher, more uniform reliability level.

This would be more efficient than replacement of motors after a specified time lapse, they believe, and would substantially reduce costs of a maintenance program.

Polaris and *Minuteman* both utilize motor casings which also serve as external missile frames, and hence require removal of a major portion of the missile's structure during motor replacement. In the method proposed by SRI, the guidance and control sections would be removed, the motors replaced with fresh spares, and the missile put back in its silo or launcher.

Meanwhile, the aging motor could be returned to a propellant loading site, the propellant removed from the casing by use of high-pressure water streams (or a solvent), and the expensive case reloaded with fresh propellant.

It has also been suggested that motors approaching the age limit be used in training shots, rather than go through a possibly expensive motor replacement program.

To establish a selective replacement program, Stanford says, missilemen must be able to answer these questions:

• What is the condition of each motor?

• How will this affect its behavior?

• Is this behavior acceptable in terms of overall reliability levels established for the missile?

• **Search for a yardstick**—Unfortunately, says SRI, there still is no "clock" or "age meter" which can show the condition of a rocket motor propellant after aging effects.

SRI hopes its "age meter" development will fill the need.

Being developed in a program for Edwards AFB, Calif., the device consists of a ceramic plate or transducer to which an electrical signal is applied. This signal creates ultrasonic vibrations in the plate which are absorbed by the propellant. Changes in the propellant vary the degree of energy absorbed and the resulting effect provides an electrical measure of the change.

The increase in types of propellants is heightening the need for a yardstick to indicate when they become of marginal reliability.

• **Three choices**—Norm Fishman, project leader, suggests this yardstick could take several forms: a surveillance program which would spot-check missile age groups by actual firings; accelerated aging and study of specimen missiles; or development of an acceptable "age meter."

The surveillance program is expensive: it calls for over-production of motors that would be fired at specified time intervals to give an indication of the quality of motors in the same age group.

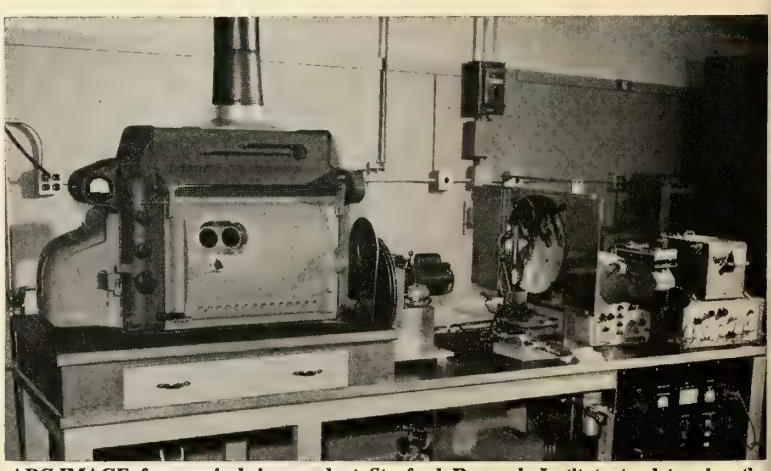
Accelerated aging and study of specimen missiles is less expensive—but assurance would have to be obtained that the data were applicable to standard units.

However, any "age meter" requires a certain amount of full-scale surveillance in order to calibrate the device against actual performance.

• **Symptoms**—Some of the manifestations of aging are degradation of the polymeric binding fuel, creep, chemical interchange, loss of ignitability, cracking of the grain, and slumping of the star points. Some environmental factors of aging are temperature, oxidation and/or moisture.

Cracking of the grain, when it occurs after ignition, can cause "catastrophic" pressure rises. In some composite propellants, migration of fuel fragments to the surface of the grain makes ignitability more difficult. A similar occurrence in a double-base propellant considerably enhances ignitability and also changes the performance of the propellant.

According to test data, ballistic properties of the propellant usually are affected less than physical properties or



ARC-IMAGE furnace is being used at Stanford Research Institute to determine the ignitability of propellants after varying periods of aging.

ignitability of the grain after aging. Motors which have been stored for some time may show no change in thrust, although the burning duration may be somewhat extended. Erosive burning and increased burning rate stems from softening of the propellant, however.

Various preventive methods have been suggested for combating the degradation of motors: A complete sealing of motors in a chamber, including dessicant packages in the motor container, coating the grain surface with a protective spray and storing in special gas atmosphere.

• **Unique tools**—Since beginning work on the propellant-aging problem in 1953, SRI has based its approach on fundamental consideration as well as direct practical investigation. SRI's type of study usually is so unique that there is no readily available or adaptable test equipment. Therefore, new techniques must be developed and hardware improvised. Test equipment is often constructed piecemeal, as the need arises, and sometimes dismantled immediately after its mission is over.

Equipment developed to further the propellant program includes arc-image furnaces, high-strain rate-test machines, creep and stress relaxation equipment, an automatic recording densitometer for low-temperature use, electron spin resonance equipment and sonic test equipment.

The history of the optical densitometer typifies this approach to research: It was necessary to determine the mechanism of low-rate embrittlement at low temperatures; several approaches yielded no conclusive results. The lab constructed an automatic recording optical densitometer within a few hours. A few more hours were spent showing that crystallinity was not a factor. Then the machine was dismantled.

In a novel application of the arc-image furnace, SRI scientists are determining the ignitability of propellants after various durations of aging. Radiant energy from a carbon arc is transmitted through a mirror and shutter system and focused onto a propellant specimen. Comparison of the energy required to ignite fresh and aged specimens of propellant is a valuable indication of future reliability of the ignition system. As well as determining ignition energy requirements, this test covers other aspects of ignition behavior.

In its study of creep properties, SRI has developed a test machine to automatically and continuously measure creep under constant load. Accurate to 0.005 in., the equipment utilizes a strip-chart recorder for data readout. An attachment allows measurement of stress relaxation behavior as well.

Rover Support Work Tops Busy Build-up at Los Alamos

Laboratory is now spending $8 million for new building—another $14.3 million is in planning stages

Los Alamos, N.M.—More than $3½ million is being spent at Los Alamos Scientific Laboratory on support facilities for the Project *Rover* nuclear rocket program. A hot cell facility, a remote-controlled inspection building, a shop and equipment checkout building, and a non-destructive test building are under construction.

About $8 million is now being spent for new building at LASL, with more than $14.3 million in additional construction, (part of it also for Project *Rover*), on the drawing board or planned for the next fiscal budget.

Four of seven buildings now being built here are totally or partially committed to support of *Rover*. The 60,000-sq.-ft. hot cell is an addition to the chemistry-metallurgy building at LASL, and will cost $2,872,400 to construct. When fully equipped, its total value will be about $4,623,000—more than half accounted for by *Rover*.

Specially designed hot cells in the structure will be used for post mortem examination of radioactive components removed from nuclear propulsion test reactors at the Nevada Test Site. This examination will cover both radiochemical and metallurgical aspects.

The hot cell, now 10% complete, is expected to be finished in February.

The remotely-controlled inspection building, known as Kiva #3, will be complete by September. ("Kiva" is the local New Mexican Indian word for "a building," and should not be confused with Kiwi, the test reactor in the *Rover* program.)

Kiva #3 will have an environmental chamber for testing *Rover* mockup systems used in temperature coefficient studies. Capability of the chamber ranges from −85°F to 700°F.

In addition to this chamber, other critical assemblies can be accommodated in the *Kiva*, operated by remote control and observed through closed circuit television. The 5000-sq.-ft. building is more than 30% complete.

LASL has just broken ground for a shop and equipment checkout building designed to handle *Rover* engineering projects. A 4400-sq.-ft. addition has already been proposed to supplement the originally-planned 8000-sq.-ft. building. Completion is anticipated by mid-November.

The non-destructive test building will contain an electronics laboratory and space for several types of test equipment. Construction is expected to be completed by September.

• **Other construction**—In addition to these *Rover* support facilities, other projects at LASL are also booming. A PHERMEX X-ray facility, a power reactor test building, and a computer center are in various stages of completion.

Four buildings make up the X-ray facility, which totals 37,010 sq. ft. and is expected to cost over $3,500,000 when fully equipped. Construction is 25% complete, and should be finished by November.

The power reactor test building, costing $1,821,900, is nearest to completion of all current building projects. Major parts of the facility were completed in March, and a shielded test pit is over 70 percent finished. Included in the structure are a reactor control room, offices, laboratories, and two reactor assembly rooms.

Highest priority during the current boom has been placed on the computer center, which will house Stretch, the world's fastest computer. The contractor has 180 days to complete the ultra-modern 9000-sq.-ft., one-story structure, with a $1000 daily penalty levied for every day over the scheduled 180. The $399,580 building, when completed, will house the $4,300,000 IBM computer.

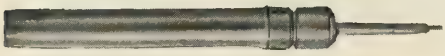
Stretch will be used to work on calculations relating to the *Rover* program, upon completion of the computer facility.

• **Future projects**—A $4,886,000 facility is planned to house Turret, LASL's planned high-temperature gas-cooled reactor. Construction on this facility is scheduled to begin by March, 1961.

Next month, engineering design will begin on a new plutonium fuel service and development facility. The building, costing over a half million dollars, will be used in investigations of plutonium, with the objective of using the material as a reactor fuel in forms other than alloys. Construction would begin about January, 1961.

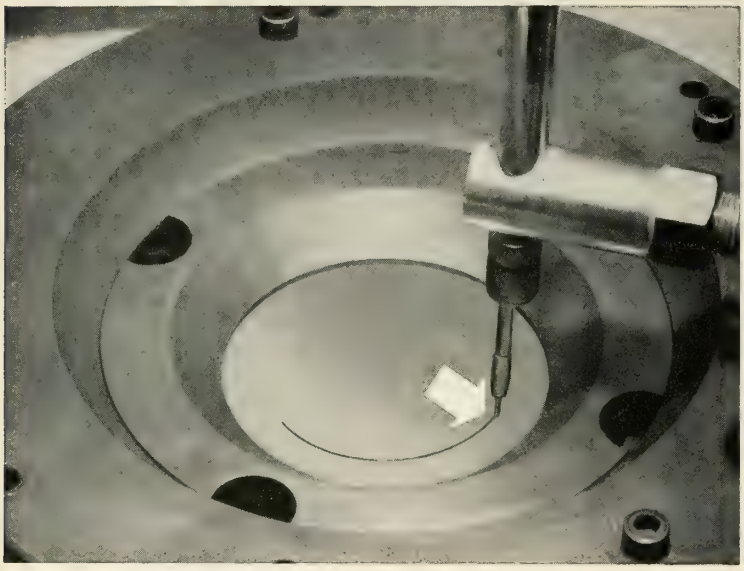
A nearly $7-million reactor core test facility at LASL is in the budget for next year, slated for use in the next stage of the plutonium reactor program.

Another "impossible" job done by the Airbrasive...



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abrading • cutting • deburring • stripping • drilling • cleaning • scribing



Comstock & Wescott found: "The most practical way to cut tungsten sheet without cracking!"

Here was a tricky job for the Airbrasive. Comstock & Wescott, Inc., Development and Research Engineers, Cambridge, Massachusetts, had to cut 0.005" thick tungsten sheet into circular components for missile systems. Mechanical cutting methods caused the brittle tungsten parts to crack. *The Airbrasive did it successfully!*

How does the Airbrasive work? It obtains its precise cutting action from a high-speed jet of dry gas and abrasive particles that quickly cuts, slices or abrades, as needed, almost any hard brittle material... germanium, silicon, glass, alloy steels, ferrites, mica, ceramics and others.

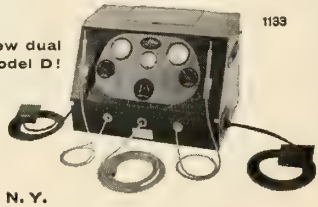
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—when and where—

JUNE

Fourth National Convention on Military Electronics, sponsored by IRE Professional Group on Military Electronics, Sheraton Park Hotel, Washington, D.C., June 27-29.

Institute of the Aeronautical Sciences, National summer meeting, Ambassador Hotel, Los Angeles, June 27-30.

JULY

Metallurgical Society of American Institute of Metallurgical Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Prof. Group on Communications Systems and Army Signal Corps, Statler-Hilton Hotel, Washington, D.C., August 1-3.

Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, August 1-12.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, August 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, Cortez Hotel, San Diego, Calif., August 9-12.

ASME-AICHE Heat Transfer Conference and Exhibit, Statler-Hilton, Buffalo, N.Y., August 15-17.

XIth International Astronautical Congress, Stockholm, Sweden, August 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, August 23-25.

German Rocket Society, Annual Meeting, Hanover, Germany, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control Institute, Storrs, Aug. 28-Sept. 9.

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Sept. 7-8.

Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Sept. 7-9.

American Chemical Society, 138 National Meeting, New York, Sept. 11-16.

—names in the news—



MAURO

Dr. John A. Mauro: Appointed consulting optics engineer by the Ordnance Department of General Electric Co. He transfers from the company's General Engineering Laboratory where he helped to design optical subsystems for *Polaris* fire control and guidance.

Gerald L. Solley: Named manager of Lytle Corp.'s newly-opened San Diego Services Division.

Dr. Harner Selvidge: Former western corporate representative of Bendix Aviation, appointed vice president and general manager of Meteorology Research, Inc.

James N. Edwards and **Alex Marco:** Join Space Electronics Corp.'s technical staff. Edwards was formerly with Hughes Aircraft Co. and is the holder of two patents in electronic circuit design. Marco was previously with Gilfillan Brothers.

Arthur S. Baker: Elected manager of marketing administration for the General Electric Rectifier Component Products Section. Formerly served as manager of marketing administration for the Audio Products Section, Radio Receiver Department.

Zeus Soucek: Appointed vice president-eastern division at Grand Central Rocket Co.



DUCKOR

Lewis M. Duckor: Elected vice president-engineering for Colvin Laboratories, Inc., responsible for coordinating all design, development and engineering functions. Was previously with Lockheed's Missiles and Space Division as senior research engineer in instrumentation.

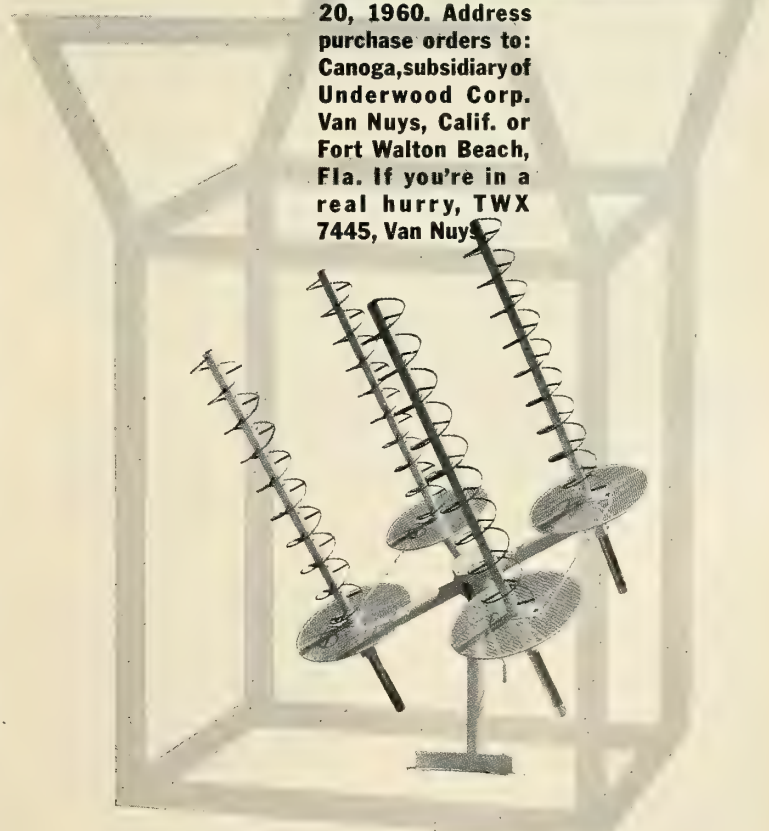
R. W. Powell: Manager of Aerojet's Avionics Division, named chairman of the Aerospace Industries Association's Electronic Equipment Technical Committee.

Z. R. S. Ratajski: Joins Kearfott Division, General Precision, Inc., as chief of research and advanced development, Precision Components' Division.

Dr. Robert V. Meghreblian: Appointed chief of the Physical Sciences Division at the California Institute of Technology Jet Propulsion Laboratory, replacing **Dr. Melvin Gerstein. Dr. Hadley Ford** named chief of JPL's chemistry section, and **Dr.**

7 ~~DAYS~~ DELIVERED IN ~~DAYS~~:

The problem: Effective manual tracking of satellite on the 225 megacycle telemetry band. The customer: Lockheed Missiles and Space Division, Sunnyvale, California. Date of order: Friday the 13th, (they did everything they could to make us prove our point), May, 1960. The job: To design, manufacture and deliver within 10 days a quad helix antenna. Date of delivery: Friday, May 20, 1960. Address purchase orders to: Canoga, subsidiary of Underwood Corp. Van Nuys, Calif. or Fort Walton Beach, Fla. If you're in a real hurry, TWX 7445, Van Nuys.



canoga

CANOGA/A SUBSIDIARY OF THE UNDERWOOD CORPORATION VAN NUYS, CALIFORNIA • FORT WALTON BEACH, FLORIDA

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John Laufer, chief of the gas dynamics section.

Dr. Robert L. Tanner: Former head of Stanford Research Institute's Antenna Research Group, elected manager of the Electromagnetics Laboratory. He replaces **Dr. Seymour B. Cohn,** who is now vice president and technical director of the Rantec Corp.

Arthur A. Warford: Former plant manager and chief chemist for Core-Lube, Inc., joins Macco Products Co. as manager-customer services.

George E. Comstock III: Former engineering section head-Tape Transports, elected chief engineer for Potter Instrument Co.

P. Eugene Laliberte: Named director of marketing in the Electronics Division of Stromberg-Carlson.

Jack H. deKruif: Formerly of Hughes Aircraft Co., appointed vice president of marketing and sales for Warner Electric Brake & Clutch Co.

Dr. Herman A. Bruson: Formerly director of research, organic chemicals, elected vice president-research, Chemicals Division of Olin Mathieson Chemical Corp.



Circle No. 15 on Subscriber Service Card.

Dr. Pei Wang: Former research associate at the University of Wisconsin and senior engineering specialist, named to the newly created post of engineering manager in charge of device services for the Semiconductor Division of Sylvania Electric Products, Inc.

Samuel P. Crago: Formerly with Hamilton Standard Division of United Aircraft Corp. joins The BG Corporation as vice president and general manager.

Perry Addleman: Elected to the board of directors of Standard Kollsman Industries, Inc., replacing **Victor E. Carbonara,** retired.

L. R. (Bob) Hoffman: Named manager of Lockheed Aircraft Corp.'s new corporate office on Boston's "Space Highway."

John N. Robinson: formerly with Tennessee Product and Chemical Corp., joins the technical service engineering staff of Metal Hydrides Inc.

Norman J. Regnier: Named program manager for an advanced semiconductor reliability study being conducted by Motorola Semiconductor Products Division for Autonetics, a division of North American Aviation, Inc., as part of the *Minuteman* program.


REGNIER

Dr. Miles C. Leverett: Manager-development laboratories for the General Electric Aircraft Nuclear Propulsion Dept., named president of the American Nuclear Society for 1960-61.

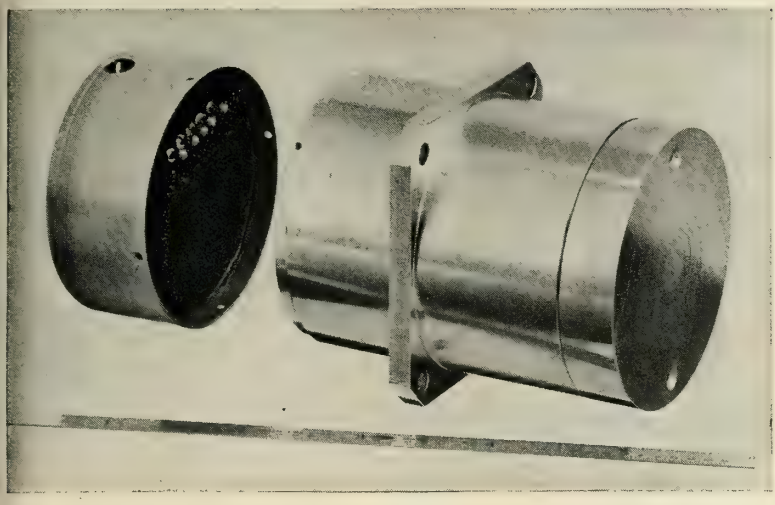
Clyde W. Kaericher: Former director of administration at Minneapolis-Honeywell Regulator Co.'s inertial guidance plant at St. Petersburg, joins Telex, Inc., as vice president in charge of corporate affairs.

Lawrence T. Garnett: Former assistant cheif engineer of the electronic controls division of Manning, Maxwell & Moore, Inc., joins Robertshaw-Fulton Controls Co.'s Aeronautical and Instrument Division as senior development engineer.

Hugh C. Beam: Named president and general manager of Western Design, a division of U.S. Industries, Inc., replacing **C. W. Sponsel.** Prior to joining the firm, he was vice president-marketing, Hoover Electronics Co. and manager of the Electronics Division, Rheem Manufacturing Co.


BEAM

Dr. Josef Roesmer: Joins Nuclear Science and Engineering Corp. as advanced scientist in the Chemistry Department.



Solid-State Inverter Gyro

Gyro Dynamics Division of Darco Industries has introduced a solid-state inverter gyro enclosed in a single housing. The solid-state inverter is designed to operate from a 24 to 32 volt DC source, but source voltages of 12 to 50 can be utilized and are permissible.

With nominal source voltages, the solid-state inverter converts the input voltage to a squarewave A.C. signal of approximately 60 volts, peak to peak. Signal frequency and voltage is regulated and maintained to within 1% when operated from a variable source of ±5%, and with ambient temperatures of −65° to 200°F.

The gyro wheel is assembled into the floated chamber, which is hermetically sealed and floated in the fluid medium. Stainless steel pivots are secured to the floated chamber on the output axis. The top pivot is hollow and provides lateral support for the torsion bar restraint. The complete assembly is double bearing supported in the gyro inner case assembly.

The viscous shear-damping mechanism provides an essentially constant damping coefficient from −65°F to +165°F without the use of a heater. Rate gyros having damping coefficients within ±0.2 of nominal have been produced for this temperature range.

All gyros are hermetically sealed and have been operated at altitudes in excess of 200,000 ft.

The potentiometer pickoff mechanism consists of a fully floated mechanical amplifier, providing a nominal ratio of 4:1. This makes it possible to provide an instrument with resolution capabilities up to ±1/300 of maximum rate (600 total turns on the potentiometer) with a gimbal deflection of only 3°. Minimum cross coupling and a high natural frequency are additional advantages.

Circle No. 225 on Subscriber Service Card.

Voltage Regulator

An on-off temperature control combining the proven mercury tube and reliable germanium transistors is being manufactured by Vap-Air Division of Vapor Heating Corp.

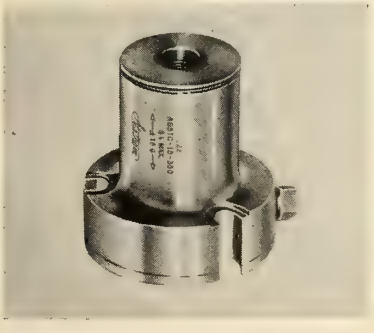
This combination enables the highly accurate mercury tube to switch loads up to 10 amps at 28 volts dc with no moving parts. Various housings are available for uses up to 350°F.

Circle No. 226 on Subscriber Service Card.

In-Flight Accelerometer

A linear accelerometer, Series A65, is now available from Statham Instruments, Inc. The In-Flight instrument responds flat within ±5% from static to 830 cps.

The unit embodies Statham's unbonded strain gage principle, with the resistive elements arranged in a complete Wheatstone bridge. It provides the accuracy, reliability and long service life characteristic of the unbonded strain gage.



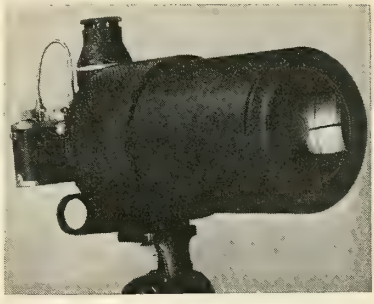
Model variations are available in a wide range from ±7.5g to ±150g. Requiring an excitation of 5v DC or AC, the new accelerometer has a nominal output of ±20 mv. Its combined non-linearity and hysteresis is less than ±1% of full-scale output. The instrument is rated for ambient temperature limits of −40° to 200°F.

Circle No. 227 on Subscriber Service Card.

Telefold Lens From ARC

A Telefold lens designed to offer a long focal length system in a very short, light-weight package is available from Atlantic Research Corp.

The three-pound lens is only ten inches long and just over five inches in diameter. The lens uses a catadioptric system which permits a 42 in. focal length to be folded into the 10 in. tube,



and incorporates a focusing system that permits its use for objects from two feet to infinity.

Designed to be used with a single lens reflex focusing camera, the Telefold lens can be adapted for use on television cameras, and on 8-mm, 16-mm and 35-mm still and movie cameras.

Circle No. 228 on Subscriber Service Card.

Optical Proving Rings

High accuracy in load measurement is now possible with an Optical Proving Ring developed by Steel City Testing Machines, Inc. Air Force experience indicates a repeatability of 1/20 of 1% of full-scale deflection.

Load is applied along the axis of the two bosses on the ring. An accurately divided scale contacts the upper edge of the ring and moves up or down through the field of a microscope as the ring is deflected. The microscope is attached to the lower

portion of the ring and contains a reticle scale which serves as a vernier, appearing superimposed over the moving scale. The combination of scales is graduated to twenty millionths (0.00002) of an inch. By estimating to half graduations, readings to ten millionths of an inch are obtained. Readings are taken directly without the need for adjustment during use.

Circle No. 229 on Subscriber Service Card.

Paper Tape Converter

A computer device to transfer data from punched paper tape to magnetic tape is available from International Business Machines Corp.

The IBM 7765 converter writes magnetic tape that can be read by a computer at 15,000 or 22,500 characters a second. Companies transmitting data with paper tape devices thus can achieve computer input at several times the speed of the fastest direct paper tape input.

Circle No. 230 on Subscriber Service Card.

UHF Command Receiver

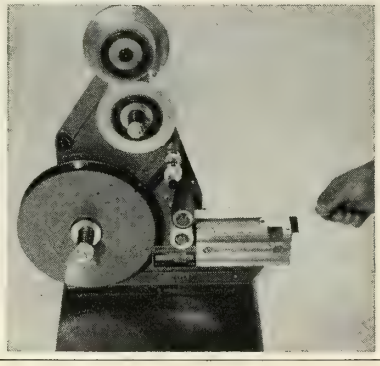
A transistorized UHF command-destruct receiver has been introduced by RS Electronics Corp.

Model 2620 is approximately one-fourth the size, and one-third the weight, of RSE Model 2610 subminiature tube command receiver, and requires only 1.5 w of input power. This receiver operates in the 400 to 550 megacycle range, has a sensitivity of 5.0 mv, a total volume of 16.8 cu. in. and a weight of 1 pound.

Circle No. 231 on Subscriber Service Card.

Adhesive Laminator

A laminator designed to make any electrical insulation pressure-sensitive right on the production line is being produced by Minnesota Mining and Manufacturing Co.



Insulating materials, such as mica, metal foil and fish paper, formerly held by typing or jigs may now be made pressure-sensitive, allowing easy positioning during production runs, eliminating expensive, time-consuming operations.

The laminator features feed spools for the double-coated tape and the insulating material, with a take-up spool for the tape separation liner. The tape and insulation are laminated together as they are removed from the dispenser.

Circle No. 232 on Subscriber Service Card.

Temp-shock Chamber

Conrad, Inc. announces the availability of a temperature-shock, temperature-humidity control chamber featuring independent refrigeration, heating, and humidity systems for the left half and the right half of the chamber. A front-to-back movable separator partition divides the chamber. The partition is controllable from a power hoist. This permits use of the chamber as one common test space, or with the partition lowered, as two independent chambers.

The temperature range is +500°F to −100°F. The humidity control range is 20% to 98% from 35°F dew point to +185°F dry bulk limits.

Circle No. 233 on Subscriber Service Card.



Circle No. 14 on Subscriber Service Card.

Light Threaded Fastener

A lightweight version of its high-strength 900-degree threaded fastener has been developed by Standard Pressed Steel Co.

The high-temperature joint is 20 to 30% lighter than the TM 9 bolt-and-locknut combination that SPS introduced two years ago for applications up to 900°F.

Similarly rated at 220,000 pounds per square inch minimum tensile at room temperature and tested out at 170,000 psi tensile at 900°, the new 922 series sheds weight via reductions in dimensions of the 12-point external wrenching nut and bolt head. The mechanical strength and fatigue properties of these lightweight assemblies are equal to those of the heavier counterparts.

Circle No. 234 on Subscriber Service Card.

Quick-Connect Couplings

Jack & Heintz, Inc. is entering into volume production of quick-connect couplings. The line of aviation couplings with immediate availability will include, Self-Sealing and Open-Type Quick-Connect Couplings for AN flared tube, pipe, hose and special connections.

ROTOLOCK will be available in production sizes from ¼ in. through 3 in., with no limit in size for special designs. The range of materials includes aluminum, stainless steel, carbon steel and plastic. The couplings can be used for the quick connection of hoses, pipes or tubing in systems handling fluids ranging from air through exotic fuels.

Circle No. 235 on Subscriber Service Card.

new literature

POTENTIOMETER SUMMARY. A 4-page summary brochure on Bourns Trimpot and Trimit leadscrew actuated potentiometers is now available. Designed for quick reference, this brochure summarizes key information on 16 standard models including resistances, terminal types, power ratings, operating temperatures, and dimensions. Cutaway drawings of Models 200, 220 and 224 illustrate the internal construction and show outstanding design features. Prices up to 50 pieces are also included in this brochure.

Circle No. 200 on Subscriber Service Card.

SPACE FACTS—A handbook of basic and advanced space flight and environmental data for scientists and engineers has been published by General Electric's Missile and Space Vehicle Dept. The 60-page pocket-sized book contains tables, graphs, and illustrations plus short descriptions of some of the problems and considerations of space vehicle design and associated areas (communications, propulsion, bio-astronautics, etc.).

Circle No. 201 on Subscriber Service Card.

HEAVY TUNGSTEN ALLOYS. Properties, applications, fabrication methods, and available sizes and shapes of three grades of tungsten alloys are given. Published by Kennametal Inc., the 8-page bulletin also describes the firm's explosion forming capabilities.

Circle No. 202 on Subscriber Service Card.

MECHANICAL VACUUM PUMPS—A brochure on a line of oil-sealed rotary vacuum pumps has been published by Consolidated Vacuum Corp. Included are physical and operational data, and information on the construction, maintenance, and pump selection featured in the new line.

Circle No. 203 on Subscriber Service Card.

SAFE/ARM INITIATOR—A four-page brochure describing their new Safe/Arm Initiator systems has been released by McCormick Selph Associates. Applications include missile destruct; initiation of solid and liquid propellant rocket motors, high explosive trains, warheads, pyrocore, mild detonating fuse and, in fact, all types of propellants and explosive charges. The brochure describes the Safe/Arm system and its operation; shows a comparison of conventional vs. Mc/S/A Safe/Arm concepts; gives advantages of the system and, provides firing and arming characteristics as well as environmental data.

Circle No. 204 on Subscriber Service Card.

MICROWAVE EQUIPMENT—A catalog providing 32 pages of information on microwave receiver front ends including data on a number of waveguide and coaxial mixer-preamplifier assemblies has been published by LEL Inc. Other products described include solid-state, miniature and sub-miniature IF amplifiers, TWT amplifiers, octave RF amplifiers, beacons and AFC units.

Circle No. 205 on Subscriber Service Card.

PYRINDICATOR BULLETIN—McCormick Selph Associates have released the first in a series of bulletins on their Pyrindicator test unit. The Pyrindicator is designed to aid in testing electro-explosive circuits. In operation, a Pyrindicator is substituted directly in any system in place of the explosive device it is designed to simulate, i.e., explosive bolt cartridge, squib, igniter, detonator or other electro-explosive unit. The system may then be operated and checked; the Pyrindicator recording that the circuit has been operated.

Circle No. 206 on Subscriber Service Card.

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Ordnance
Research
Development

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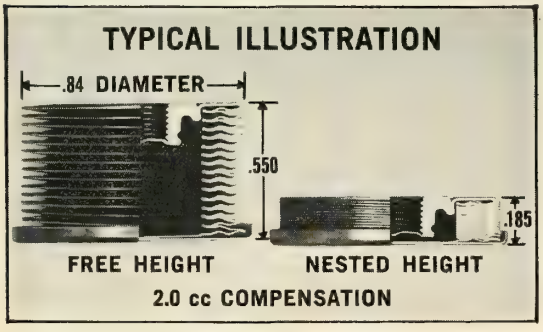
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contracts

NASA

$1,510,000—Electronic Associates, Inc., Long Branch, N.J., for an advanced general-purpose analog computer.

NAVY

$7,500,000—Hughes Aircraft Co., Culver City, for building guidance systems for *Polaris* missiles.

$2,500,000—Aerojet-General Corp., for production of the *Tartar* missile solid-propellant rocket engine.

$144,958—Atlee Corp., Waltham, Mass., for production of tube shield liner inserts designed to protect sensitive electronic vacuum tubes from vibration, shock and overheating.

$120,000—Siegler Corp.'s Hufford Division, for ground support equipment components for the *Terrier* system.

$50,000—Gladding, McBean & Co., Los Angeles, for improvement in techniques of manufacturing ceramic radomes used with the *Sparrow III*. Subcontract from Raytheon Co.

AIR FORCE

Control Data Corp., Minneapolis, for two Model 1604 large-scale solid-state computers to be used as part of the ground-based data receiving stations for *Discoverer, Midas* and *Samos* satellite systems. Subcontract from **Lockheed's Missile and Space Division.** Amount not disclosed.

$2,156,000—Missile Systems Corp., Los Angeles, for equipment related to the nation's nuclear armament program and our atomic retaliatory capabilities.

$115,150—Barnes Engineering Co., Stamford, Conn., for infrared missile radiometers and ancillary equipment.

$93,500—The Pfaudler Co., Rochester, N.Y., for investigation of methods of producing metallic coatings used to protect certain components from extremely high temperatures.

$61,700—Benson-Lehner Corp., Los Angeles, for high-speed plotter system.

$34,952—University of Colorado, Boulder, for design, fabrication and test of rocket-borne lunar orientation device.

$25,931—Control Equipment Corp., Needham Heights, Mass., for study and experimental investigation of the influx rate, size, mass and velocity of the extraterrestrial particles entering earth's atmosphere.

ARMY

$2,586,918—The Williamson Co., Cincinnati, for 1586 *Hawk* missile containers. Work to be performed at Madison, Ind.

$2,199,965—Sperry Rand Corp., Salt Lake City, for research and development on the *Sergeant*.

$1,869,998—Sperry Rand Corp., Salt Lake City, for industrial product and production engineering services on the *Sergeant* missile.

$1,500,000—General Electric Co., Burlington, Vt., for safing, arming and fusing equipment for the *Little John* rocket.

$1,219,204—Budd Electronics Inc., for three antenna filter groups which are part of the AN/TRC-24 radio relay equipment.

$1,153,520—Poorvu Construction Co., Inc., Wellesley Hills, Mass., for construction of a physics laboratory at Laurence G. Hansom Field.

$1,080,000—Massachusetts Institute of Technology, Cambridge, for 12 months basic and applied research in the field of electronic and monecular physics and communication.

$1,050,709—Gilfillan Bros., Inc., Los Angeles, for radar sets and related equipment.

$1,025,000—Raytheon Co., Waltham, for the *Hawk* missile system.

$902,708—Hayes Aircraft Corp., Birmingham, Ala., for engineering, design, fabrication, modification and rework ground services equipment for *Saturn*.

$838,210—Chrysler Corp., Detroit, for *Jupiter* missile ground support equipment.

$714,264—Chrysler Corp., Detroit, for modification services on the *Redstone* system.

$655,519—Sperry Rand Corp., Salt Lake City, for *Sergeant* missile ground handling and test equipment (two contracts).

$230,398—Douglas Aircraft Co., Santa Monica, for *Nike-Hercules* launching area items.

$141,945—Sperry Rand Corp., Salt Lake City, for engineering services for *Sergeant* missile system.

$136,735—Gilfillan Bros., Inc., Los Angeles, for *Nike* system components.

$112,604—Douglas Aircraft Co., Santa Monica, for *Nike* system repair parts.

$103,350—Consolidated Electrodynamics, Pasadena, for recording oscillograph, galvanometers.

$73,952—Solar Aircraft Co., San Diego, for *Saturn* model 1 10MV variable-speed free power turbine.

$66,606—Hayes Aircraft Corp., Birmingham, Ala., for engineering, fabrication and manufacturing services for *Saturn* missile second-stage adapter.

$63,735—Ampex Data Products Co., Atlanta, for system-recorder/reproducer for *Saturn*.

$44,000—Brown Engineering Co., Huntsville, Ala., for closed circuit TV system for *Saturn* program.

$37,630—A. J. Etkin Construction Co., Oak Park, Mich., for construction of launcher site improvements, vicinity of Detroit.

$37,426—Brown Engineering Co., Huntsville, for engineering and fabrication services for *Pershing*.

$36,800—U.S. Steel Corp., Los Angeles, for rocket motor containers.

letters

Going to Lions or Dogs?

To the Editor:

When you launched your salvo of philosophical missiles in the June 13 editorial ("Nuclear Testing—Morals vs. Survival"), you might have anticipated retaliation by your readers. I, for one, take violent exception to certain of your editorial statements. It's not that I quarrel with your conclusions, but merely with the "morally" questionable path by which you reached them!

To quote the first paragraph of your editorial:

"It is easy for people who have no responsibility for defending this country or its allies to call for a complete cessation of nuclear weapons testing. *From a moral point of view, they are right.*" (Italics are mine.)

If I may presume to so state, that second sentence is hogwash of the purest ray serene. If the people to whom you refer are "from a moral point of view . . . right," how could there exist any such thing as a *"responsibility* for defending this country"? It is precisely because there *does* exist such a responsibility, or strict moral duty, to defend this country that these people are wrong—dead-wrong, to be sure, and "from a moral point of view." It is precisely because patriotism *is* moral or "virtuous" (characteristic of a man, "vir") that treason and disloyalty are *im*moral and vicious. Precisely because it *is* moral to defend this country against unjust aggression—if need be, even to the extent of employing horrendous thermonuclear weapons—the pacifism of one who "would rather crawl on his knees to Moscow than risk the holocaust of thermonuclear war" is hideously *im*moral.

I fully agree when you state that "war and the weapons of war aren't moral." You would have done well, however, to add for completeness, "Likewise these things are *not im*moral." It's the *use* of war and the weapons of war that is either moral or immoral depending on the historical context. Clearly, nuclear testing in itself is a quite indifferent means "from a moral point of view." If such testing is an effective means for safeguarding our country by deterring unjust aggression—and it *is* such a means—then it is a good and "moral" means which we would be fools to ignore. But if nuclear testing is, in addition, the *sole* effective means of guaranteeing our continued ability to deter unjust aggression, then it is immoral *not* to resume such testing! Can anyone suggest an alternative means effective in deterring unjust aggression by a hostile power whose repeatedly avowed intention is to "bury" us? What alternative is there to "carrying a big stick" when we deal with an enemy whose every diplomatic, economic and military maneuver is dictacted by a relentless drive for domination of the world?

To set "morals" in opposition to "survival," as you have done in your editorial, bespeaks a fundamental confusion of means and ends—something not uncommon in this age of moral relativism gone "hog-wild." If we subvert the moral order by subordinating "morals" to "survival," we become almost indistinguishable in our crassness and cynicism from the enemy threatening us—in which case we may as well throw away our missiles since we lack anything worth fighting for! Survival and non-survival, like war, can be moral or immoral depending on the context. "From a moral point of view" the early Christian found non-survival preferable to a survival dependent on sacrifice of principle: he chose rather to "go to the lions" than to "go to the dogs." What a dramatic contrast he provides to our decadent, muddle-headed, A.D. 1960 pacifist on the one hand; and to our morally bankrupt, modern materialist on the other!

Yours for sane conclusions soundly arrived at,

Gerald J. Tomis
Boston

Ioways

To the Editor:

On page 39 of your May 16 issue you say "No mention of Dr. James Van Allen of Iowa State University."

Dr. Van Allen is not at Iowa State University. He is the head of the physics department of the State University of Iowa, Iowa City, Iowa. I know this seems very confusing.

Iowa State University is the new name for the Iowa State College of Agriculture and Mechanics Arts, Ames, Iowa.

We are very proud of Dr. Van Allen and his work at the State University of Iowa, at Iowa City.

Clarence F. Schmarje
Schmarje Tool Company
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So are we—and glad to get I.S.U. and S.U.I. sorted out.—Ed.

All That's Needed

To the Editor:

After reading several recent M/R's, I find you've got all the dope I need to stay atop missile/space developments. Thanks for cutting down (from 3 publications to 1) my "on the job" reading.

Richard Hopewell
Orlando, Fla.

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editorial . . .

More Money for Defense

The recent actions and the apparent temper of the Senate leave little doubt that the U.S. defense budget will be substantially increased for the coming year.

The military money bill as passed by the Senate—$40.5 billion—is $1.2 billion higher than the House version and $1.3 billion more than the President wanted.

While the House has tended to go along with the Administration, and while the Senate additions must be compromised in committee and then passed by both houses, it seems reasonably certain that a fair measure of the increases will stick.

In the Senate they have the sure support of Sen. Symington and the indicated support of Sen. Lyndon Johnson. Both of these gentlemen are running for President and can command considerable support.

The additional money will probably go, as was pointed out on this page May 30, for stepped-up production of *Atlas, Titan* and *Minuteman;* for additional *Polaris* subs; for reinstatement of the B-70 and a speed-up of the ballistic missile, *Skybolt,* which it will carry; for more emphasis on *Minuteman* and *Polaris,* itself; for a hurry-up of *Samos* and *Midas,* the Air Force reconnaissance and early warning satellites.

Three things are influencing Congress in this move to both increase and speed up our defense program: first, an honest belief that we are behind in our military strength and—if not slipping further—certainly not catching up fast enough; second, the fact that the nation's state of preparedness—particularly in missiles—will most certainly be a major issue in the coming election campaign; and third, that our foreign relations position is at its worst in peacetime history, and continuing to deteriorate.

As a consequence of this last item, we see the Soviet government reverting to Stalinist tactics and attitude while Communist China chides Russian leaders for not reviling us even more. We have lost face in the Orient and, worse, have caused a friendly Japanese government to do likewise, thus contributing to tremendous Communist gains there. We have lost the faith and trust of our allies; while it would not be correct to say we stand alone, it is certainly correct to say we do not have enthusiastic international support.

In such a situation we have no alternative but to be strong, not only militarily but in the other fields where our strength will be most felt —the exploration of space, research and development, scientific education and industrial progress. We might halt, for a time, the worship of consumer goods for consumer goods' sake.

Whatever money Congress appropriates in addition to that requested by the President may or may not be spent by this Administration, just as the White House may or may not face squarely the position into which the nation has slipped.

But a new administration will take over in six months, midway of the fiscal year. Then, in any case, we will have some hope of positive action to restore our strong position among the nations of the world.

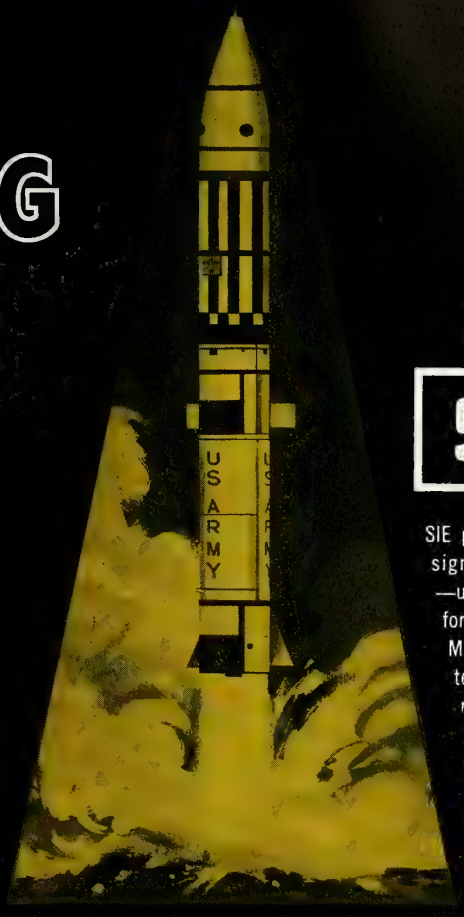
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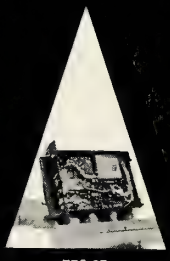
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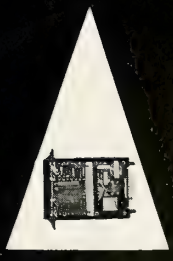
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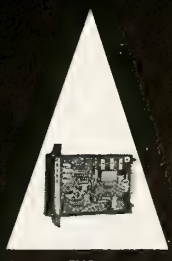
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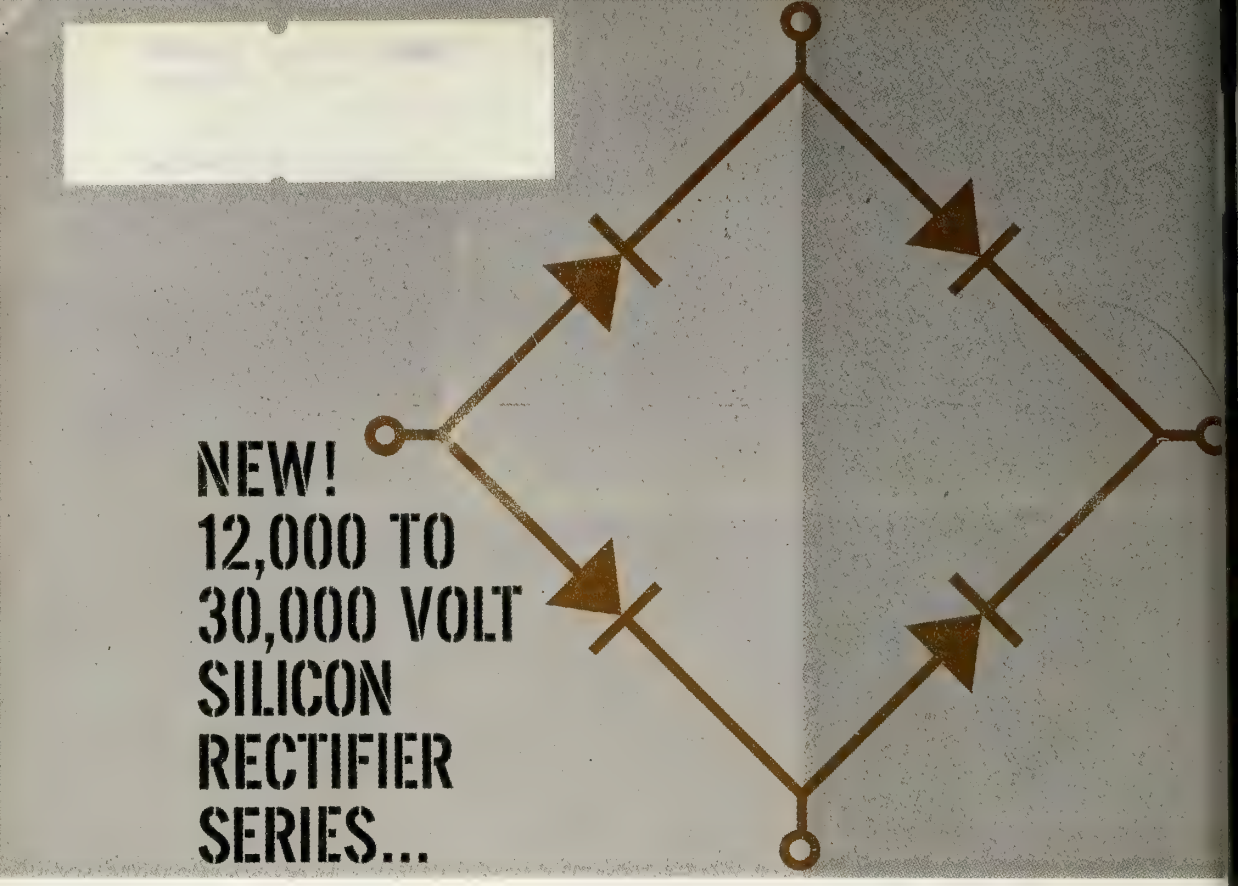

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1N3057	22,000	15,500	95
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missiles and rockets

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JUL 1960



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missiles and rockets

July 4, 1960 Volume 7, No. 1

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THE COVER

The Army's 4.5 multiple rocket launcher fires one of its 25 rockets during the recent mass demonstration, Project Man, at Fort Benning, Georgia.

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30,432 copies this issue

letters

Experts Praise Fuel Story

To the Editor:

I was delighted to have the opportunity recently of reading the excellent "Missile Market and Product Guide Edition" put out by M/R (May 20). It is a fine piece of work. However, even more importantly, we were most pleased to see the story on rocket fuel development on page 74 of this edition. It is an excellent job and we believe it accurately covers the subject. We are, of course, pleased to see Grand Central Rocket mentioned so prominently and do appreciate being a part of your story.

J. T. Harker, Director of Marketing
Grand Central Rocket Co.
Redlands, Calif.

Harness by Lockheed

To the Editor:

On page 30 of the June 13 M/R you published a picture with a caption stating: "Harness and sensors are worn by subject of Air Force space medicine school to measure his reactions to conditions of stress." The article concerns "Ways Sought to Ease Ordeal of Space."

We should like to point out that the subject in the picture is Dr. O. S. Adams, psychologist with Lockheed's Human Factors Laboratory (Operations Research Division) at Marietta, Ga. The equipment is Lockheed's bioelectric harness.

Dr. Adams was project leader on the recently completed space-type investigation which Lockheed's Human Factors Laboratory conducted, under contract, for the Air Force's Aero-Space Medical Laboratories.

We are enclosing a news release on this investigation, feeling that you would be interested in full information about the study and Dr. Adams. Two Strategic Air Command crews wore bioelectric harnesses such as Dr. Adams demonstrated in the picture which you published.

We certainly would appreciate your clarifying this caption.

M. L. St. John
Manager, Newsbureau
Georgia Division
Lockheed Aircraft Corp.
Marietta, Ga.

The photo of Dr. Adams got separated from the news release to which it was originally attached and was misfiled under "School of Aviation Medicine." M/R is happy to give due credit to Lockheed's laboratory.—Ed.

reviews

FUNDAMENTALS OF ROCKET PROPULSION, Raymond E. Wiech, Jr. and Robert F. Strauss, Reinhold Publishing Corp. 130 pp.

This book provides an all-inclusive review of the rocket engine—its history, fundamentals of operation, design of components and methods of applications.

Chapters advance one step at a time through the basic laws governing rocket engine design; the design and operation of current engines; the need for and probable design of future engines; and the rocket engine's job in space flight and satellite missions.

The book fully describes all rocket engine types so that the function and operation of each is understood clearly.

SIXTH MATERIALS REVIEW, A. Lyem. Order PB 161463 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 92 pp., $2.25.

Worldwide research and development progress in polymers and plastics are highlighted.

Categories discussed include high polymers, plastic materials, synthetic fibers, metals and inorganic materials.

AERO-THERMODYNAMICS AND FLOW IN TURBOMACHINES, M. H. Vavra, John Wiley & Sons, New York, 609 pp. $14.50.

This text will probably become a standard in the library of every engineer designing turbomachines. The book is built upon the classical principle of thoroughly developing the theory—here, the flow relations—and then applying the results to the design of practical machinery.

This is a book for mathematically oriented engineers who prefer making their errors on paper to making them in hardware. For those students who may have forgotten some of their mathematics, an extensive appendix gives a review of vector analysis, and an introduction to operations involving dyadics.

A REVIEW OF CERTAIN FERROUS CASTINGS APPLICATIONS IN AIRCRAFT AND MISSILES, J. Varga, Jr. Order PB 151077 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 54 pp., $1.50.

This report describes significant advances in foundry technology that have recently enabled foundries to produce complex aircraft castings.

The report gives requirements for aircraft and missile steel castings and various castings processes. Tensile properties of heat-treated alloy steels are listed in tables.

CONTROL SYSTEMS ENGINEERING, Edited by William W. Seifert and Carl W. Steeg, Jr. McGraw Hill. 964 pp., $15.

This is a relatively complete coverage of the mathematical aspects of modern control systems engineering, as applied in the study of complex, large-scale automatic control systems.

The book has drawn on the specialized talents of 11 different contributers, all whom are former members of the Dynamic Analysis and Control Laboratory at Mass. Institute of Technology.

The first two chapters introduce the general subject of control-systems engineering. The remaining 15 chapters are devoted to a systematic development of the theoretical techniques used in the analysis and synthesis of control systems.

A thorough coverage is included on modern control system theory from the trial-and-error procedures which are commonly used in the design of linear systems to the application of game theory in the synthesis of complex systems.

COMPOSITE MATERIALS AND COMPOSITE STRUCTURES (Proceedings of the Sixth Sagamore Ordnance Materials Research Conference) Order PB 161443 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 562 pp., $7.

Recent advances and probable future developments in the physical, mechanical and metallurgical behavior of composite materials and structures are surveyed in a comprehensive collection of papers delivered by forty specialists in metallurgy, plastics and related fields.

The papers cover metal composites, glass reinforced plastics, laminated and other plastic structures, and materials for ablating composites.

Separate sections in the volume are devoted to glass reinforced plastics, composite systems for thermal protection metallic composites and composite materials and structures.

THE WELDING OF TITANIUM AND TITANIUM ALLOYS, C. E. Faulkner and C. B. Voldrich. Order PB 151079 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 69 pp., $1.75.

This report discusses advances in titanium welding, including the use of inert gas shielded metal-arc welding in the production of titanium assemblies.

The study also covers general welding procedures, surface cleaning, quality control, stress relief treatment, and the mechanical properties of welded joints in titanium mill products.

STANDARD DESIGNATIONS OF ALLOYS FOR AIRCRAFT AND MISSILES, J. J. Vagi. Order PB 161192 from OTS, U.S. Dept. of Commerce, Washington 25, D.C. 65 pp., $.50.

Metals and alloys used in aircraft and missile construction have been tabulated by trade designation, material specification and other standard categories as an aid in classifying metallurgical data.

There are separate tables for hot-work tool steels and selected high-strength and heat and corrosion resistant alloys.

Also included is an alphabetic list of major producers of high strength metals and alloys.

when and where

JULY

Metallurgical Society of American Institute of Metallurgical Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University, R&D Management Development Seminar, University Park, July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Prof. Group on Communications Systems and Army Signal Corps, Statler-Hilton Hotel, Washington, D.C., August 1-3.

Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, August 1-12.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, August 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, Cortez Hotel, San Diego, Calif., August 9-12.

ASME-AICHE Heat Transfer Conference and Exhibit, Statler-Hilton, Buffalo, N.Y., August 15-17.

XIth International Astronautical Congress, Stockholm, Sweden, August 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, August 23-25.

German Rocket Society, Annual Meeting, Hanover, Germany, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control Institute, Storrs, Aug. 28-Sept. 9.

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Sept. 7-8.

Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Sept. 7-9.

American Chemical Society, 138 National Meeting, New York, Sept. 11-16.

THE GRAND CENTRAL REPORT

NEW HYBRID ROCKET:
DEPENDABILITY AND CONTROL

Rocket thrust control—vital for space applications—has been demonstrated by a "hybrid" motor development with control from near-zero to full power.

Thirty-two motors have been built and fired successfully in a cooperative effort by Grand Central Rocket Co. and The Marquardt Corporation entirely on company funds.

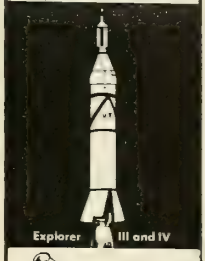
The "hybrid" consists of a solid propellant fuel, deficient in oxidizing agent, and a liquid oxidizer under pressure, which is sprayed upon the solid material. Ignition is hypergolic. By modulating this oxidizer flow from zero to 100%, thrust can be varied over a wide range.

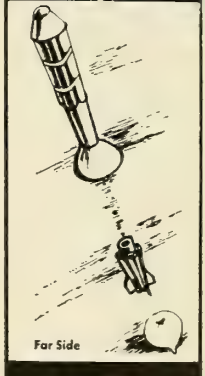
The hybrid provides the advantage of thrust modulation while retaining the important attributes of reliability, simplicity and lower cost inherent in a solid propellant motor.

This significant development may soon be used for orbital corrrection motors, retro-rockets for soft lunar landings, and to provide the limited and variable "g" forces required for space operation with human payloads.















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WASHINGTON

Hush-Hush Rocket Deals

The State Department will deny it, but COUNTDOWN hears that two very important deals have been concluded between SEPR—the French rocket company—and two American firms. One deal is with the Rocketdyne Division of North American Aviation for liquid-propelled engines, and the other is with Thiokol Chemical for solid motors. Losing competitors on the deals are Aerojet-General and the British.

Corvus Almost Combat Ready

Final push is on to make the Navy's carrier-based *Corvus* operational. The radar-homing air-to-surface missile with a nuclear warhead is now in the pre-operational testing phase and should be ready later this year.

Cutting the Fuze

Marines are still completing final evaluation of the West German-made *Cobra* anti-tank missile. This has pushed the final decision on whether to buy until the end of July. Look for the Army also to reach a decision on the *SS-10* and *SS-11* by August 1.

Specs for Dyna-Soar

DOD is setting July 31 as the target date for completing its clearance of specs on the *Dyna-Soar* boost-glide bomber. This will be followed by a bidders conference at Boeing in Seattle, with a resulting alignment of subcontractors. Preliminary specs for the subs are being drawn up now by WADD. Mock-up of the new system is due for completion next June.

Secret Navy Missile

Navy has placed a contract with Electronic Communications Inc.'s Advanced Technology Corp. for feasibility study of a new missile. Type and purpose of the new bird are classified.

Space Tellerisms

Dr. Edward Teller, physicist "father" of the H-bomb, casts a jaundiced eye on the stars. From a recent speech on "peacetime uses of space:"

". . . somebody in this lifetime could go to Andromeda, but I recommend against it."

". . . if there is life out there, then where is everybody?"

". . . don't be premature and ask for a purpose in our space research. After all, Columbus set out to solve the trade problem with China, and that still isn't solved."

INDUSTRY

Ampex Merger May Be Coming

Industry insiders are watching a possible merger between Ampex Corp. and Telemeter Magnetics. If it comes about, the deal is expected to involve a swap of two shares of Telemeter for one of Ampex.

Mid-summer Minuteman

Expect the Air Force to award the hotly-contested *Minuteman* third-stage motor contract by the latter part of July. Hercules Powder, which is battling down to the wire with Aerojet-General for the big award, reports successful test firings of *Minuteman* motors made with plastic cases. Hercules claims its double-base fuel has the "highest I_{sp} measured" for a solid.

High Polaris Production

Production capacity for *Polaris* is now geared to insure deliveries of the sub-launched ICBM to the Navy and still permit release of land-launched versions to NATO. While policy of priority delivery to the Navy will be maintained, it is believed concurrent deliveries overseas are contemplated.

Whitson Elected Martin V.P.

Dr. William L. Whitson—former Daystrom vice president and onetime ARPA chief scientist—has switched to Martin. Whitson was elected a vice president by the Martin Board.

Plant Shuffling at Ogden

The word now is that the Air Force won't be taking over the Marquardt plant at Ogden, Utah, as a *Minuteman* maintenance plant after all. The apparent reason: Congress has put the Boeing *Bomarc-B* back in business and the plant will be needed to turn out engines.

INTERNATIONAL

European Space Pact

A committee for promoting European space research cooperation is awaiting formal governmental approval by at least six of 10 nations involved in the venture. This was decided at a meeting last month in Paris. The committee, which may use the British *Blue Streak* for a vehicle, is composed of representatives from Sweden, Norway, Denmark, Holland, Belgium, Britain, France, West Germany, Switzerland and Italy.

Pills for Space

Russian pharmacologists are now engaged in the Soviet man-in-space program. They are reported to be experimenting with tranquilizers, compounds for toning the circulatory and respiratory systems to protect space travelers.

Italian Sounding Rocket

In shots this summer from Sardinia, the Italian Aeronautical Ministry will be using three-stage high-altitude rockets. First stage will be a *Nike* booster, the second, an *Asp*, and the top a *C-7* made by Bombrini-Parodi-Delfino. There also will be some two-stage vehicles composed of *Asps* and *C-7's*.

"not competing with industry . . ."

Aerospace Corp. to Help Mak

New non-profit organization will help Air Force achieve advanced ICBM, an AICBM and method to detect nuclear tests in space

by William J. Coughlin

Aerospace Corp. will provide the Air Force with systems engineering and technical direction for three planned new missiles and the means to detect nuclear tests in space, MISSILES AND ROCKETS has learned.

They will be:

• An advanced ICBM smaller than *Minuteman* with improved guidance accuracy and a "substantial" nuclear payload capacity.

• A defensive missile for use against the ICBM—a step beyond *Nike-Zeus.*

• An advanced ballistic missile of intermediate range for possible NATO use. It will be the AF entry along with Navy's *Polaris* and Army's *Pershing.*

• A study phase of ARPA's project *Vela,* detection of nuclear tests in outer space by measuring existing background radiation. It would be carried out if Russia and the U.S. agree to an earth nuclear test ban. Nuclear testing in space would add measurable amounts of radiation.

Aerospace Corp., the non-profit organization set up to meet congressional criticism of the relationship between Air Force and Space Technology Laboratories, will take over only a minor portion of the work STL is doing for the Ballistic Missiles Division.

It is expected to hire about 1300 of the 5181 persons now employed by STL. Only 250 are scientists and engineers from STL's technical staff, and most of these will come from STL's Advanced Systems Planning Division. Presumably, A. F. Donovan, vice president and division director, will remain with STL.

STL contracts with BMD for systems engineering and technical direction of the *Atlas, Titan* and *Minuteman* weapon systems will be continued to avoid disruption in development.

In addition to new missile weapon systems, Aerospace Corp. will support BMD in management of early warning, reconnaissance and communications satellites and advanced planning for other military space systems. It also will engage in advanced R&D in these fields. The *Sky Bolt* program will remain at Wright Air Development Division because of the complexity of integrating aircraft and missiles.

Aerospace Corp. also will be active in such areas as advanced re-entry vehicles and penetration aids, new propulsion and guidance systems, satellite communications systems, satellite inspection systems, manned military space systems and other corollary undertakings.

The company also plans to accept projects from other agencies such as National Aeronautics and Space Administration and Advanced Research Projects Agency, according to Board Chairman Roswell L. Gilpatric.

STL, in its approach to new business, will continue its interest in systems engineer-type programs but avoid management-type projects which would impose the same limitations on hardware development that existed in its association with BMD.

The company now has many proposals into government agencies stressing capabilities in experimental fabrication work, assembly and test, research studies, plus systems engineering.

• **New challenge**—At a press conference in Los Angeles to announce organizational details of the company, spokesman for the organization and Air Force made it clear that Aerospace Corp. is moving into new fields rather than assuming major tasks now handled by STL.

Board Chairman Gilpatric termed it a unique approach and a unique response to a "new challenge."

Asked what was new about the challenge, Undersecretary of the Air Force Joseph V. Charyk explained the Air Force looks at present missiles as the early phase of a whole series of missile and space weapons which will form the U.S. military forces of the future.

For these weapons, a new management approach is needed to blend advanced technologies in such exotic fields as electronics and nuclear rocketry, he asserted.

Lt. Gen. Bernard A. M. Schriever, Commander of the Air Research and Development Command, said USAF needs the most competent technical people in the country to provide it with management of high caliber.

"You can't run programs of this magnitude just by wishing," Gen. Schriever said. "You've got to have people and Aerospace will be part of the management team."

• **Room for growth**—Board member Trevor Gardner, now chairman and president of Hycon Manufacturing Co., said the new corporation will provide for the Air Force a skilled mass of objective talent which it does not have available through any other channel at the moment. Active recruiting for top scientific and engineering talent will get under way immediately but board members declined to say what ultimate size of the Aerospace staff might be.

The 250 members of the technical staff who will go to Aerospace Corp. are being selected by IBM machine on the basis of the amount of time they have put in on the projects which are being transferred. They will be discharged by STL and hired anew by Aerospace Corp. STL has made it clear to the Air Force that it expects no objections to this transfer.

The 1150 support personnel going to Aerospace Corp. will be those who are doing basic work on Air Force programs in such fields as technical training and USAF mail service, and some of those who are in allied fields such as technical writing and security. The latter groups will be apportioned between STL and Aerospace Corp. on the basis of need.

Aerospace Corp. is operating on a letter contract with the Air Force while a firm contract is under negotiation. Estimated dollar volume of contract has not been disclosed.

STL's business with the Air Force last year totaled $68.5 million.

3 New Missiles

• **Not a competitor**—Formation of Aerospace Corp. followed criticism of the relationship between the Air Force and STL on the grounds of conflict of interest with the commercial activities of the Thompson Ramo Wooldridge, parent company of STL, and with STL's own profit making nature.

"Unlike STL, this is a non-profit organization," Gilpatric said." "There is no question of competition with industry: no question of getting into hardware."

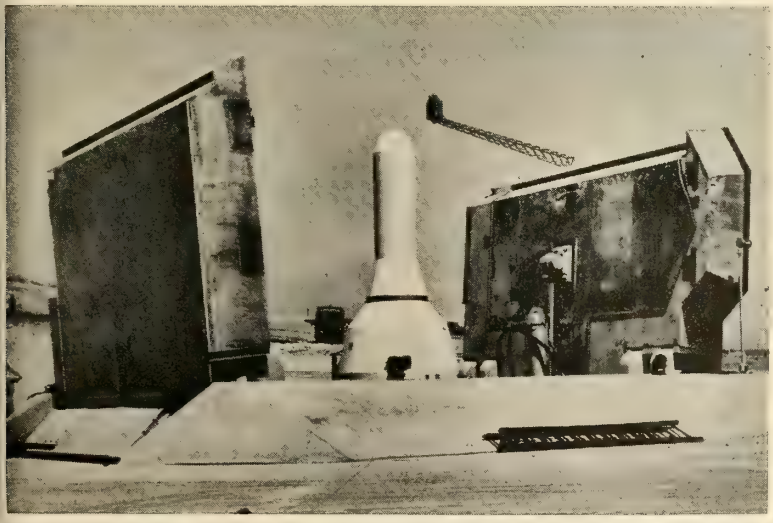
The Air Force is purchasing the sprawling new El Segundo facility of STL for use by Aerospace Corp. under a facility contract. Value of the purchase was not disclosed because it still is "under active negotiation"—but it is believed to be well in excess of $20 million.

Although it is expected that Aerospace Corp. ultimately will occupy the entire research and development center, the facilities initially will be shared by Aerospace Corp., the Ballistic Missile Division, the Ballistic Missile Center, and units of STL which are at work on Air Force programs.

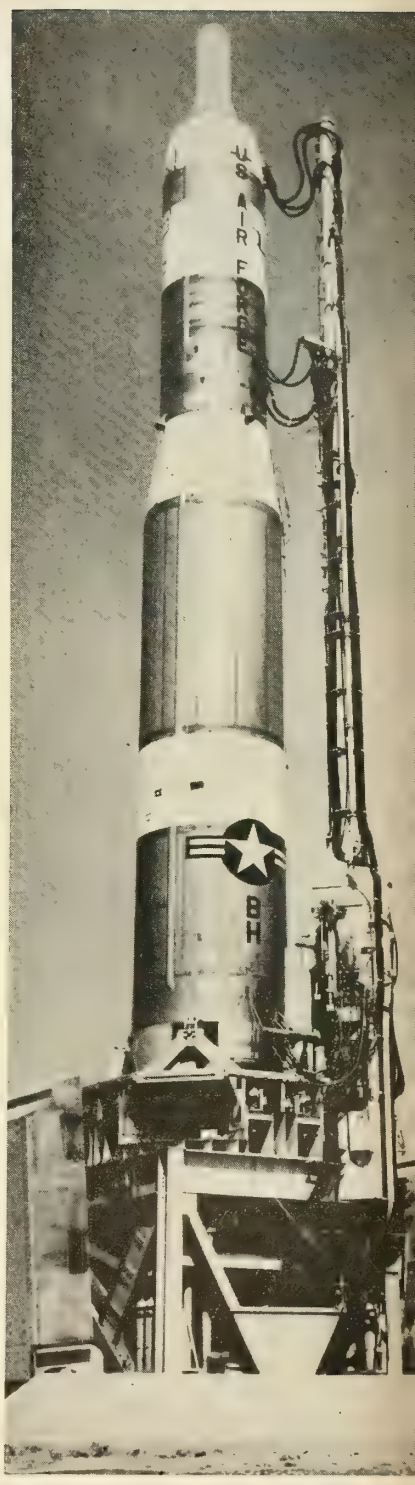
Among the programs which Aerospace Corp. will take over are *Samos, Midas,* and *Discoverer,* in which STL played a relatively small role. Aerospace participation will be considerably more active, it was indicated by Gen. Schriever.

The ARDC commander said the Air Force does not plan any changes in the contractural arrangements with its present contractors. He added, however, "We intend perhaps to do a little more looking down their throats."

No president has yet been named for the company. Head of the executive committee is Dr. Charles C. Lauritsen, California Institute of Technology. Other board members include Dr. Clifford C. Furnas, President, University of Buffalo; Edwin E. Huddleson, Jr., of Cooley, Crowley, Gaither, Godward, Castro & Huddleson; Roger Lewis, Vice President, Pan American World Airways, Inc.; Maj. Gen. James McCormack, USAF Ret., Vice Pres. Massachusetts Institute of Technology: Gen. Earle E. Partridge. USAF (Ret.); Arthur Raymond, Former Vice President, Engineering, Douglas Aircraft Co.; Dr. Chalmers W. Sherwin, Professor of Physics, University of Illinois; Dr. Jerome B. Wiesner, Director, Research Laboratory of Electronics, Massachusetts Institute of Technology.



FIRST PHOTO of *Titan* underground elevator launch facility at Vandenberg AFB, Calif. Missile is being elevated to firing position through 200-ton steel and concrete protective doors. American Machine & Foundry designed and built prototype and will construct 36 more under a $81,576,000 Air Force contract let last week.



CHECKOUT missile has been raised from silo and is in firing position. Firing of a *Titan* from this prototype operational facility will take place sometime this year.

What Congress Should Do About the . . .

RENEGOTIATION MESS



FRIEDMAN

A special House Armed Services Procurement Subcommittee has recommended that the present Renegotiation Act be enacted into permanent law. The subcommittee also has rapped Defense Department reliance on negotiated contracts and incentive contracting—holding any savings to be a "fallacy." The House has urged passage of HR 12572 to impose new restrictions on incentive contracts. In the following critique, Mr. Jacob Friedman takes a hard look at the issues involved in renegotiation and proposes specific solutions to the dispute. Mr. Friedman is a registered professional engineer and Washington business-engineering consultant. He formerly was a Navy facilities contract negotiator and, in 1951, a deputy director of the National Production Authority's tax amortization division.

by Jacob Friedman

Renegotiation today is the harshest word in the defense industry's vocabulary.

Scratch a missile contractor and he'll tell you the Renegotiation Board is nothing more than a band of pirates who grab hard-earned profits year after year.

But scratch almost any congressman and he'll praise the board as a group of sainted heroes who each year justifiably recover millions of dollars in excessive profits.

Both these viewpoints are extreme. While they portray the focal point of the dispute that has raged almost since the inception of the Renegotiation Act in 1951, neither gets down to the real issue—the law itself.

Criticism of the Renegotiation Board, insofar as the defense industry is concerned, is so much wasted motion. The Board is merely the instrument of the law.

If inequities in Renegotiation Board actions are to be corrected, then the law must be corrected. That the whole renegotiation process today stands in need of drastic correction, there can be little question. For the law—notwithstanding its objective to recapture excessive profits—is having some profoundly adverse effects on the defense industry at a critical period in the nation's history.

To obtain the proper remedies, objective concessions are needed from both sides.

No argument is being advanced here to forget all about renegotiation and let extra profits become a form of subsidy. On the contrary, renegotiation fulfills a necessary function. It is needed particularly in the area of fixed price negotiated contracts where there are unknown factors affecting costs and profits. But renegotiation must be made to function under firmer ground rules.

Consider the case of Boeing Airplane Co. A Regional Renegotiation Board determined that no excessive profits had been made by the company during FY 1952. However, the National Board overruled this decision and made a finding of almost $10 million in excessive profits. Boeing appealed and—a full eight years later—the case is still awaiting a final determination by the U.S. Tax Court.

Without attempting to pass on the merits, we can readily see that this case at least indicates a lack of consistency in interpreting the statutory factors.

• **Double standard**—Much of the strife over renegotiation presently lies in conflicting values established by the Defense Department under Armed Services Procurement Regulations for certain fixed factors and those established by the Renegotiation Board in accordance with the law.

These factors—character of business, amount of Government-owned facilities, range of subcontracting, pricing risk, etc.—are known and agreed to in contract negotiations. But, when the Renegotiation Board looks over a contractor's total renegotiable business for a given year, these fixed factors may be assigned a different value—in effect overruling the Defense Department.

Testimony before the House Ways and Means Committee in April, 1959, pointed up this conflict in a 1954 case involving Lockheed Aircraft. The National Board told Lockheed in a letter introduced in the record:

"Notwithstanding the decrease in sales and profits from the prior year and the contractor's acknowledged efficiency and lowered costs, the Board has concluded that the contractor's renegotiable profits, accompanied as they were by substantial Government assistance and subcontracting as well as the minimal risks to which the contractor was exposed by reason of 94.9% of its production being either CPFF or fixed price incentive, are greater than can be considered reasonable."

It is significant that each of these factors—on which excessive profits in the amount of $6 million was determined—may have been fixed factors considered as a basis for the contractual agreement and not affected by conditions thereafter.

• **The profit incentive**—Primarily, Congress should concern itself with reduction of overall costs in defense buying. But there is a large question whether the Renegotiation Act obtains this objective.

Profits from incentive contracts, while a small portion of total defense costs, represent the bulk of those considered excessive by the Board. In theory, the incentive contract holds out the promise of more profits as a reward for reducing overall costs. This, in turn, is intended to establish patterns for lower production costs in the future.

However, contractors frequently complain that they are not being treated fairly in the case of price reductions on incentive contracts resulting from their efficiency of operation. This introduces the question whether or not the contractor reduced costs through efficiencies not normally expected.

The Board, however, considers that jobs done for less than the target cost do not necessarily represent savings at all, since the yardstick for determining the target cost may be inaccurate. Other factors having no bearing on the contractor's efficiency also may arise.

The incentive to industry is profit. To take away any part of the target profit when the actual cost does not exceed the target cost is short-sighted. It defeats the purpose of the incentive contract. For unless the contractor can feel that the lower his costs are, the more his profit, then incentive contracts are "incentive" in name only.

Renegotiation of incentive savings depends on differences of amounts—rather than magnitude of the amounts—of actual costs and renegotiated target costs. Thus, in order to maintain the incentive for lower overall costs, the Board should tend to become more liberal in renegotiating target costs as actual costs reach lower levels. This would take coordination with the procuring agency to obtain pertinent information regarding the original negotiations. In turn, the Armed Service Procurement Act should provide for penalties when contractor withholds from contract negotiator information affecting target costs.

The actual elimination of any profits would depend upon the profit determinations relative to the remainder of the contractor's renegotiable business. However, under pending legislation (H.R. 12299) wherein contractors must prove that incentive savings are due entirely to skill, efficiency or ingenuity as a condition precedent to retention under each contract, a portion of such profits will be eliminated before consideration by the Board on an overall basis. Such a proposed law not only appears questionable as to practicality and intended purpose of an incentive contract; it also appears unfair in that losses on other renegotiable contracts will not offset such eliminated profits.

(This proposed provision has been dropped in accordance with the recent proposed provision in H. R. 12572, which calls for adjustment in target cost or price to exclude any sum found after audit resulting from inaccurate, incomplete or noncurrent data.)

It is noted that higher profits are realized on incentive contracts through lower overall costs—in contrast to higher profits through higher overall costs on cost plus percentage contracts, which are now illegal. Nevertheless, public policy dictates that excessive profits by a contractor should not be made on Government contracts. On this basis, a strong justification that the renegotiation function on a backward-look basis should continue is a high volume of contract work accomplished under fixed price incentive contracts. When industry concedes this point it will the in a more constructive position to receive cooperation from Government that will lead to objective results.

What's Wrong . . .	*How it Can be Corrected . . .*
• "Double standard" exists between DOD Armed Services Procurement Act regulations (ASPR's) and the Renegotiation Act. ASPR's take into account such fixed factors as character of business, amount of Government-owned facilities, range of subcontracting, pricing risks, etc. in determining profits on negotiated contracts. But, the Renegotiation Board may assign different values to these fixed factors on the overall basis of renegotiable business during each fiscal year, thus making Government's word uncertain.	• Change the Renegotiation Act to limit the Board to consideration only of variable factors in determining excessive profits. Furthermore, fixed factors and those subject to variation should be spelled out wherever practicable in the law, including a provision that if a fixed factor changes during the term of a contract it then becomes a variable factor subject to the renegotiation process.
• Emphasis on incentive contracts is not presently directed to consideration of lower overall costs.	• Provide that there can be no reduction in target profit (based on target cost or subsequent adjustment thereof) if actual cost is less than target cost. This in itself does not encourage enough incentive to reduce costs to the lowest practical levels. Therefore the Act should further provide that the Board generally give more favorable consideration in renegotiation of incentive savings as actual costs reach lower levels. In turn, ASPR's should provide penalties for contractors who withhold information from the contract negotiator relative to target cost.
• Consideration of private investment in plants, which affects return on net worth, is emphasized in determination of excessive profits; yet risk of private expansion of the unconventional and expensive facilities for production required currently only in limited quantities is now greater than at any time during the last decade.	• Restore accelerated tax amortization to encourage industry to risk its own capital on plant and equipment which will be used for defense research and development.
• Contracts resulting from advertised procurements where three or more bidders compete are subject to renegotiation notwithstanding the current status of competitive pricing.	• Change the Renegotiation Act to provide that total contracts awarded to a company under advertised bidding should not be subject to renegotiation except at the option of the contractor (to offset possible excessive profits from negotiated contracts). Exceptions to this provision would be contracts awarded when there are not more than two bidders; or if the procuring agency determined that a unique situation, e.g., proprietary items, limits a source of supply and makes a particular contract subject to renegotiation.

Congress Adds Less Than $.5 Billion to DOD Budget

Congress spooned a half-hearted increase into the FY '61 defense budget last week prior to recessing for the presidential nominating conventions.

Net additions to President Eisenhower's budget totalled less than one-half billion dollars, practically erasing the defense issue from the forthcoming presidential campaign insofar as GOP and Democratic spending philosophies are concerned.

Apparently the Democratic leaders were anxious to avoid the "spender" label.

Major additions to the $39.2 billion Administration bill were:

- $241 million for *Polaris* missiles and submarines.
- $160 million for Army modernization—mostly for ground equipment and chemical rockets.
- $190 million to restore the Air Force B-70 to full weapon system status.
- $100 million for the procurement of any type of fighter as a safeguard if the *Bomarc* air defense missile fails.
- $83.8 million to be used at AF discretion for *Minuteman, Midas, Samos,* and *Discoverer.*
- $85 million move for storing parts for a bomber alert.

Offsetting these additions, which run to $859.8 million, was an across-the-board $400 million cut in DOD procurement. The House conferees had insisted upon this 3% cut, apparently getting it in return for keeping the Eisenhower request for $293 million to build a conventionally-powered aircraft carrier.

The other principal tradeoffs centered around *Bomarc* and the B-70.

The biggest concession wrung from the House was the restoration of money for *Bomarc B,* a program it had voted to kill altogether. The $244 million put in the compromise bill conforms with the Administration's appeal for the final funding of nine squadrons. Another $75 million is provided for two northwest *Bomarc* sites.

For further flexibility, if *Bomarc* six is successful, the conferees said the $100 million earmarked for fighter aircraft could be used for the B-70 if progress warrants. The bill was expected to be sent to the White House this week.

In other defense developments:

- The first *Polaris* missile submarine, the George Washington, arrived at Cape Canaveral to prepare for its first underwater missile launch, expected sometime this month.
- A *Nike-Zeus* AICBM test missile exploded in an underground launching cell at White Sands, N.M. The cell was a new design, eliminating the exhaust vent.

Lack of Tactical Missiles Cited

The Senate Preparedness Subcommittee this last week attacked the Administration for failing to provide the Army with sufficient new tactical missiles and other modern weapons.

The subcommittee—headed by Senate Majority Leader Lyndon B. Johnson (D-Tex.)—demanded an immediate "searching inquiry" by the Defense Department into the adequacy of the weapons in the hands of Army combat troops.

The subcommittee's attack and accompanying demand for a study underlined growing concern among many top Army officials as to the adequacy of current tactical missile procurement programs. These officials fear the United States may be faced with a "tactical missile gap" in the 1960's. (M/R, May 9, p. 11)

The subcommittee specifically listed six new Army missiles in a report and bluntly made clear that the Army had insufficient funds to purchase any of them in needed quantities.

The list and the subcommittee's comments:

- *Little John*—"substantial quantities are needed."
- *Sergeant*—"only one sixth of the active Army requirements are under contract."
- *Pershing*—"only two are on order at present" for training.
- *Hawk*—"only one third of active Army requirements are in production today."
- *Redeye*—"none are in the hands of troops although an urgent need exists."
- *Davy Crockett*—"hundreds are on order when thousands are required."

The subcommittee called the two air defense missiles and the four surface-to-surface missiles "essential . . . to bring about the modernization of our ground forces to the peak necessary."

"These are the items which provide Army troops with the punch they need," it said. "Missiles are fast becoming the core of firepower for a modern armed force."

Labor Troubles Continue —With Some Bright Spots

Unsettled labor conditions still plagued the missile industry this week, with negotiations at some companies ending in hopeless deadlock.

On the brighter side, International Association of Machinists members at Convair and Douglas have ratified earlier agreements made by their bargainers to accept the companies' last offer. Machinists represented by the United Auto Workers had accepted a Douglas offer earlier.

Negotiations between the IAM and Lockheed's Missiles and Space Division at Sunnyvale, Calif., disintegrated after the machinists rejected the company's last offer by an overwhelming vote. The Lockheed strike is expected to continue for some time.

Boeing is still being threatened by an IAM strike at its plants in four states. The union has voted to strike and has rejected the company's last offer.

UAW employees at Chance Vought and Bell Aircraft have also given their leaders the power to call a strike. The Bell machinists are presently working without a contract.

38,000 United Aircraft IAM and UAW employees are still out at the company's plants in Connecticut.

Soviets Set for More Shots into South Pacific

This week the Soviet Union is expected to begin lobbing multi-staged 7000-plus-mile missiles at another Pacific Ocean target area—apparently to solve re-entry problems.

The Russians warned ships to stay out of a 50,000-square-mile area near Palmyra Island, 1000 miles southwest of Hawaii, between July 5 and July 31. This target area is 150 miles further southeast than the one the Soviets used in January, indicating that the rockets may be launched from a different base.

As has been the case with previous "spectacular" demonstrations of Soviet rocket prowess, the tests presage visits by Premier Nikita Khrushchev to Western nations. Khrushchev will begin a nine-day official visit to Austria on the eve of the test period.

Underplaying the military significance, the Russians have stated the tests are for the peaceful purpose of developing rockets that can reach Venus or Mars.

The announcement followed speeches by Khrushchev and Soviet Defense Minister Rodion Malinovsky asserting that Soviet military forces were being strengthened and their shift to missiles was being accelerated.

First Deep Space Travelers May Be Rated 'Expendable'

LOS ANGELES—The first interplanetary travelers may have to be considered "expendable"—if they stay in space too long.

David Reitz of Martin-Denver puts a time limit on space flight of around 100 days. He suggests that longer periods of exposure to cosmic radiation might prove fatal.

The researcher told the Institute of Aeronautical Sciences last week that the solution lay in speedier propulsion and faster trips.

"Lunar trips can be undertaken," Reitz said in his paper, "but excursions to other planets, where distances are of the order of millions of miles instead of several hundreds of thousands, will in 130 days subject men to doses from cosmic radiation alone equal to 25 rem. This is the maximum allowable for a single emergency exposure."

Additional radiation probably would be received in passing through the Van Allen radiation belts, he pointed out.

Reitz noted that the first expected relatively safe periods for interplanetary travel will be during periods of low solar activity in 1963-66 and 1975-77. He indicated that even during those periods more than 100 days of travel time would be dangerous.

"Should propulsion units not be capable of obtaining this kind of performance," he said, "it may well be decided that the first interplanetary travelers are expendable or can at least receive a dose greater than 25 rem."

He said, however, that outlook for such a propulsion requirement being met successfully appears to be favorable for the 1975-77 period. If this is accomplished with a nuclear reactor, he noted, then radiation from the reactor must be added to cosmic radiation in determining the allowable flight time.

• **Orbital exposure**—In regard to manned orbital missions, Reitz said that a study of cosmic ray intensity indicates that a near-circular orbit which lies below the inner radiation belt will not expose a human being to a dose greater than the allowable 5 rem yearly for any orbital inclination less than 48 degrees or greater than the allowable 13-week dose of 3 rem for any inclination less than 71 degrees.

He said the minimum allowable time in a 90-degree orbit at an altitude of 400 km. or less is about 80 days.

"At 3,500 k., only orbits of inclination less than 25 degrees do not expose a human being to a dose greater than 3 rem during a 13-week period, while at 6,000 km. all orbits have an exposure time limitation."

Reitz said that experiments with shielding materials indicate that lead and lithium hydride are nearly as efficient for gamma rays and fast neutrons as any which have been tested. He said, however, that lithium borohydride might prove an even better neutron shield than lithium hydride.

He indicated that cosmic and nuclear radiation would become less of a handicap as the ability to carry heavier shielding increased due to improved propulsion systems.

Pentagon Moves to Cut Down Security Stamping

Department of Defense security classifiers are expected to be a little more discriminating in using their rubber stamps under a DOD directive attempting to eliminate unnecessary secrecy.

The new policy, according to a DOD spokesman, should result in significant savings in time and money for the 24,000 contractors engaged in classified defense work, including the added saving created by large reductions in security personnel.

The latest DOD attempt to bring order to its sometimes illogical security specifications system is for the censors to concentrate only on the details or components of a weapons system or program which clearly need protection.

The revision involves a rewritten DOD Form 254 security check list attached to defense contracts, which will afford timely identification of information requiring classification while determining the lowest acceptable level of security.

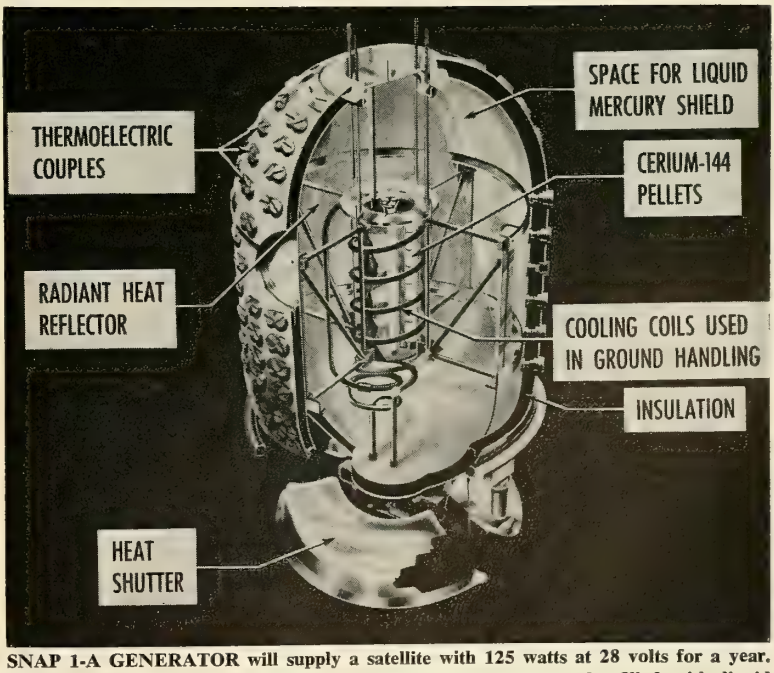
Under the new regulation an automatic annual classification review is mandatory.

Human Neuron Duplicated In Device by Aeronutronic

Aeronutronic Division, Ford Motor Co., last week announced development of a tiny electronic device that duplicates a neuron—the learning unit of the human nervous system.

The electronic neuron, called MIND (Magnetic Integrator Neuron Duplicator), is about one-fourth the size of a penny and consists of a magnetic core with an inner hole through which wires are strung. It was developed as part of a research program, sponsored partly by the Department of Defense.

Year-long power source



SNAP 1-A GENERATOR will supply a satellite with 125 watts at 28 volts for a year. The 175-lb. device, being developed by The Martin Co., can be filled with liquid mercury to shield the radioactive heat source during ground handling. Studded with 277 thermocouples, the generator is equipped with a temperature-sensitive shutter which assures a constant electrical output.

Atlas Flight Is Victory For All-Inertial Guidance

All future Atlases will carry the proven Arma System, but radio-inertial package will be retained on Atlas-D

HEMPSTEAD, N.Y.—Recent success of the *Atlas* ICBM all-inertial guidance does not mean it will displace radio-inertial systems already in use, says the Air Force.

At a joint Air Force/American Bosch Arma Corp. press conference here describing Arma's advanced inertial package, Lt. Col. Frank Box, AF Ballistic Missile Div., ARDC, said radio will continue to be used in the *Atlas* D-series. All future models will have the all-inertial system.

(The D-series *Atlas* is now operational although test shots for system improvement will continue for some time. The E-series, which will get the new guidance, is in static test now. It will be flight tested within 4-5 weeks, according to Convair.)

The June 11, *Atlas* firing from Cape Canaveral placed another star in missilery's progress report—the first successful free-world ICBM flight fully controlled by an all-inertial guidance system.

With the ink hardly dry from history's last addition, new components and state-of-the-art packaging techniques for tomorrows ICBM guidance will be even more accurate, smaller, and more reliable. Its developer, Arma Div. of American Bosch Arma Corp., already is well along with second and third-generation guidance packages.

During this first release of information to the public concerning the still highly classified system, an Air Force official said the guidance package exceeded all design requirements. (A statistical accuracy of falling within a 2-mile target circle was probably the minimum requirement, since radio-inertial guidance systems previously used have reportedly halved this mark.)

• **Radio-inertial still used**—In describing the *Atlas* guidance program, Col. Box emphasized that radio command guidance is still in use and will continue to be used.

Radio-inertial guidance was initially selected by the Air Force because its state of development offered minimum time and cost for completion to use in the accelerated ICBM program. Although very accurate, and small in weight and volume, it has one big limiting factor: It necessitates a relatively tight grouping of launch pads to permit firing in salvo. This makes the entire complex vulnerable to one direct hit or one catastrophic accident.

Development costs to date of the Arma system are in the "tens of millions of dollars," said Col. Box. Up to 10 shots probably will be made before the guidance is declared ready for operational use.

Started as a company-sponsored project six years ago, Arma guidance won a feasibility contract in 1955 and the development award in 1959.

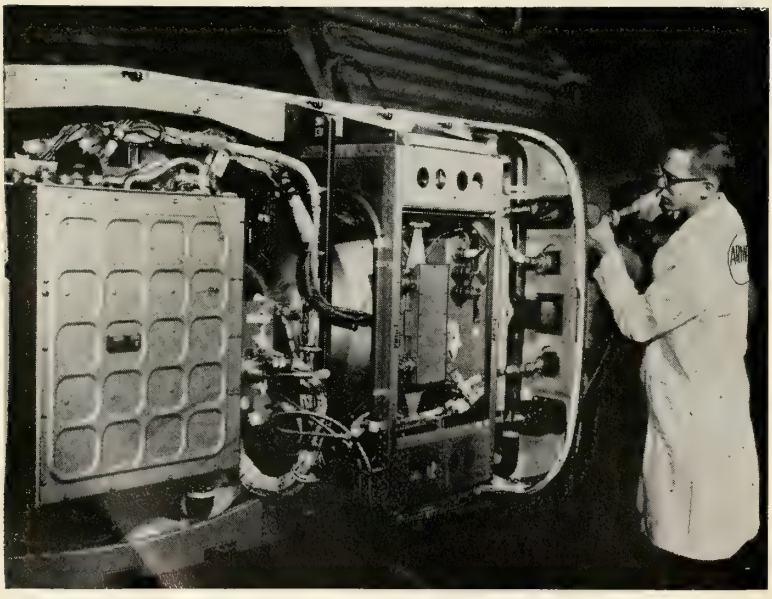
First flight test of the system occurred March 8. A dry run of the system generated all necessary signals for telemetering to a ground station. Actual performance data from the radio-guided missile was used for comparison with the inertial steering signals.

• **Size reduction soon**—The present missile-borne system is large, consisting of three basic units: the all-inertial guidance platform, the solid-state digital computer, and the control central.

The platform uses two 2-degree-of-freedom fluid-suspended Arma gyros. (These cover 2 axes each with a redundancy in azimuth.) Three precision accelerometers are used to sense vehicle motion in space, operating with an accuracy of 1 ft./sec.

For the future, size and weight will be reduced greatly. Already, the gyros have been cut by 75% in size, the accelerometers 80%. The control-box electronics has been repackaged within the platform outer sphere to further reduce total volume and weight. Finally, with microminiaturization techniques the guidance computer has been reduced 70% in size.

Accuracies in the improved components are vastly superior to the currently used parts, said an Arma official.



ARMA'S ALL-INERTIAL guidance system gets final adjustments prior to its June 11 test flight in the *Atlas-D* ICBM. Installed in an external pad on the missile are the computer (left), stable platform (center), and control central (right).

Tapco to Build Closed-cycle Torpedo Engine for BuWeap

Tapco Products Group of Thompson Ramo Wooldridge, Inc. has been awarded a cost plus fixed fee contract of about $300,000 for research and development of a closed-cycle torpedo engine for Bureau of Naval Weapons.

The contract strengthens the company's position in the secondary power generation field. Only recently, it received a contract for the National Aeronautics and Space Administration's *Sunflower II*.

Testing of first versions of the silent-running engine is expected in 18-24 months. Presumably the engine will use a solid fuel as the basic energy source. Under the closed-cycle system, fuel is expanded, enters through a turbine and is cooled and condensed. It then goes back to its original fuel state.

Tapco first entered the auxiliary power generation field when it furnished liquid, self-contained units for *Bomarc* and *Terrier*.

Polaris Guidance Needs Are Critical

by Frank G. McGuire

COLORADO SPRINGS, COLO.—A velocity error of as little as 5 ft./sec. at warhead separation will cause the *Polaris* ballistic missile to miss its target by a mile.

Separation—which occurs within a minute or two after launch, when the missile is only one-sixteenth of its way to the target—is the "moment of truth" in the trajectory. Any errors at this point will be reflected, and even multiplied, in deviation from the planned impact point. An error in lateral position at separation, for instance, will cause an impact error 15 times as great.

These critical requirements of the *Polaris* inertial guidance system were pointed out here last week by Rear Adm. J. A. Jaap, Navy director of development programs, at the annual meeting of the Institute of Navigation. Citing other critical examples, Admiral Jaap said that the warhead is separated when the missile is traveling at a speed of 14,000 knots at an altitude of 70 miles—and still climbing. The guidance equipment must be sufficiently precise to correct velocity errors of only a few feet per second and position errors of one foot at this point.

The position of the launching submarine is not so critical, the Admiral said, but errors cannot be allowed to accumulate. Submarines will carry three inertial navigation systems and an electronic computer to instantaneously fix positions as accurately as possible.

The Navy's *Transit* satellites are designed to give submarines a position fix within one-quarter mile. Ultimate goal is one-tenth mile.

• **U-2 cosmic research**—In another paper, Dr. S. Fred Singer, Professor of Physics at the U. of Maryland, discussed problems of radiation in space. He said that research on cosmic radiation has been undertaken by the Air Force since early this year with special equipment mounted on U-2 high-altitude aircraft.

He praised the Air Force's "well organized and excellent program" on radiation problems in space. Much of this research is being carried out over North America and the polar areas, he said, noting that aircraft are better than satellites for some phases of the program because they travel a controlled trajectory.

On the dangers of the radiation belts surrounding the earth, Singer said they present little danger if they are crossed quickly and in the right place. In another side, however, he remarked "until rocket reliability is greatly increased, the radiation belts present little hazard to manned space flight."

• **U.S. guidance defended**—Soviet success in hitting the moon with an instrumented payload while similar U.S. attempts failed was not necessarily due to any greater capability in accuracy, Dr. Newell Sanders, Assistant Director, Office of Space Flight Development, National Aeronautics and Space Administration, told the ION.

He said the apparently poor accuracy on the part of American probes was due partly to the use of solid propellant final stages. Deviations in separation velocity of the payload package could easily throw the probe off its intended trajectory by a substantial margin, Sanders said.

"In practice," Sanders noted, "We have injection accuracy of one part in 5000. This would easily put us within 20,000 miles of Mars. A lunar probe would be more accurate, due to the shorter distance involved," he added.

Our ability to track a vehicle in space is just as impressive, Sanders said. NASA currently has the capability of determining—at interplanetary distances—a probe's velocity to within one meter per second through use of Doppler radar, and its range to within ten meters through use of pulse radar.

This capability becomes necessary in using radio command guidance correction techniques during the course of a flight.

The best area for course correction during a lengthy interplanetary flight is early in the trajectory and at least before the payload gets one third of the way to its destination. Corrections can be made later in the flight, but only at greatly increased payload penalties as the probe progresses.

After the one-third point in the trajectory, the curve of payload penalty versus distance back to true course rises with great rapidity. The propellant required to regain proper heading is carried at the expense of useful payload.

• **'Pseudo targets'**—In a paper describing a new system for computing guidance parameters for interplanetary flight, Dr. R. M. Leger, Chief of Flight Performance and Analysis at Convair-Astronautics, presented a possible solution to disadvantages posed by necessity for launching at an exact time, to achieve a desired trajectory.

The "pseudo target" method proposed by Leger would simplify the explicit computations and provide a maximum amount of decoupling between launch time and other dispersions.

Noting that "the facts of life" in launching of interplanetary vehicles saddles scientists with the problem of coping with a three dimensional guidance situation, he describes the pseudo target system as a hybrid method set up in terms of polynomial expansions. The guidance system then controls to the pseudo target by explicitly computation of Keplerian orbits.

Previous methods of guidance have utilized two opposing techniques, Leger said. One is the use of pre-computed flight data reducing the guidance reference to a series of polynomials which are evaluated in flight. The other is in-flight computation of the required conditions for target impact.

Polynomial expansions have the advantage of summarizing the effects of many detailed perturbations in a relatively compact form. These perturbations usually require extensive computation.

The disadvantage of the polynomial, however, is that they have a tendency to be limited over the range of variables, and are inherently associated with a specific coordination system.

Extension of the polynomial method of handling variable launch times leads to two alternatives, according to Leger:

Compute a complete set of guidance coefficients for each of the several specific launch dates under consideration. Try to launch at the first of these times then the second in case of initial failure then the third alternative launch date and so on. Fine adjustment in this system is accomplished by holding the actual launch until the precise time on the selected date.

Add terms involving the launch time parameter to the polynomial expansions and launch at any time within reasonably limits.

Both the foregoing require considerable preflight computation. The former also requires either a rapid reload capability on the art of the guidance computer, or enough storage capacity to store all coefficients for all possible launch times. "Direct computation of precision trajectories has usually been found to be too time consuming to be carried out in flight for launch guidance purposes," Leger said.

Giving extensive technical description of the pseudo target system, he said Convair found the system to be little more complex than single-launch-time systems using polynomial expression. He added, however, that much work remains to be done on the method.

NASA Receives ABMA Men, Facilities

HUNTSVILLE, ALA.—In a brief ceremony Thursday, the Army transferred 4700 employes and turned over $100 million worth of buildings and equipment to the National Aeronautics and Space Administration.

NASA's new Marshall Space Flight Center, headed by Dr. Wernher von Braun, became fully operational upon receiving the personnel and property of the Development Operations Division, Army Ballistic Missile Agency. The property affected is part of Redstone Arsenal here and part of the facilities at Patrick Air Force Base, Cape Canaveral, Fla.

Participants in the ceremony included Maj. Gen. August Schomburg, commanding general, U.S. Army Ordnance Missile Command; von Braun; and Col. Richard Hurst, commander, ABMA.

Marshall Space Flight Center came into being in March but had only a small staff planning organization for the remainder of the fiscal year. The civilian employes involved remained on the Army payroll.

Marshall Center now becomes the NASA operations center for development of vehicles and propulsion and for launch operations. Its activities are supervised by the NASA Office of Launch Vehicle Programs, headed by Maj. Gen. Don R. Ostrander, USAF.

In another development, it was announced that Commander Bart Slattery, USN, will move to Huntsville later this summer as public information officer for the Marshall Space Flight Center. He is now stationed at the Pentagon.

mergers and expansions

FORD MOTOR CO. has established a Special Military Vehicles Operations department as part of its Defense Products Group. Frank S. Kipp, formerly manager of Defense Contract Administration, has been appointed general operations manager. His former office, together with Special Military Vehicles Office, and Mobilization Planning and Defense Sales Department, has been transferred to the new department from the Defense Products Group.

C-E-I-R, INC. has merged with General Analysis Corp., operating under the C-E-I-R name. General Analysis, with divisions at Dugway, Utah, and Fort Huachuca, Ariz., and headquarters at Los Angeles, has had annual sales of about $700,000 and a current backlog of $1.4 million. GAC Stockholders will receive 9 shares of stock in C-E-I-R for 20 GAC shares.

LOCKHEED ELECTRONICS CO. formalized its decision to make headquarters near Princeton, N.J., last week. The Lockheed Aircraft Corp. subsidiary bought 210 acres on which it will begin development in 1961.

ROCHESTER MANUFACTURING CO. has embarked on a long-range research and development and expansion program including a 10,000-sq.-ft. addition to one of its plants in Rochester, and a move to a new plant by its West Coast subsidiary.

NATIONAL CASH REGISTER has established a Military Development and Marketing Department to include its electronic, electromechanical and mechanical systems and components in such areas as airborne, digital and analog computers, related communications equipment, simulators and other devices.

HOUSTON FEARLESS CORP. has acquired Marchetti Associates, Boston electronics research-engineering company formerly affiliated with Avco Corp.'s Crosley Division. Marchetti will operate within the Houston Fearless Federal Group.

COMPUTRONICS, INC. has been formed in Denver, Colo., to develop, manufacture and sell components and systems for instrumentation, computers, controls and data handling. Although a completely independent firm, Epsco, Inc. is a major stockholder, and two Epsco officers serve on the board of directors.

Quail Moves Nearer Operational

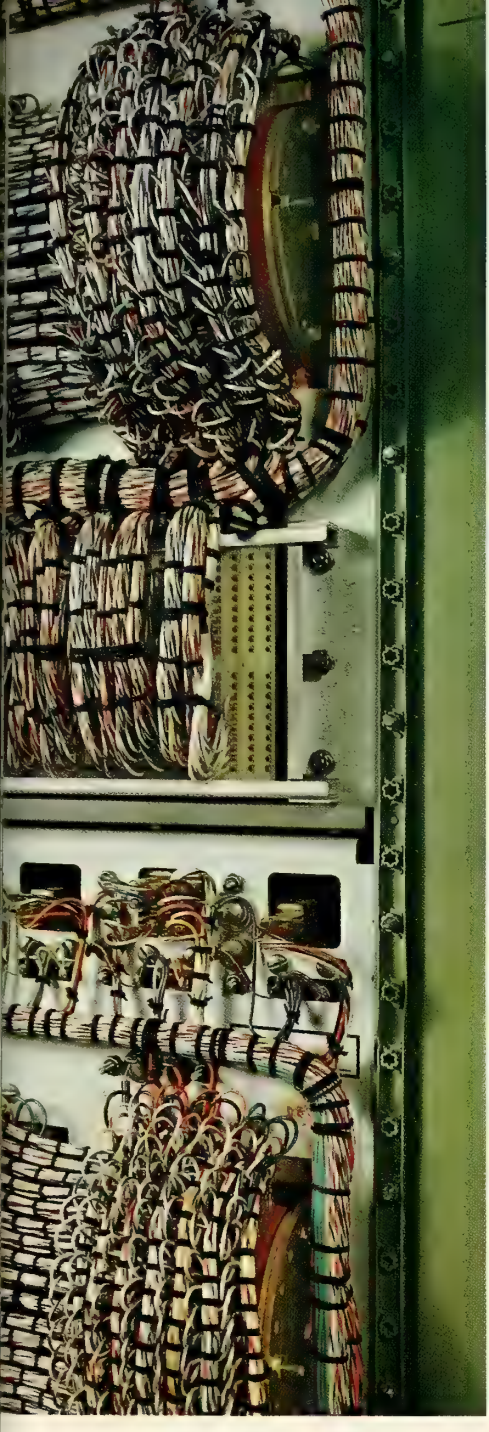


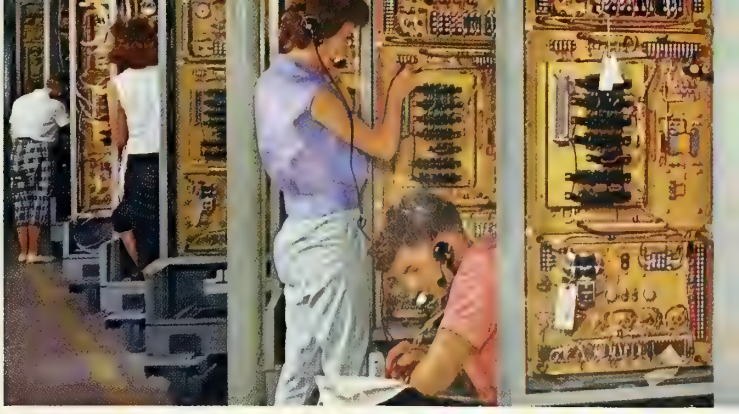
A COVEY OF THREE Quail decoy missiles was salvoed from a SAC B-52G for the first time June 24. The successful test at Eglin Gulf range pushed the divisionary missile a step closer to operational status. The 10-ft. Quail, with electronic augmentation, produces a blip on radar similar to that of a Bomber.

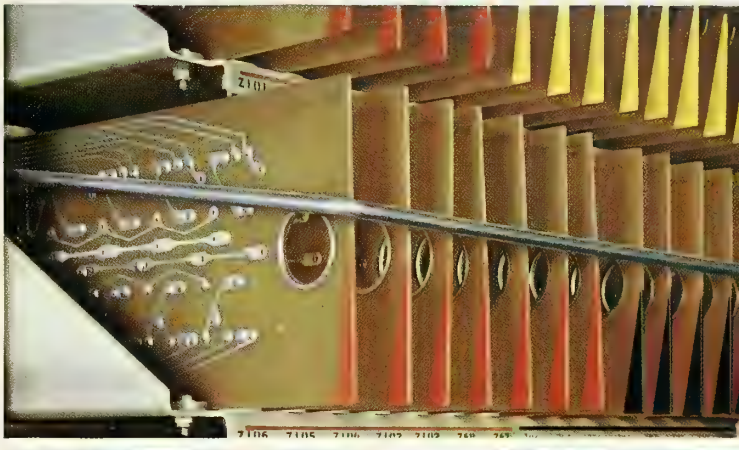
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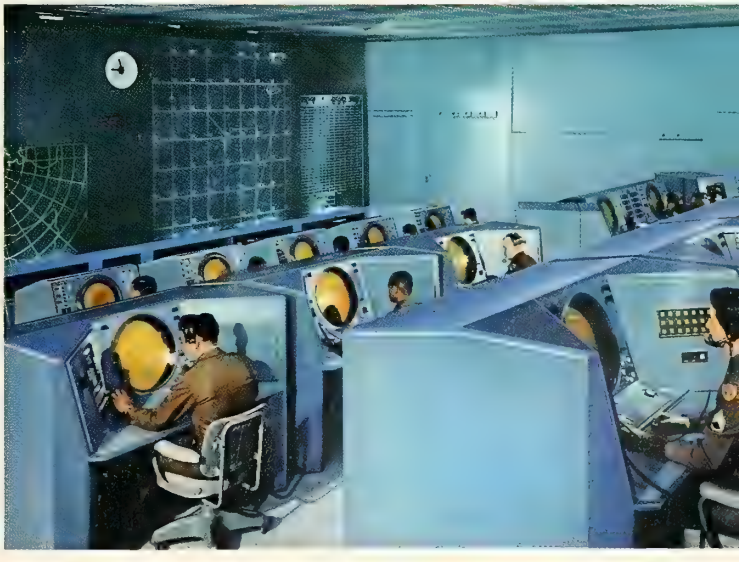
United Industrial Corp.—UIC is distributing as dividends to its own shareholders stock in two of its subsidiaries, Aircraft Armaments, Inc. and U.S. Semiconductor Products. The move is designed to: 1) promote autonomous expansion of certain of its subsidiaries; 2) enable its holders to participate in the equity ownership of such subsidiaries and 3) provide the parent company with additional funds to further its own plans for future acquisition and development.

Avco Corp.—Earnings in the fiscal second quarter ending May 31 climbed to an indicated $3.1 million from $2.9 million for the previous year's period. Indicated sales rose to $86.8 million from $80.7 million for the second quarter period last year.





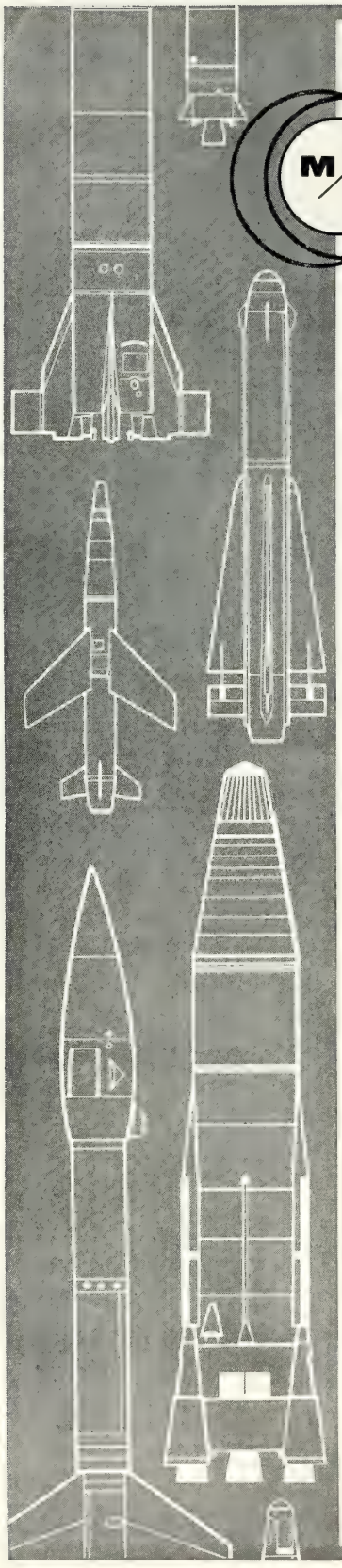




On guard against air attack—The Martin Missile Master electronic air defense system will protect ten major metropolitan areas by year's end. First installations have been delivered ahead of schedule and are now operational. According to the Army, Missile Master "will provide the most efficient and economical control and distribution of firepower available for the defense of strategic areas in the continental United States."

At $00^h\ 00^m\ 01^s$ GMT, July 1, 1960, Martin logged its 590,304,000th mile of space flight

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During the first six months of 1960, the advertising of 185 missile/space manufacturers appeared in M/R

THE MISSILE/SPACE WEEKLY

missiles and rockets

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Technical Countdown

ELECTRONICS

Free Radicals Harnessed

The energy released by free radicals can be captured and converted to useful power, according to Energy Conversion Laboratories. The reactions are reportedly being controlled at near room temperature to directly produce electricity. The company offers to demonstrate the technique to any interested parties.

Welded Circuitry Next Step?

Welded-wire matrix circuitry looks like the next major breakthrough in electronics. The big potential of the technique is in adaptability to computer design and automated manufacturing. Circuitry is flexible, has high volumetric efficiency, and offers high-temperature stability and resistance to thermal and physical shock. (Details will be covered in later issue of M/R.)

New Antenna Concept for Hard Bases

"Ring-arrays" may be the answer to problem of hardened antenna installations at missile bases. Such an electronically scanned antenna—now under development at General Electric—would be entirely flat except for small vertical radiating elements arranged in widely spaced concentric rings. For higher-elevation coverage, the radiators could be slots, with no vertical elements.

Lighter and Cheaper Solar Cells

An evaporated coating for solar cells is reported by Bausch & Lomb to have several advantages over the more conventional glass cover slip. Although efficiencies run slightly lower, the process reduces total cell weight about 10% and costs only one-fifth as much as the glass cover. There are no thermal stress problems and no cement (which may solarize and darken to reduce efficiency after exposure to ultraviolet).

Higher Component Densities

Component density continues to increase in missile electronics. The *Sky Bolt* computer is reported to have 3-5 times the density of any other existing ballistic missile guidance computer.

PROPULSION

Thrust compromise for Centaur

Thrust of the uprated Pratt & Whitney LOX-liquid hydrogen *Centaur* engine probably won't quite reach 20,000 lbs. NASA propulsion specialists are convinced the engine can be modified to boost thrust that high from its present level of 15K, but they question whether it will be worth the money involved. Also, they are afraid reliability may fall off when the engine is pushed so hard. A compromise of 18 or 19K is likely to emerge from the contract negotiations this summer.

J-2 Weighs in at 2500 lbs.

The Rocketdyne J-2 200,000-lb.-thrust engine for *Saturn* will weigh about 2500 lbs., excluding tanks. Present plans are to build it into a four-engine 800K second stage with burning time exceeding 100 seconds. Start will be based on a gas generator that, like the engine itself, burns LOX and liquid hydrogen.

Storable for Mach-2 Drone

Typical of the best storable propellants for drone engines is hydrogen and inhibited red fuming nitric acid, says Rocketdyne. Successfully tested in a sustainer-booster system, data indicated that the storable could give Mach-2 performance to a drone for a substantial time period.

Solid-Propellant Torpedo Next

Navy's solid-propelled torpedo program for ASW is advancing. One manufacturer reportedly has test-fired such a torpedo at depth below 1000 ft. and at speeds above 35 knots.

MATERIALS

Self-coating Ceramic for High Temp

Boeing ceramists have developed a ceramic graphite-base material which forms its own protective coating when exposed to high temperatures. The oxidation-resistant coating forms at 2200°F in a typical composition of 50% graphite, 24% molybdenum disilicide and 25% titanium boride. Current work is directed toward using the composite graphite bodies in environments in excess of 3000°F for extended periods.

Meteoroid Impact Simulated

Plastic projectiles will be slamming into materials specimens at speeds up to 26,000 mph as soon as Republic Aviation engineers finish building the actuator —a high-powered hydrogen gun. The hydrogen gas, heated to 15,000°F by an electrical spark discharge, ruptures a metal diaphragm and forces the projectile down a gun barrel.

Modern Technique, New Application

Reporting success in the explosive forming of thrust chambers for drones, Rocketdyne calls its development a feasible production technique.

ASW ENGINEERING

Needed: Standard Depth Terminology

The word "depth" means many things to many people engaged in underseas technology, and there's agitation for standardization of terminology such as used in describing frequency bands. Very deep water (VDW), ultra deep water (UDW), etc., have been suggested. The designation doesn't make any difference as long as a common range definition exists.

NuPad Ranging Has 10-yr. Life

Martin Company's 30-man ASW department is working on a NuPad concept (nuclear-powered active detection). Application is isotopic decay for an electric power source with no moving parts. Active ranging system would be expendable and would have life of 10 years.

Acoustical Lab Submerged

The Martin company has created its own underwater sound laboratory at Middle River, Md. It's dredged an inlet down to 25 ft. depth. The lab can supply power up to 1500 watts and handle transducers up to 1000 lbs. in weight.

Undersea Area Needs Fresh Thinking

A Discussion of:

- Major research program for accurate underwater maps and sub-surface current tables.
- Fixed (anchored) telemetering stations at many locations with instruments that will combine accurate, rapid data acquisition from near-surface depths to 15,000 ft. with equally rapid analysis and readout. Variables to be taken simultaneously are depth ±1 ft., temperature, ±0.01°C, current velocity ±0.1 knot, direction, ±5°; sound velocity, ±0.1 ft./sec., plus direct reading of salinity.
- A propelled deep-diving "fish" to obtain profile data rapidly by fast descent-ascent recording and telemetering either to an aircraft or a mother ship.
- A good underwater buoyant material, probably a plastic, with a near-constant density less than sea water at any depth.
- Electronics without maintaining atmospheric pressure.
- Providing the submariner with accurate information about the immediate volume in which he is operating—a water velocity meter with an accuracy of ±0.1 knots and a sound velocity meter with an accuracy of ±0.1 ft./sec.

by Richard W. Van Hoesen and Marvin S. Weinstein

Underseas technology is a new region of discovery to be explored and treated, just as the atmosphere and outer space. It needs whole new families of instrumentation—but most of all it needs a cross-fertilization in the scientific community of new ideas, new thinking and drastically new approaches.

The problem area covers every bit of navigable water, principally the oceans and salt water harbors of the world and secondarily the navigable rivers and bays. "Area of interest" is not really a correct term, for in reality we are interested in the vast water volume of our globe.

A true understanding of all the variables existing in the volume must be obtained if we are to make full use not only of our present surface and subsurface vessels, but also of planned and future developments. The total mass of analyzed data now available only begets the need for more and better information.

• **Physical variables**—Let's concern ourselves with the military problems of surface and subsurface vessel design, navigation, detection, ranging, ordnance, ordnance control systems and evasive action. We will not dwell on the equally important topics of marine biology and chemistry but shall concentrate on physical variables in the sea.

A modern meteorologist preparing a gross weather map requires at least three accurate bits of information gathered simultaneously at each of many stations on the earth. The variables are: surface air temperature, barometric pressure and wind speed and direction.

This information is not sufficient for the flight meteorologist. He needs additional information on the gradients between the earth surface and the operating ceiling of the aircraft. He needs accurate data on wind, temperature and humidity sampled at many points in the air volume. Further, he requires more frequent sampling since the air space is in use around the clock by more and more aircraft of ever-increasing variety and flight capabilities. The flight meteorologist long ago discovered that fixed station, earth-bound data collection is not enough. He reached out first of all with manned aircraft, sampling over fixed areas. He then increased his data collection capability manyfold by using free floating balloons.

The radiosonde, complemented by RDF and backed up with visual (theodolite) tracking, multiplied his capability many times—and yet he found that the gaps between measuring sites were not being adequately filled. He now has at his disposal special, far-reaching weather radar to fill part of the gap and present constantly changing information.

Let us now examine the lot of the naval meteorologist, responsible for giving advice to ships transiting the open ocean. Weather stations on all land masses surrounding the ocean and island weather stations provide him with the previously discussed weather data. He has in addition data of variable worth collected at various times, from ships transiting the area.

The ships, for instance, give him information on estimated sea state and local wind conditions. He does not have a good profile of surface waves and currents in the transit area at the time of departure. All such vital facts must be calculated from the meager information available. Obviously, he is at a disadvantage in comparison to the continental air meteorologist. This in itself is a good introduction to the vast problems to be solved in this field. We have not yet breached the surface of the sea and a major need has been revealed.

But now let us just dent the surface of the sea. This really is all that a search sonar transducer mounted on the bottom of a destroyer does. The range capability of a sonar in perfect operating condition is severely limited by ever-changing water conditions. Sound refraction at a thermocline can prevent detection of a submarine lurking beneath the thermocline, but well within the maximum range capability of the sonar.

Gross data is now obtained by dropping a B-T (Bathythermograph) over the side on a length of wire, recovering the B-T and determining the depth-versus-water temperature curve under the ship at the particular time of measurement. This information can then be used to obtain gross information on change of sound velocity with depth.

Certainly, this information is better than none, but what is really necessary is a device which will give an accurate picture of the depth-versus-sound velocity contours in a wide area around the ship and which can obtain this information quickly and frequently as the ship moves along on patrol or in escort service.

The same information is of course desired by the submarine. A modern destroyer with Variable Depth Sonar would increase its capability manyfold if it had sufficient information to adjust the sonar depth to varying sound conditions. Likewise the submarine skipper could use the information—offensively for better detection range or defensively to provide cover for efficient evasion tactics.

• **Accurate charts**—We can now descend deeper into the sea and concern ourselves with submarines. The submarine USS Triton just completed a successful submerged circumnavigation of the earth. This voyage was likened to Magellan's voyage. Truly the Triton's voyage was a remarkable feat—and certainly as pioneering as Magellan's.

It would have been even more hair-raising if it had been accomplished far below periscope depth. This would have been entirely analagous to Magellan's venture. Accurate charts were not available to Magellan, nor are underwater profile charts available to the submariner. Magellan had to put up with surface current conditions as he encountered them. This also would have been the lot of the Triton's skipper. Just as Magellan had no advance weather information the Triton could not have any advance subsurface temperature and current information.

Rather than belabor the analogy further, it need only be said that the minimum information felt necessary for reasonable safe surface and air navigation is not available to the deep-running submarine. The Navy needs accurate underwater maps and subsurface current tables. Since no one is absolutely sure of all the variables that enter into subsurface currents, a major research program must be undertaken to include several years of investigation, with the hope that significant trends will be observed from which accurate long-range predictions can be made.

The submariner also must have accurate information about the immediate volume in which he is operating. He needs a water velocity meter with an accuracy of ±0.1 knots and a sound velocity meter with an accuracy of ±0.1 ft./sec. The sound velocity instrument must be capable of giving information at the ship and sampling a large volume around the ship.

• **What's being done?**—The United States must embark on a major oceanographic research program. Various starts are being made in this direction; one is a bill before Congress to provide the funds necessary to build a small fleet of oceanographic research vessels. It is necessary, however, to equip these ships and many more, both military and civilian, with a whole new family of instruments. Instruments must be designed which will combine accurate, rapid data acquisition from near surface depths to 15,000 feet with equally rapid analysis and readout.

The minimum variables to be taken simultaneously are depth ±1 ft., temperature ±0.01°, current velocity ±0.1 knot, direction ±5°; sound velocity ±0.1 ft/sec. It would also be desirable to have a direct reading of salinity. The instruments to make these measurements are not available today. The current techniques for deep sampling are many years old, require time and use indirect methods to obtain vital information.

The most used item on an oceanographic cruise is the Nansen bottle wire cast. The Nansen bottle is an ingenious metal flask, to which two very accurate reversing thermometers are attached. One thermometer is open to sea water pressure and the other is protected from the pressure by a heavy glass enclosure. The combination instrument is slowly lowered to the approximate depth as calculated by wire paid out and the angle measured to the vertical at which time a heavy metal "messenger" is slid down the cable.



VAN HOESEN



WEINSTEIN

The authors are senior scientists and founders of Underwater Systems, Inc., a Wheaton, Md., engineering corporation specializing in acoustics, underwater sound, ultrasonics, magnetics, pressure and sub-audio signals, magnetic tape and direct data recording, and electronic instrumentation.

Both men are electronics engineers and physicists. Mr. Van Hoesen, previously associated with Naval Ordnance Laboratory, Naval Research Laboratory, and Vitro Laboratories, is president of Underwater Systems. Dr. Weinstein, former chief of the hydroacoustics branch of Naval Ordnance Laboratory, is the firm's senior scientist.

When the "messenger" reaches the Nansen bottle valve, capturing a sample of sea water and simultaneously separating the mercury column in the thermometers, the bottle is then raised to the surface, the thermometer readings recorded and the water transferred to a flask for later analysis.

The entire measurement process takes much time and limits the number of observations that can be made in any one location. To obtain true water temperature and absolute depth from the thermometer readings requires much additional work.

• **New thinking required**—The Nansen technique is given only as a concrete example of one present-day technique, not as a criticism of the Nansen bottle-reversing thermometer system as an accurate scientific instrument. It has indeed had the test of time since it is essentially the same as when it was invented by Fridtjof Nansen near the end of the 19th century. This is however, the middle of the 20th century: we need new instruments, new thinking, drastically new approaches, and an opportunity for scientific hybridization.

While most readers of this magazine are not specialists in the underwater medium, they are nevertheless thinking scientists and engineers. We all must think of the vast volume of water as a new region to be explored. We should treat it just as we treat the atmosphere and outer space.

• **How do we do it?**—First of all, we need fixed (anchored) telemetering stations at many locations, fully equipped with instruments to sample the entire depth. These would correspond to fixed weather stations.

Next we should consider a propelled deep-diving "fish" to obtain profile data rapidly by rapid descent-ascent recording and telemetering either to an aircraft or a mother ship. These would correspond to high-altitude sounding rockets. It may be very desirable to obtain data at a constant depth over a long track. This could be accomplished by a propelled underwater fish, programed to maintain depth and course, record all data and then rise at the end of the track and telemeter the data to a shore station, mothership or aircraft.

The latter, could conceivably be used in combination with the vertical sampler to find a depth for optimum detection range or a safe zone for high-speed undersea travel without risk of being detected.

It is obvious that a whole family of instruments is needed. The needs range from single variable to multi-variable acquisition. Furthermore, simple medium accuracy, dependable and expendable devices are needed to fulfill certain tactical military needs. Relatively com-

plex, expensive and highly precise equipment is needed for the research work.

Does this not strike a familiar chord with the missile scientist? We hope we have not lost materials engineers, propulsion specialists and electronic circuit and components men along the way. Every one of these specialists and more are required if this underwater frontier is to be crossed.

Let's cite just two examples in materials and electronic components. The first concerns body and buoyant material for underwater "satellites." A good underwater buoyant material ideally would have a constant density less than sea water at any depth. The best material at present is gasoline. Gasoline, for example, with all its hazardous drawbacks, is the material used to buoy the bathyscaph Trieste. A safe, compact inexpensive material is needed. Probably a plastic will be found to fill the bill.

The second example concerns electronic parts for the deep-diving measuring and telemetering systems. Every present-day underwater electronic system is enclosed in a heavy metal case to protect elements from sea pressure.

The cases become bigger, heavier, more difficult to handle and prone to leaks as the need for greater depths increases. How much simpler it would be if we could enclose the electronics in an oil-filled compliant chamber and forget about maintaining atmospheric pressure in the electronics compartment. To do this will require study of solid-state devices (obviously vacuum tubes are out) and the behavior of components under great pressure. This could open a new field in component design and materials testing.

In this article, we have only scratched the surface of the problem. It has been written only to whet the scientific appetite, not to pacify scientific hunger pangs. More ideas must come from more minds if we are to be successful.

Chemical Booster Proposed For Manned Moon Missions

NASA official urges clustered base for direct shot of Super Nova, sites nuclear need beyond moon

A chemical-nuclear *Super Nova* vehicle for manned moon missions in the early 1970's is proposed by a high official of the National Aeronautics and Space Administration.

Harold B. Finger, NASA chief of nuclear engines, suggests that the vehicle might be based on a clustered chemical booster with thrust of 2 to 3½ million lbs. Such a vehicle would accomplish the same manned lunar landing mission as an all-chemical *Nova* vehicle with about 10 million lbs. takeoff thrust.

Finger told the American Nuclear Society in Chicago that NASA recognizes that it must begin soon the design of a vehicle capable of lunar landing missions. Two approaches are possible: space rendezvous and orbital refueling on the one hand, a direct shot from earth and return on the other.

The all-chemical *Nova* and the chemical-nuclear *Super Nova* are designed to accomplish the direct shot, Finger explained. The space rendezvous and orbital techniques will be studied actively at the new NASA Marshall Space Flight Center in Huntsville, Ala., based on the use of several *Saturn* vehicles.

Finger did not elaborate on the chemical booster proposed for his nuclear-chemical vehicle. However, it is known that NASA is studying several concepts based on a single 1½-million-lb.-thrust Rocketdyne F-1 engine, rather than a cluster of F-1's as in the more well known *Nova* concept. The single F-1 would have a circle of 188,000-lb.-thrust H-1 engines around it. H-1 is the engine unit in the *Saturn* cluster.

Beyond the lunar mission, Finger declared, "for interplanetary missions, nuclear rocket stages are so far superior to chemical systems in delivering high payloads that their development becomes a necessity if we are to have real freedom to travel at will in space.

"For such missions, I like to quote numbers that show that a 150,000-lb. nuclear powered space ship can be started up in an earth orbit, orbit Mars, and return to the earth orbit with approximately 20,000 lbs. or about 7 times as much as can be returned with an all-chemical system."

Present NASA plans call for flight-testing a nuclear rocket stage as an orbital start stage by 1965, Finger declared. The nuclear engine will be boosted into orbit by a two-stage *Saturn* vehicle.

Noting that other flight-testing methods have been proposed, Finger said none had been ruled out of the NASA program. Among the other methods, he listed ground-launched test shots and limited range flights over water with a nuclear second stage. "They are being evaluated before the flight test system and program are finalized," he added.

The NASA propulsion chief said a major advantage of the orbital start test is in the fact that it appears to have the potential for development to operational status. The other testing methods are advocated as preliminary to an orbital start—to demonstrate the feasibility of nuclear flight.

A two-stage chemical *Saturn* with a nuclear third stage would deliver about twice the payload of an all-chemical *Saturn* for an escape-velocity mission, Finger asserted. He continued:

"It is, however, my attitude that even if such a configuration gave no payload increase, such a three-stage chemical-nuclear *Saturn* should become an operational vehicle in order to supply us with operational experience on nuclear stages."

Finger said such experience would develop reliability and a feeling of confidence in the engine's capability and that operating problems have not been overlooked. "Such a feeling of confidence is essential if we are to commit our stable of vehicles beyond *Saturn* to nuclear systems," he added.

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Kiwi A Instrumentation Near Perfect

Instrumentation of the Project *Rover* nuclear rocket test area operated with an overall error of under 1%—less than the statistical sum of all the component errors—during the Kiwi A test.

This performance was achieved despite some unique problems, according to spokesmen for Edgerton, Germeshausen and Grier, Inc., *Rover* instrumentation contractors, who recently outlined their design philosophy before the American Rocket Society.

The low error was probably brought about by compensation between individual parts of the system, said Bryant L. Hanson, EG&G senior scientist.

Hanson's firm has a subcontract from the J-8 division of Los Alamos Scientific Laboratory of the University of California to instrument the *Rover* test area.

The system is designed to provide more than 800 channels for measurement and control, resulting data being telemetered over two miles of cables. This media was chosen in preference to radio because designers had more confidence in the final accuracy of its data transmission—and also because of its relative simplicity. The maintenance and disassembly building (MAD Building), test cell, and control point complex are mutually separated by about two miles.

All connections between the flatcar-mounted Kiwi A reactor and the test cell are of the breakaway type, so that the reactor can be returned to the MAD building via remote-controlled locomotive. These connections contain gaseous and fluid services, as well as instrumentation.

Subsystems for handling propellant, purge gases, cooling water, and heavy water were designed for remote control operation. "An unusual degree of flexibility in subsystem control was necessary," according to Percival T. Gates, another senior engineer with EG&G, "to allow measurement of engine response as a function of rod position and frequency, mass flow and various other parameters—as well as to incorporate suitable means to operate the power control system under closed loop conditions using an analog computer."

• **Bugaboos**—The serious consequences inherent in a failure of the instrumentation were an overriding consideration in all planning, since non-reversible processes at moderate power levels "could define a point of no return in so far as subsequent hot runs of a particular core" might be involved.

"Loss of data under these circumstances would be most unfortunate," Gates added.

Control system failure was another bugaboo, since an emergency "scram" would subject the entire assembly to intolerable thermal stresses.

Scram refers to emergency action taken to rapidly reduce the reactivity of a nuclear reactor of this type. It can be accomplished by using control rods to sharply cut reactivity, or by dumping a selected material, in many cases boron, into the core to speed the dropoff.

Boron acts as an absorbent to neutrons, the particles necessary to sustain a nuclear chain reaction; when these are absorbed, the reaction drops. This system is quite similar to that applied to the Tory 11A reactor in the *Pluto* nuclear ramjet program previously described. (M/R June 20 Pg. 30)

Some characteristics of the system:

• Most analog measurements are in real time outputs.

• Accuracy of one percent was required, (and achieved with Kiwi-A), of subsystem performance and core diagnostic data.

• Channels are instrumented for bandwidths from DC to 40 cycles per second.

• Due to use of an unshielded reactor, locally mounted transducers are subjected to severe neutron and gamma fluxes.

• Multiple range measurement capability is incorporated, to obtain accuracy sufficient in view of wide dynamic range or uncertainty of expected values.

• Data reduction system is not required to be of high capacity or speed, because of the length of the test cycle and the nature of the data—which was, in the case of Kiwi-A, taken for analysis only in event of malfunction.

• Large investment involved in producing a relatively short high power run dictated a requirement for extreme reliability.

• No attempt was made to develop a prototype of flyable instrumentation.

The instrumentation system is basically a conventional analog system using proven equipment and techniques wherever possible, according to Hanson. But a high degree of refinement and specialization was needed to adequately handle the particular task of testing the nuclear reactor.

The system utilizes chopper preamplifiers, multi-channel strip chart recorders and DC meters. Conversely, it is devoid of multiplexing equipment and radio telemetry. Heart of the quantitative channels are the Offner electronics chopper preamplifiers which drive Sanborn multi-channeled direct writing recorders through approximately two miles of wire.

• **Data guarded**—Gain controls are incremental, rather than continuously variable, on preamplifiers and recorder amplifiers. Gain accuracy and stability specifications for both these inputs are such that an overall accuracy of 1% is probable, independent of detailed voltage calibration.

This philosophy was followed, Hanson said, so that a failure of the voltage calibration system would not prevent scientists from obtaining usable data based upon the station log of gain settings. Values of the fixed gains are chosen so that, for all signal levels between 0.83 and 400 millivolts, it is possible to get at least 75% full-scale recordings on the recorders.

All the channels have approximately a ten-volt DC full-scale signal on the long lines. To minimize cross-talk and pickup effects, the transmission of power level AC signals over the long lines is "religiously avoided," and other steps are taken to eliminate these undesirable effects.

The possibility of an error being introduced into the system due to the radiation environment of the reactor core area was considered, and an analytical method was developed and solved, based on a Laplace transform.

Results indicated that when the thermocouples were intimately bonded to the core structure, the error introduced was approximately 0.8%. If the thermocouple junction is suspended freely in the gas channel, the error may be increased to as high as 2%. Transient response of the thermocouples in all cases is approximately .2 sec., Hanson stated.

• **Alternatives**—Gates spelled out considerations affecting future instrumentation for nuclear reactor tests in the propulsion field. He listed possible choices between analog/digital systems, hard wire/radio transmission, and continuous/sampled data systems.

For Kiwi-A, as an example, a direct wired analog system was chosen,

"with the full realization that special design efforts would be required to achieve the accuracy and reliability implied by the testing concepts."

This choice was made for several reasons. First, hard-wire was chosen over radio transmission because of its simplicity and confidence in its accurate transmission performance.

Secondly, it was recognized that any sampled data schemes considered would require high sampling rates to cover a 40 cycle bandwidth. Also, the need for a high percentage of analog data in real time would require extensive and complex demodulating equipment. Relative cost, availability and a strong desire to stick with simple circuitry mitigated against sampling techniques, Gates said.

Finally, the advantages of the pulse code system, especially that of ease in achieving high transmission and data handling accuracy, appeared most applicable.

For the majority of analog measuring channels involving subsystems and core diagnostics, low-level transducer signals are run 400 feet from the test cell to a distribution bunker through a tunnel. Signals are preamplified prior to transmission through the long lines to the control complex.

At the control point, signals connect directly to conditioning amplifiers of strip chart recorders. Auxiliary recorder outputs allow paralleling meters, limit circuitry, and computer inputs with the recorded signal level.

The long lines are 19 gage wire in 51 pairs of buried cables. Balanced conditions are maintained at driving and load ends. Measurement signals are not mixed with switched or carrier type channels in the same cable.

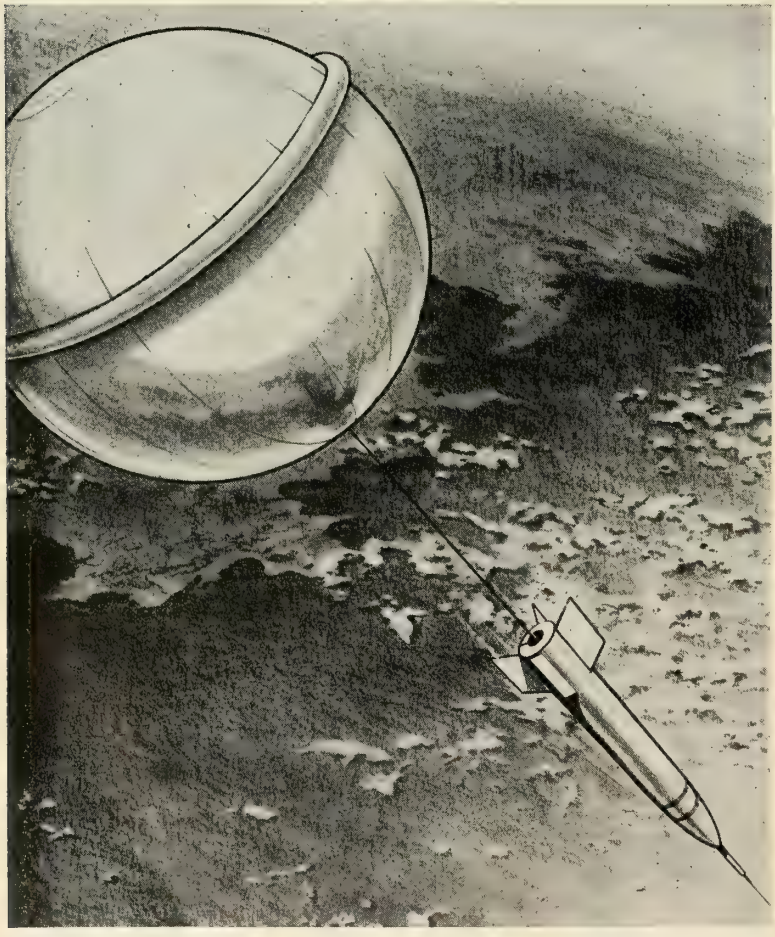
• **Easy reliability**—Enhancing the reliability of the system required no elaborate measures.

Primary measurements are dually or triply instrumented. In some cases, provisions are made through meter observations to select the most reliable signal for closed loop system usage, although all signals are recorded.

All power supplies are doubly protected. DC supplies are run in parallel through diodes with a battery standby. An auxiliary alternator is kept on the line in case of power failure, with provisions to automatically dump nonessential loads. A spare transducer excitation oscillator is kept in standby.

Balloons to Aid Vehicle Recovery

Balloon-parachute systems, designed to stabilize, decelerate and recover reentry vehicles, are being developed by Goodyear Aircraft Corp. for the Wright Air Development Division of the Air Force's Air Research and Development Command.



CONTROLLED DESCENT of a re-entry vehicle commences by reeling out the Goodyear balloon until it reaches a flow region suitable for maximum drag. After a considerable reduction in speed, a parachute completes the recovery.

In operation, the balloon will be ejected and inflated directly behind the primary (re-entry) body. Once the primary body is stabilized, the balloon will be slowly reeled out until it reaches a flow region suitable for maximum drag.

When the primary vehicle has slowed sufficiently, a parachute will be ejected to complete the recovery. The combination is necessary because parachutes are not reliable at speeds greater than Mach 2 and one alone will not stabilize a high-speed vehicle.

Initial flight tests, involving a 9-ft.-diameter balloon and modified *Cree* test missiles from Cook Electric Co., will take place within a month.

The first flight is expected to hit speeds of Mach 2 at 150,000 ft. Subsequent experiments will reach speeds of Mach 3 and altitudes of 200,000 ft.

The coated fabric balloon is treated with temperature-sensitive paints. Instruments will measure the drag forces on the cable and check the internal balloon pressure.

The balloons have proven perfectly stable in a series of wind tunnel tests at the Langley and Lewis research facilities of the National Aeronautics and Space Administration. Quarter-scale models reached simulated altitudes of 155,000 ft. and speeds approaching Mach 3.5.

Goodyear spokesmen said that flight tests at speeds up to Mach 10 and at 200,000 ft. are contemplated as a probable follow-up to the initial *Cree* experiments.

Inflation time for the balloons is around 0.10 sec. In addition to the recovery aspect, they may make it possible to reduce significantly the heat shielding of a re-entry vehicle.

Pneumatic Bar Aids Saturn Welding

by Jay Holmes

HUNTSVILLE, ALA.—An engineer here has developed a tricky gadget that solves the problem of matching wrinkly edges of thin aluminum to be welded into *Saturn* LOX and fuel tanks.

William J. Franklin, a mechanical engineer from Oklahoma, has produced a pneumatic stainless steel circular backup bar that presses the huge cylindrical tank sections into position for accurate circumferential welding.

The large diameter and thin shell of the propellant tanks create a vexing problem in fabricating the huge booster rocket. *Saturn* tanks come in two sizes: a central tank 105 in. in diameter and eight outer tanks 70 in. in diameter. The 70 in. tanks vary in thickness from 0.05 in. to 0.19 in. The 105 in. tanks vary from ¼ in. to ⅜ in.

And to make matters more difficult, the welding backup bar must be removed after welding through a hole 15 in. in diameter.

Here is how Franklin solved the problem: Stainless steel bands are slipped over the outside of the cylindrical sections near the edges to be welded. Then the circular backup bar is assembled inside the tank sections. The outer ring of the bar is segmented stainless steel. Inside the stainless steel are successive layers of high-temperature plastic and rubber.

After the two cylinders are brought together, air is pumped into the rubber sections so that the circles expand and stretch the diameter of the skins by about ¼ in. Now that the skins are stretched to an exact fit, welding is performed.

• **Stress relieved**—After welding, the backup bar is released, allowing the aluminum to contract to its original position. This relieves some of the tensile stress in the welded area.

When the last section of tank containing the front end is welded into place, one man remains inside. Afterward, he disassembles the backup bar and passes the pieces out through the opening. The aluminum skin is strong enough to hold a man walking around inside. However, he must wear clean, rubber-soled shoes.

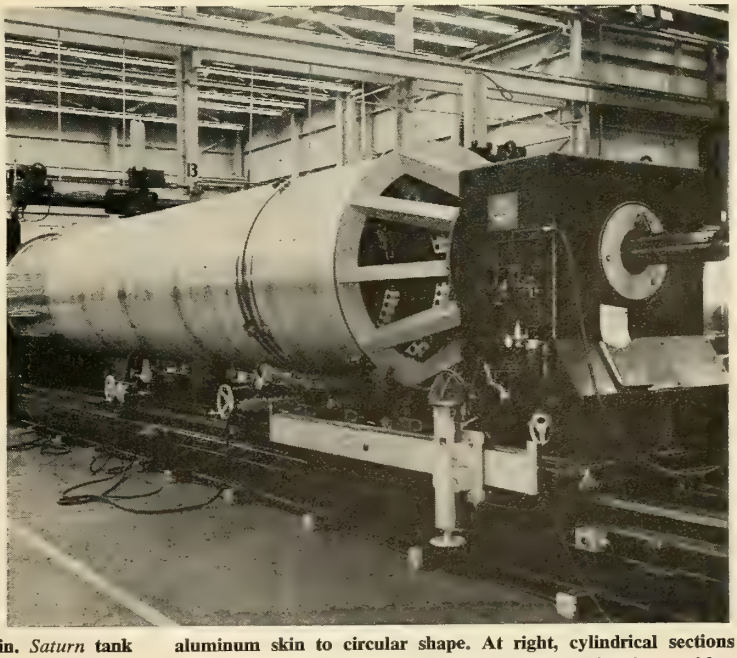
The new backup bar was developed in time for use on the *Saturn* fabrication. The circular bar used to weld *Jupiter* tanks at the Army Ballistic Missile Agency was rigid and did not follow the material completely.

Franklin, chief of the tool engineering section in the Fabrication Laboratory of ABMA's Development Operations Division, said tooling for welding has been a problem since first attempts were made to provide a pressure-tight weld seam and still maintain a high-quality, porosity-free weld with high joint efficiency on tanks for the *Redstone* missile.

The new device, which Franklin calls the Serpentine Segmented Backup Bar, can be controlled to allow for different thicknesses of metal in the exterior skin. He said the bar provides the same reliable and uniform backup pressure throughout the entire 360° of the weld, since the internal rubber bladder supplies equal pressure both radially and circumferentially.

Franklin, 38, has been a missile designer for six years and transferred to the National Aeronautics and Space Administration this month, with the switch of the ABMA group to NASA's George C. Marshall Space Flight Center.





BACKUP BAR is fitted into a section of a 70-in. *Saturn* tank by worker at Redstone Arsenal. Air is pumped through tubes to inflate pneumatic ring, providing pressure that holds thin aluminum skin to circular shape. At right, cylindrical sections are held in position for welding. Stainless steel bands on either side of seam provide countertension.



Missiles and Rockets

ASTROLOG

A status report on U.S. missiles and rockets and all space vehicles presently in orbit

★ *Indicates change since May 2 edition*

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SPACE VEHICLES			
ADVENT (ARPA-Air Force)	GE-Bendix prime for polar-orbiting phase	New overall name for advanced communications satellites STEER, TACKLE and 24-hour instantaneous repeater called DECREE	R&D
AGENA (Air Force)	Lockheed, prime; Bell, propulsion	1700-pound satellite after burnout	Used in DISCOVERER program; larger model to be used with ATLAS and THOR under development; NASA also will use to take place of cancelled VEGA
ATLAS-ABLE (NASA)	STL, prime; GE/Burroughs, Arma, guidance; Rocketdyne, Aerojet-General, ABL, propulsion	Orbit 200-lb. vehicle around moon or send into deep space	Two lunar orbit attempts beginning this summer
★CENTAUR (NASA)	Convair, prime; Pratt & Whitney/-JPL, propulsion	Pair of LOX-liquid hydrogen engines, 30,000 lbs. total thrust, atop ATLAS booster, capable of orbiting 8000 lbs. or accelerating almost 3000 lbs. to escape velocity.	First test flight in 1961
COURIER (ARPA-Army)	Army Signal Corps, prime	Delayed repeater communications satellite	R&D; satellite in advanced stage; first to be launched in spring
DISCOVERER (Air Force)	Lockheed, prime; GE, re-entry vehicle	THOR-AGENA launchings of early stabilized satellites	Of first 11 launched, 6 stabilized in orbit; ejected capsules not recovered
DYNA-SOAR I (Air Force)	Boeing, space craft and systems integrator; Martin, propulsion	Boost-glide orbital space craft; first space bomber; TITAN booster	R&D; first glider flights from Edwards AFB by 1962; intensive material studies underway
★ECHO (NASA)	Langley Research Center, prime	Puts 100 ft. inflatable sphere in 1000 mile orbit; passive communication satellite	First launch failed in May. Another due in July
FIREFLY (NASA)		Geodetic survey satellite	
JUNO II (NASA)	ABMA/Chrysler, prime; Ford Instrument, guid.; Rocketdyne/JPL, prop.	Early deep space booster; small payload	Five more shots planned
★MERCURY (NASA)	NASA, prime; McDonnell, capsule	First manned satellite	Capsule tests on ATLAS to begin; manned capsule launching by REDSTONE down Atlantic this summer; first manned flight scheduled in 1961.
★MIDAS (Air Force)	Lockheed, prime	Early-warning satellite; detect ICBM launchings by infrared before birds leave pad; R&D models weigh 2 tons; operational system to have 12-15 satellites	R&D; second launching May 24 partial success.
★NIMBUS (NASA)	Contract to be let shortly	Follow on to TIROS weather satellite	First launching scheduled for late 1961
NOVA (NASA)	No prime announced; Rocketdyne, propulsion	Clustered 6-9 million lb. booster plus upper stages	Early R&D on 1.5 million lb. F-1 engines
ORION (ARPA-Air Force)	General Atomic	Space station launched by series of atomic explosions	Advanced engineering studies under way; tests may be attempted; program shifted to Air Force alone

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
★PROJECT 3059	No contracts announced	Solid motor in 1 million to 2 million lb. thrust class	Research determining feasibility; study contract expected soon; NASA contracting for complementary studies with United Technology Corp.
★SAMOS (Air Force)	Lockheed, prime	Reconnaissance satellite; formerly SENTRY	R&D; stabilization already achieved in DISCOVERER series; first test launching scheduled this year; scheduled to be operational late 1963.
★SATURN (NASA)	NASA Marshall Center, prime and booster; Douglas and Convair, upper stages; Rocketdyne, booster and mid-stage engines; Pratt & Whitney, top-stage engines	Series of multistage vehicles based on 1.5-million-lb. clustered booster and upper stages using combinations of LOX-liquid hydrogen engines. Earliest model will orbit 23-25,000-lb. payload	Static firings of clustered booster in progress successfully since April; first flight test spring of 1961; flight with live upper stages scheduled 1963
★SCOUT (NASA-Air Force)	Chance Vought, prime; Minneapolis-Honeywell, guidance; Aerojet-General/Allegany/Thiokol, propulsion	Solid four-stage satellite launcher; 200 lb. payload in orbit	Air Force and probably Navy also to use for research; first test in April partially successful; AF test expected soon
★THOR-ABLE (Air Force-NASA)	STL, prime; Rocketdyne/Aerojet-General/ABL, propulsion	Three-stage vehicle with orbital capability of 200 lbs. New ABLE-STAR upper stage has restart engine, boosts heavier payload	THOR-ABLE phasing out. THOR-ABLE-STAR operational in TRANSIT and will be used for COURIER
★THOR-AGENA (Air Force)	Lockheed, prime; Bell, propulsion	Two-stage vehicle capable of orbiting more than 300 lbs. AGENA-B restartable upper stage boosts payload capacity to 1250 lbs.	Operational in DISCOVERER program. AGENA-B first used May 24 to launch MIDAS II. NASA to use extensively beginning late '61
★THOR-DELTA (NASA	STL, prime; IT&T, guidance; Rocketdyne/Aerojet-General/Allegany,prop.	Improved THOR-ABLE with 480-lb. payload capability	Nearly operational; to be used in ECHO and TIROS programs
★TIROS (NASA-AF-Army-Navy-Wea. Bu.)	RCA-Army Signal Corps, prime	Meteorological satellite; TV pictures of cloud cover	R&D; three launchings this spring; first launching in April a success; two more scheduled; one late this year.
★TRANSIT (ARPA-Navy)	Johns Hopkins Laboratory, prime	Navigational satellite; R&D model weighs more than 250 lbs.; operational model about 50 lbs.	TRANSIT 1B R&D satellite put in orbit April 13; 11A plus piggyback satellite successfully in orbit June 22, four satellite transit systems scheduled operational 1962.
TRIBE (ARPA)		Family of space launching vehicles	Planning
YO YO (Navy)	No contract announced	Tactical sea-launched one-pass reconnaissance satelloid	R&D
★X-15 (NASA-AF-Navy)	North American, prime; Thiokol, propulsion	Rocket plane; 3600 mph; flight at edge of space; on AF model each XLR-11 rocket engines develop 16,000 lbs. of thrust; later XLR-99 engines to develop 50,000 lbs. Three planes delivered	Powered flights in progress; plane #1 has hit Mach 3 and more than 80,000 ft. with XLR-11 engine; plane #2 out of operation for installation of XLR-99 engine for fall flight; plane #3 heavily damaged by fire June 8 in test prior to flight with XLR-99
MISSILES & ROCKETS			
ALFA (Navy)	Avco, prime	ASW surface-to-underwater; 500 lb. solid; conventional; formerly called ABLE	Deployed on destroyer escorts
★ASROC (Navy)	Minneapolis-Honeywell, prime; Sangamo Electric, Sonar; Torpedo, GE; depth charge, M-H.	Surface-to-underwater; solid rocket torpedo or depth charge; nuclear or conventional: range about 8 miles.	R&D; operational on Destroyers Norfolk & Peary; plans call for deploying on 150 destroyers and cruisers.
ASTER (Navy)	Ford Instrument, prime	Antisubmarine rocket launched from surface ships; 30-35 mile range; marriage of TERRIER and torpedo	R&D
ASTOR (Navy)	Westinghouse, prime	ASW underwater to underwater; rocket torpedo; nuclear	R&D
★ATLAS (Air Force)	Convair, prime; GE/Burroughs, Arma, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	ICBM; more than 5500-to-9000-mile range; liquid; nuclear	49 military launchings: 31 successes, 8 partial, 10 failures; 6 scientific launchings: 5 successes; 1 failure. Two operational at Vandenberg; 11 scheduled sites for 13 squadrons named
ARM (Air Force)	No contract announced	Anti-radar missile	R&D

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
BOMARC-A (Air Force)	Boeing, prime; Westinghouse, guidance; Marquardt, propulsion	Ramjet surface-to-air interceptor; liquid booster; 200 m. range; Mach 2.7; nuclear	First squadron operational at McGuire AFB, N.J.
★BOMARC-B (Air Force)	Boeing, prime; Westinghouse, guidance; Thiokol, propulsion	Ramjet, surface-to-air; solid booster; Mach 2.7; more than 500 m. range; nuclear	Ten launchings: 2 success, 8 failures; first successful flight April 14. Production program sharply cut back by Air Force.
★BULLPUP (Navy-Air Force)	Martin, prime; Martin, guidance; Thiokol (Reaction motors), propulsion	Air-to-surface; 4-8 mile range; conventional 250-lb. bomb; new model has pre-packaged liquid; nuclear-tipped model under development	Deployed with Atlantic and Pacific Fleets; bigger model under R&D; Air Force buying modified version; Marines launching BULLPUP from helicopters
COBRA (Navy)	No contract announced	Anti-ship radar missile	Early R&D
COBRA (Marines)	Boelkow Entwicklungen, West Germany, prime; Daystrom, U.S. distributor	24.6-pound anti-tank missile; 1 mile range; 191 mph speed; solid propellant	Marines planning to purchase; Army considering them; already operational with West German troops
CORPORAL (Army)	Firestone, prime; Gilfillan, guidance; Ryan, propulsion	Surface-to-surface; 75-mile range; liquid; nuclear	Deployed with U.S. & NATO troops in Europe
CORVUS (Navy)	Temco, prime; W. L. Maxson guidance; Reaction Motors, propulsion	Air-to-surface; pre-packaged liquid; radar homing; about 100-miles range	First successful test July 18, 1959
CLAYMORE (Army)	No contract announced	Anti-personnel missile	R&D
CROW (Navy)	No contract announced	Air-to-air missile	R&D; has been flight tested
★DAVY CROCKETT (Army)	In-house project at Rock Island, Ill., arsenal	Surface-to-surface; solid; bazooka launched; sub-kiloton nuclear warhead; two launchers of different size for various ranges; vehicle mounted or carried by two men	R&D; operational in FY '61; first NATO deliveries also FY '61
EAGLE (Navy)	Bendix, prime; Sanders, guidance; Aerojet propulsion	Air-to-air; 100-mile range; nuclear; for launching from relatively-slow aircraft	Early R&D
★FALCON (Air Force)	Hughes, prime; Hughes, guidance; Thiokol, propulsion	Air-to-air; 5-mile range; Mach 2; solid; conventional; GAR-11 has nuclear warhead	GAR1 through GAR4 operational; GAR9 & 11 R&D
GENIE (Air Force)	Douglas, prime; Aerojet-General, propulsion	Air-to-air; unguided; 1.5-mile range; nuclear	Operational
GIMLET (Navy)	No contract announced	Air-to-surface; unguided; considered highly accurate	R&D
HAWK (Army)	Raytheon, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 20-mile range; solid; conventional; designed to hit low-flying planes	Operational; units training for early deployment to Europe and Far East; advanced Hawk under development; Jan. 29 successfully intercepted Honest John, first known intercept of one tactical missile by another
HONEST JOHN (Army)	Douglas, prime; Hercules, propulsion	Surface-to-surface; unguided; 16.5-mile range; nuclear	Operational; deployed in Europe
HOUND DOG (Air Force)	North American, prime; Autonetics, guidance; Pratt and Whitney, propulsion	Air-breathing air-to-surface; 500-mile range; Mach 1.7; turbojet; nuclear	Operational; to be launched from B-52G intercontinental bombers; stockpile expected to exceed 400; training fully underway; B-52 launched one in April after non-stop flight with it to North Pole from Florida
★JUPITER (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion; Goodyear, re-entry vehicle	IRBM; liquid; nuclear	To be deployed with Italian troops in Italy and may be used as AICBM target drone; 29 military launchings; 22 successes; 5 partials; 2 failures. One 15-bird squadron to be deployed in Turkey. Last R&D test shot launched Feb. 4
LACROSSE (Army)	Martin, prime; Federal Telecommunications Laboratories, guidance; Thiokol, propulsion	Surface-to-surface; highly mobile; 20-mile range; solid; nuclear	Operational; 4 units being trained; 3 more planned for 1960; to be deployed in Europe and Far East; advanced LACROSSE R&D program dropped at least temporarily
LITTLE JOHN (Army)	Emerson Electric, prime; ABL, propulsion	Surface-to-surface; unguided; 10-mile range; solid; nuclear	Operational this year; units training with it

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
LOBBER (Army)	No contract announced	Surface-to-surface; cargo carrier; 10-15 mile range; also can drop napalm; LOBBER with warhead called BALLISTA	Studies
LULU (Navy)	No contract announced	Surface-to-surface; nuclear	R&D
MACE (Air Force)	Martin, prime; AC Spark Plug, guidance; Allison, propulsion	Air-breathing surface-to-surface; more than 650-mile range; turbojet & solid; nuclear; B model has 1000-m. range	Being deployed with U.S. troops in West Germany; now all mobile but hard-base version in R&D
MATADOR (Air Force)	Martin, prime; Thiokol/Allison, propulsion	Air-breathing surface-to-surface; 650-mile range	Being turned over to West Germans; also deployed in Far East
★MAULER (Army)	Convair, prime	Surface-to-air; IR guidance; highly mobile antiaircraft and antimissile missile for field use; to be on trucked vehicle	R&D; NATO may buy
★MINUTEMAN (Air Force)	Boeing, major contractor; Autonetics, guidance; Thiokol, propulsion first stage; Aerojet, propulsion second stage; Avco, re-entry vehicle; AMF-ACF rail launcher	2nd generation ICBM; solid; fixed or mobile; nuclear; 3 stages	R&D; scheduled to be operational mid-1962 at Malmstrom AFB; launching of eight tethered birds from silos successfully completed in May; first full R&D launching from Cape in Dec.
★M-55 (Army)	Norris Thermodor, prime	Four-inch diameter, small, short-range poison gas rocket; to be fired from 45-tube launchers	Operational
MISSILE A (Army)	ARGMA to act as prime; six R&D contracts for components scheduled to be let soon	Surface-to-surface; 65-70 mile range; solid	Design studies
★NIKE-AJAX (Army)	Western Electric, prime; Western Electric, guidance; Hercules Powder, propulsion	Surface-to-air; 25-mile range; Mach 2.5; solid & liquid; conventional	Deployed in U.S., Europe & Far East; about 170 batteries in U.S.
★NIKE-HERCULES (Army)	Western Electric, prime; Western Electric, guidance; Hercules & Thiokol, propulsion	Surface-to-air; 80-mile range; Mach 3+; nuclear; claimed effective against air-launched air-breathing missiles	Rapidly replacing NIKE-AJAX; estimated 80 batteries deployed in U.S.; N-H soon to have tactical anti-missile capacity
★NIKE-ZEUS (Army)	Western Electric, prime; Bell Telephone, guidance; Thiokol and Grand Central, propulsion	Anti-missile; 3-stage; 200-mile range; solid; nuclear	R&D test launchings at White Sands at the rate of about one a month beginning Aug. 26. 8 launchings; 5 successful, 2 partial, 1 failure. Test shots in the Pacific planned in mid-1961. Administration has refused to okay Army recommendation to begin major production
★PERSHING (Army)	Martin, prime; Bendix, guidance; Thiokol, propulsion	Surface-to-surface; two-stage solid; under 700-mile range; nuclear	R&D; to replace REDSTONE; first R&D launching Feb. 25 from Cape; four launchings: 4 successful; first stage only live
★POLARIS (Navy)	Lockheed, prime; GE, guidance and fire control; Aerojet-General, propulsion; Lockheed, re-entry vehicle	Underwater and surface-to-surface; solid; 1200-mile range can hit more than 90% all targets in Russia; nuclear	67 launchings of test vehicles; 46 successes; 18 partial; 3 failures; launched from surface ship Aug. 27, 1959; expected operational late in 1960; 1100-mile plus range vehicles under test at Cape Canaveral; first sub launchings this summer; 21 subs authorized or planned by Administration to date
RAVEN (Navy)	No contract announced	Air-to-surface; about 500-mile range	Study
★REDEYE (Army)	Convair, prime; Atlantic Research, propulsion	Surface-to-air; 4-foot, 20-lb. bazooka-type; IR guidance; solid; conventional; container-launcher disposable	R&D; Marines also will use; NATO may buy
REDSTONE (Army)	Chrysler, prime; Ford Instrument, guidance; Rocketdyne, propulsion	Surface-to-surface; liquid; 200-mile range; nuclear	Deployed with U.S. troops in Europe
REGULUS II (Navy)	Chance Vought, prime; Stavid, guidance; Aerojet-General, propulsion	Surface-to-surface; turbojet & solid; 500-mile range; nuclear	Deployed aboard U.S. submarines; used as target drone
SERGEANT (Army)	JPL/Sperry, prime; Sperry, guidance; Thiokol, propulsion	Surface-to-surface; solid; more than 75-mile range; nuclear	Production. To replace CORPORAL this year
SHILLELAGH (Army)	Aeronutronics, prime	Surface-to-surface; lightweight; can be vehicle-mounted	R&D; expected to be operational mid-1960's

PROJECT	CONTRACTORS	DESCRIPTION	STATUS
SIDEWINDER (Navy)	GE-Philco, prime; Avion, guidance; Naval Powder Plant, propulsion	Air-to-air; IR guidance; 6-7-mile range; conventional; new I-C models to have switchable IR and radar-guided warheads	Deployed with Navy and Air Force; all-weather type under development
★SKY BOLT (Air Force)	Douglas, prime; Nortronics, guidance; Aerojet, propulsion; GE, re-entry vehicle	Air launched ballistic missile; more than 1000-mile range; solid; nuclear	R&D; to be purchased by British; operational 1964-65; both U.S. and British planes to test launch from Eglin AFB, Fla.
SLAM (Air Force)	No contract announced	Surface-to-surface; low-altitude; supersonic; nuclear-powered ramjet; nuclear	Study-R&D
SNARK (Air Force)	Norair, prime; Northrop, guidance; Aerojet-General, propulsion	Surface-to-surface; 5500-mile range; solid and turbojet; Mach .9; nuclear	Deployed at Presque Isle, Maine
SPARROW III (Navy)	Raytheon, prime; Raytheon, guidance; Aerojet-General, Thiokol, propulsion	Air-to-air; 5-8 mile range; Mach 2.5-3; solid and pre-packaged liquid; conventional	Operational with carrier aircraft; earlier SPARROW I obsolete; new contract aimed at extending range and altitude
★SUBROC (Navy)	Goodyear, prime; Kearfott, guidance; Thiokol, propulsion	Underwater or surface-to-underwater; 25-30 mile range; solid; nuclear	Estimated operational date: 1961. To be installed first on Thresher Nuclear-powered attack submarine
SS-10 (Army)	Nord Aviation, prime	Surface-to-surface; primarily anti-tank; 1600-yards range; 33 lbs. solid; wire guided; conventional	Operational with U.S., French and other NATO and Western units; battle-tested in North Africa
SS-11 (Army)	Nord Aviation, prime	Surface-to-surface; also helicopter-to-surface; 3800-yard range; 63 lbs.; wire guided; conventional	Operational. Under evaluation by Army.
TALOS (Navy)	Bendix, prime; Farnsworth/Sperry, guidance; Bendix/McDonnell, propulsion	Surface-to-surface; 65-mile range; solid & ramjet; Mach 2.5; nuclear	Operational aboard cruiser Galveston
TARTAR (Navy)	Convair, prime; Raytheon, guidance; Aerojet-General, propulsion	Surface-to-air; 10-mile range; Mach 2; 15 feet long & 1 foot in diameter; solid dual-thrust motor; conventional	Many test firings in Pacific; expected deployment 1960 as primary armament of guided missile destroyers; production
TERRIER (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	Surface-to-air; 10-mile range; Mach 2.5; 27 feet long; solid; conventional	Operational with fleet
TERRIER-ADVANCED (Navy)	Convair, prime; Reeves/FTL, Sperry, guidance; ABL, propulsion	About 100% performance improvement over TERRIER	Operational Advanced TERRIERS to be deployed about mid-1960
★THOR (Air Force)	Douglas, prime; AC Spark Plug, guidance; Rocketdyne, propulsion; GE, re-entry vehicle	Surface-to-surface IRBM; 1500-mile range; liquid; nuclear	Operational; 4 bases set up in England. 63 military launchings: 44 successes; 11 partial; 4 failures; 29 scientific launchings; 24 successful, 2 partial; 3 failures; R&D and "hot rod" advanced tests completed Feb. 29.
★TITAN (Air Force)	Martin, prime; Bell, Remington Rand, guidance; Aerojet-General, propulsion; Avco, re-entry vehicle	Surface-to-surface ICBM; 5500-mile range; liquid; 90 feet long; nuclear TITAN I nearing operational status, burns LOX-Kerosene; TITAN II, two years off, has storable propellants, inertial guidance, bigger payload	16 launchings test vehicles: 12 successes; 1 partial; 3 failures. Five sites for 8 sites for 11 squadrons named; 14 squadrons planned; operational spring 1961; first Vandenberg launchings scheduled this Oct.; operational "J" series of launching begins this Summer
★TYPHON (Navy)	Westinghouse, prime; Bendix propulsion	Medium and long range seagoing anti-missile missiles; formerly called SUPER TARTAR and SUPER TALOS; solid booster and ramjet sustainer; conventional; supersonic	Early R&D; may be used on hydrofoil destroyers
WAGTAIL (Air Force)	Minneapolis-Honeywell, prime	Air-to-ground; low-level; solid; designed to climb over hills and trees	R&D
WILLOW (Army)	Chrysler, prime	Highly-classified missile	R&D
ZUNI (Navy)	Naval Ordnance Test Station, prime	Air-to-air, air-to-surface; solid; unguided rocket; 5-mile range; conventional	Operational

SATELLITES

SATELLITE	COUNTRY	STATUS
★EXPLORER I (30.8 lbs.)	U.S.	Launched 1/31/58, est. life 3-5 years. Orbits earth, perigee: 216.8 m., apogee: 1198.3 m., period: 107.9 min. (Discovered Van Allen Belt)

SATELLITE	COUNTRY	STATUS
★VANGUARD I (3.25 lbs.)	U.S.	Launched 3/17/58, est. life 200-1000 years. Orbits earth, perigee: 405.7 m., apogee: 2460.6 mi.; period: 134.1
LUNIK I "MECHTA" (3245 lbs.)	Russia	Launched 1/2/59. Believed to be in orbit around sun on 15 mo. cycle.
★VANGUARD II (20.7 lbs.)	U.S.	Launched 2/17/59, est. life 10 years +. Orbits earth but is "wobbling," perigee: 346.9 m., apogee: 2045, period: 125.3 min., inclination to equator: 32.88°.
PIONEER IV (13.40 lbs.)	U.S.	Launched 3/3/59. Orbits sun, and achieved primary mission, an Earth-Moon trajectory.
★EXPLORER VI "PADDLE-WHEEL" (142 lbs.)	U.S.	Launched 8/7/59, est. life: to Aug. 1961. Orbits earth, former perigee: 156 m., former apogee: 26,357 m., former period: 12½ hours, present orbit unknown; speed: at perigee 23,031, at apogee: 3126 mph., inclination to equator: 46.9°.
★VANGUARD III (about 100 lbs.)	U.S.	Launched 9/18/59, est. life 30-40 years. Orbits earth, perigee: 318.8 m., apogee: 2330.2 m.; period: 130
LUNIK III (about 614 lbs.)	Russia	Launched 10/4/59, est. long life, orbits earth-moon; took first picture far side of moon; est. perigee: 30,000 m., apogee: 291,000 m.
★EXPLORER VII (91.5 lbs.)	U.S.	Launched 10/13/59, est. life 20 years, orbits earth, perigee: 343.7, apogee: 672.4; period: 101.2; transmitter to cut off in October.
DISCOVERER V CAPSULE (less than 300 lbs.)	U.S.	Launched 8/13/59. Satellite burned up in atmosphere Sept. 28. Capsule also thought to have been destroyed, but it was later rediscovered and first thought to be an unidentified Soviet satellite. Est. life several months. perigee: 134, apogee: 1074.
★PIONEER V (94.8 lbs.)	U.S.	Launched 3/11/60, est. life: forever orbits sun, interplanetary radio communication satellite, passed 20 million miles June 20.
★TIROS I (270 lbs.)	U.S.	Launched 4/1/60, est. useful life: 3 mos., perigee: 428.9 m.; apogee: 468.5; period: 99.2. Picture-taking weather satellite.
★TRANSIT IB (265 lbs.)	U.S.	Launched 4/13/60, est. life: 16 mos. minimum; perigee: 229; apogee: 456.4; period: 95.6. First R&D navigation satellite.
★SPUTNIK IV (10,008 lbs.)	Russia	Launched 5/15/60; est. life: relatively brief; original perigee: 188; apogee: 229; changed to 191/429 on May 19. Test of support systems, cabin, for manned space flight; attempt to return from orbit failed because of poor orientation of retrorocket.
★MIDAS II (5000 lbs.)	U.S.	Launched 5/24/60; est. life: 40 months; perigee: 300.1; apogee: 319.6; period: 94.4; Telemetry for IR scanning failed two days after launch.
★TRANSIT II-A (223 lbs.)	U.S.	Launched 6/22/60; est. life: 50 years, perigee: 382; apogee: 657.
★NRLI (40 lbs.)	U.S.	Launched 6/22/60 with TRANSIT II-A; Solar radiation measuring satellite.

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management

AF Applies Weapon System Concept

by Don Zylstra

BEDFORD, MASS.—Techniques that produced the nation's family of ballistic missiles in a record compression of development time are being applied to harness Air Force control of its vast war-making potential.

The Ballistic Missile Division's weapon system concept is being introduced into command and control electronics at Laurence G. Hanscom Field here. The huge electronic complex welds together the Air Force Research and Development Command, Air Materiel Command and electronics systems "users." Their task is to make communications and control systems for all weapons compatible—and instantly responsive to direction and control at any command level.

Electronics systems testing and development have been assigned to the Command and Control Development Division, promptly dubbed C Square D Square (C^2 D^2), one of four divisions in the major reorganization of ARDC. Logistics counterpart of C^2 D^2 is AMC's Electronics Systems Center. To insure compatibility of weapons systems and the men who will live with them as operators, the Command and Control Defense Systems Office (CCDSO) represents the Air Defense Command at Hanscom. Plans call for other systems "customers," including TAC, SAC, and air training commands to be represented too.

Maj. Gen. Kenneth P. Bergquist heads the Command and Control Development Division and Maj. Gen. Clyde H. Mitchell the Electronic Systems Center at Hanscom. Directing the Command and Control Defense Systems Office for ADC is Brig. Gen. Loren G. McCollom.

C^2 D^2 is an outgrowth of the Air Defense Systems Integration Division (ADSID), a tri-command group to integrate electronic units subordinate to SAGE with air-breathing weapons systems and the ground environment. With the growth of ballistic missiles projects and their electronics systems, ADSID was expanded into C^2 D^2 and the relationship of ARDC, AMC and ADC was retained in the enlarged Hanscom complex.

• **Applying civilian know-how**—MITRE Corporation, organized as a non-profit technical advisory group to ADSID, for systems analysis and

Hanscom Complex Leadership



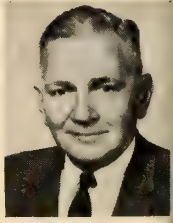
BERQUIST



MITCHELL



McCOLLOM



HALLIGAN



Civilian and military personnel man the Satellite Situation Display Room in Hanscom's Space Surveillance Control Center.

mmunication

engineering, continues to serve C² D² in the same capacity. MITRE was organized a year and a half ago when Massachusetts Institute of Technology decided technical management exceeded the research functions that were properly the province of its Lincoln Laboratory; it sponsored establishment of MITRE as a non-profit corporation.

C. W. Halligan, on leave from Bell Telephone Laboratories, is president of the group. Robert R. Everett is vice president for technical operations, and Peter J. Schenk is executive vice president. MITRE has been unlike Space Technology Laboratories in its relation to BMD in the systems management area; it has never served in a "line" capacity as STL once did in early missiles development. Administrative direction of contractors remains solely with C² D², following MITRE's recommendations.

Indications are that the Air Force may follow this procedure in establishing "Aerospace Corp.," non-profit successor to STL.

MITRE is often asked for "recipes" for merging two types of electronics systems. The group also makes preliminary designs of new concepts, digesting new military needs and smoothing requirements before they are proposed to industry.

Typical of MITRE's services to C² D² is the survey begun Jan. 15 by the Winter Study Group under the corporation's sponsorship. Where BMD was able to set its own new pattern of weapons systems offices and projects, C² D² inherited existing electronics projects and programs. These enterprises are under scrutiny by the Winter Study Group to decide how they fit the new development division and what's next in terms of new programs.

Personnel total about 100, half of them military. Twenty-five per cent are from MITRE and the others are specialists, borrowed wherever their know-how could be found—from Systems Development Corp., The Rand Corp., Bell Laboratories, and others.

• **Master plan is goal**—Panels listed by the Winter Study Group include: design methodology, weapons, logistics, reliability, vulnerability, threat, people, data processing equipment, data processing utilization, display, communications equipment, sending equipment and cost. Dr. A. G. Hill of MIT heads a steering group to advise Winter Study personnel. Technical director for the group is Gordon Thayer, an American Telephone and Telegraph vice president. Assisting him are C² D² Lt. Col. John L. Lombardo and J. F. Jacobs, MITRE technical director.

The study group hopes to "finish a one-shot survey of all existing electronic systems, those in development and in planning stages by midsummer," Peter Schenk said. Their report will advise C² D² how to tailor them into a master reaction plan.

A possible following study would be a similar survey, including a review of related systems in other armed services—probably at a Joint Chiefs of Staff level.

• **Division of duties**—Within C² D² are four directorates—only two performing line functions. Systems Management directs 13 "L" systems project offices or ESSPO's (counterpart of BMD's WSPO's). Spelled out, ESSPO becomes Electronic Supporting System Project Offices. The Technology directorate has systems planning and applied research functions designed to usher in the next generation of electronics systems.

AMC's Electronic Systems Center divides its approach to the 13 systems under three directorates—(a) command control and communications systems, (b) intelligence and warning systems, and (c) weapons control systems.

C² D² systems management covers the entire electronics field—including SAGE, designated 416-L; a weather observation system integrated with FAA and the Department of Commerce, 433-L; BMEWS, known as 474-L; and the Space Surveillance Center or space track facility, 496-L. The latter, located at Hanscom keeps tab on all man-launched space vehicles.

The Hanscom complex deals entirely in complete systems in both the development and logistics area. Agencies for the development and procurement of electronic systems components are now the responsibility of the Rome Air Materiel Area, Rome, N. Y.

• **Keeping on fairway**—Unlike weapons system development, where there is usually a definite break between systems models or refinements, development of electronics systems implies a carefully planned "evolution." Such progress involves changes made without interrupting the 24-hour operation of electronics and communication systems, because most such facilities are one-of-a-kind projects.

In summing up his view of AMC's task at Hanscom, Gen. Mitchell put it this way: "If we didn't continue research during the whole span of systems development, we would inevitably deliver an obsolete system. The twin ghosts of inflation and obsolescence cast their dark shadows over the drawing board of the electronics engineer just as they plague the aeronautical engineer. A sign on the wall in the office of one of our electronics plants reads, 'if it works, it's obsolete.' Amusing perhaps—but often painfully true. The other side of the coin is that, if it doesn't work, we're doomed. If I may switch my metaphor, we've got to stay in the narrow fairway between these two out-of-bounds markers."

Historically, the world's armed services have acquired new weapons and methods for using them from dedicated groups of zealots impressed with the potential of the weapons they developed. Fighting and defense forces have been assembled by bringing these weapons "building blocks" under a single command. Whether such arms collections adapted themselves to each other, or were readily brought to bear in a concerted military effort, were secondary considerations when months and years were available to prepare to deploy them.

• **Electronic reduction**—But complex weapons systems in the Space Age have sown the seeds of their own frustration by compressing reaction time into minutes—to the point where less than half an hour may be available

to react effectively to enemy attack. Supersonic aircraft and a growing variety of missiles, plus refinements in all fields of weapons, propulsion and transport, extend the arms and legs of the fighting man to carry nuclear warheads swiftly to any point on earth.

A Space Age electronics revolution has provided the "reflexes" that govern the response of individual weapons systems to awesomely complex stimuli. The Air Force is welding them into a reaction pattern corresponding to extensions of the eyes, ears and brain of the fighting man. To achieve the optimum planned response at all levels of command and control is Hanscom's function.

In governing a striking power multiplied a hundredfold in speed and capacity since World War II, electronic devices must control weapons reaction instantaneously, with miniscule selectivity. They must reduce upper-echelon command problems to a few straightforward decisions left for top military commanders—ultimately the nation's chiefs of staff and the President himself.

This implies a series of electronic systems imposed one above the other —elements in an ascending pyramid, climaxing in ultimate command and control. At the base of the pyramid, these systems will perform functions akin to the most automatic human reflexes. At higher levels they will respond to planned inputs—as the human system does to carefully learned habit patterns.

And, at peak levels in the structure, the response will correspond more closely to reasoned human response to stimuli gathered by the brain through the eyes, ears and other senses.

To approach desirable efficiency, the Air Force command and control complex must deal with intelligence gathered by every conceivable means. The spectrum of this data extends from radar impulses spelling out the path and speed of incoming targets, the information supplied by underwater sonar and ASW gear, or airborne surveillance cameras, to the reports from consuls and military attaches.

All of this disparate data must be sorted, weighted and fed into the command and control complex at the point where it will have its appropriate effect on the ultimate decision.

"Unfortunately none of these sources oblige by yielding their data in computer language," Schenk said. "All of this welter of information must be translated into figures, the computer's universal tongue, and programed to enable the machine to supply an answer. 'Electronic brain' is a misnomer too readily applied to our computers. At best they can digest masses of information—even offer a variety of possible decisions—but ultimately the commander must command.

"To enable him to reach the best answer, the data sifted by the computer must be selective. Insisting on every detail isn't technically feasible or even humanly desirable. But by using electronic aids correctly we *can* transmit, process and display the data needed for decisions that will control our Space Age war machine."

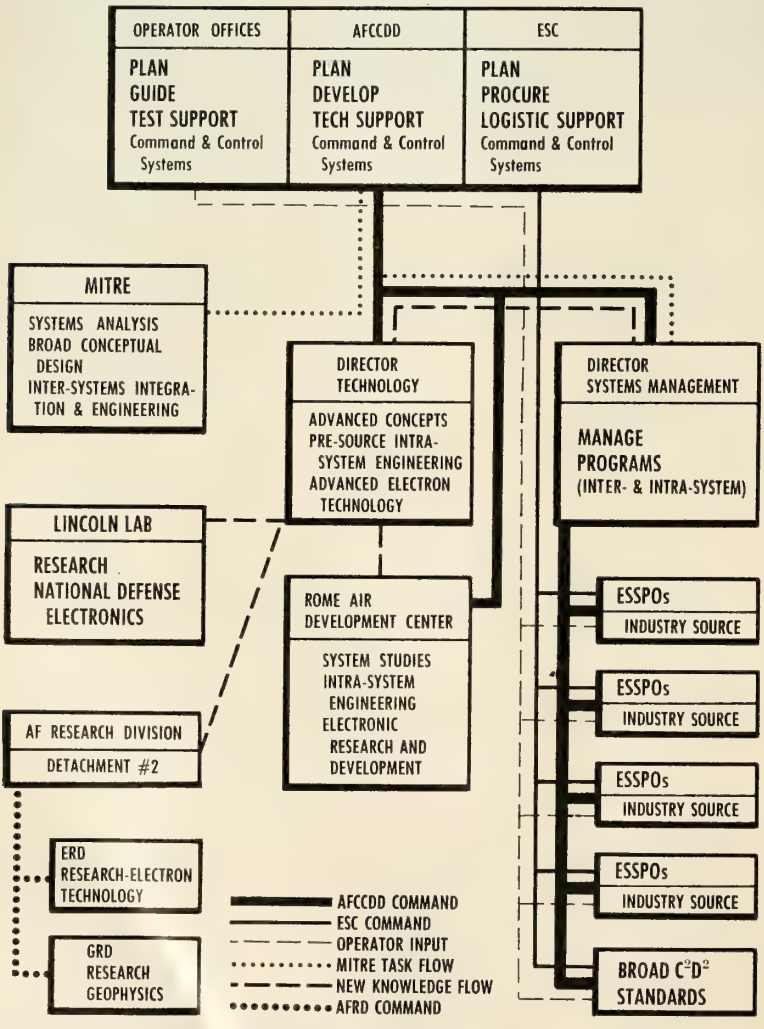
While the computer far exceeds the humain brain in speed and accuracy once it embarks on its pre-arranged task, the information it "displays out" must be available for human decision and control at any command level.

Human override must remain a possibility—to prevent, for instance, shooting into an unsorted cluster of mixed enemy and friendly flying objects, if the computer hasn't been supplied the entire "friendly list."

Typical human intervention at a command post such as NORAD might involve human estimates of the degree of weapon readiness, whether to bring forces into play in a token or massive strike, estimates of the relative "hotness" of the war in related areas, how much force to withhold for a follow-on strike.

Establishment of the Hanscom complex answers the need for an infinitely sophisticated command and control network.

Until C^2D^2 was established, no single Air Force Agency had focused on command and control integration. Even when this coordination is well advanced we will still be without a true, nationally commanded defense system. At best we have "watch committees" of senior officers, observing potential external threats and controlling our retaliatory forces.



RELATIONSHIPS of the Hanscom complex.

Isolator Solves Vibration Problems

Kerley's tuned cable mounts use unique construction to block build-up at resonance, will not bottom out under overload

by Charles D. LaFond

Problems of simultaneous shock, vibration, and noise in missiles and ground support equipment are being solved successfully by a versatile cable isolation mount developed by Kerley Engineering, Inc., Washington, D.C.

Competitively priced, the anti-resonance tuned isolators employ a unique steel cable construction which, its developers say, is effective in any plane, withstands tremendous shock and steady-state g loads, limits noise transmission, and will not bottom out under overload. Because of its modular, all-metal construction, applications appear to be nearly unlimited—temperature, humidity, salt spray and radiation effects are negligible.

Not touted as a cure-all for every design deficiency, the cable isolation mount is being pushed as a new medicant for the troubled designer facing impossible specification requirements.

The units are being tested by various military agencies and industry in everything from gyros to generators. The high interest follows reports that they have been used successfully to solve "impossible" problems.

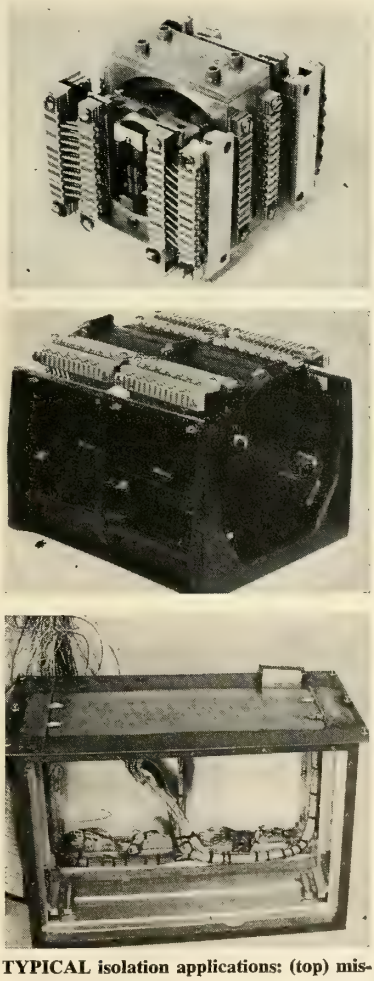
In one test program alone (for the isolation of a *Mercury* capsule radar beacon), Kerley's system successfully endured test of −100° to +1000°F and shock of 80 g's to simulate re-entry. The beacon survived too.

• **Construction unique**—Essentially, the Kerley mount consists of a short L-beam joined to flat-stock extensions of each leg by continuous S-shaped cable wound through "combs" (see photographs).

Diameter of the holes through which the cable is strung is smaller than the cable diameter. Thus, the cable must be twisted to pass through each hole. Tolerances on the holes are held to ±0.001 or 0.002 inch.

The plurality of cable and the total number of cable strands provide most of the surface for friction damping—no snubbers are needed.

Cable arrangements provide anti-resonance features; the random arrangement of strands builds a nonuniformity into the assembly, preventing high build-up at resonance. Prestressing the cable makes response nonlinear, and further breakup at resonance is achieved.



TYPICAL isolation applications: (top) missile gyro designed to take 20 g's from 5-10,000 cps; (center) *Mercury* capsule test radar beacon isolated from re-entry violence; (bottom) B-58 electronics-cabinet corner mounts.

After passing the resonant point, there are no secondary harmonics causing additional response buildup. The output goes down and—without exception—stays down, according to Kerley.

Under heavy shock, energy is absorbed through several motion cycles; the cables act as parallel linkages, rotating the motion into another plane. Bottoming is thus prevented.

Under severe overload, the cables give—but the isolator does not bottom out. If damage occurs, it is to the mount, not the item being supported. A few strands may break and the natural frequency is altered but the isolation still exists.

• **Costs competitive**—Per item costs for small (⅛-in. cable, nominal length) are double that of standard rubber mounts. As size increases, comparative costs decrease. A ¼-in. cable unit is about the same price as a rubber mount designed for the same load.

But Kerley feels it can do a better job with fewer isolators. Also, as production in its New Jersey plant increases, quantity lots will be considerably lower. (A 30-40% reduction on large quantities will soon be available.)

Reductions are due to the higher production yield of mounts now possible. Reproducibility to spec requirements is held to a very close tolerance —no failures have ever been reported by users, said Kerley.

• **One big use barrier**—Biggest hurdle now faced by Kerley is to teach users how to install the mounts.

Use of the isolators today is largely an art, not a science, principally because fundamental knowledge of vibration and shock damage is scant. The same holds true for the performance of the cable isolators. Kerley's present successes are due in large part to personal experience, difficult to pass on to customers.

Arthur D. Little, Inc., Cambridge, Mass., has just started a program to study performance characteristics of the Kerley mounts. It will perform a complete mathematical analysis of the units. From these studies, instructional

material will be prepared for future users.

• **Are claims justified?**—Kerley Engineering says it is solving the multi-directional shock and vibration problem—effectively, safely, inexpensively. To investigate these claims, M/R asked recent users, all associated with the missile/aircraft industry. Here are representative comments:

• Melpar, Inc., Arlington, Va., feels that the isolators have saved it "several hundred thousand dollars" on its contracts for electronics equipment for the B-47 and B-58 bomber programs.

Company officials said they had a very serious problem after testing the first of a large order of rack-mounted sets. Rigidly mounted, according to specifications, they failed shock and vibration tests. Because of space limitations, conventional MIL-spec rubber mounts could not be used, so they tried the cable isolators. So successful were the units that Melpar recently purchased 10,000.

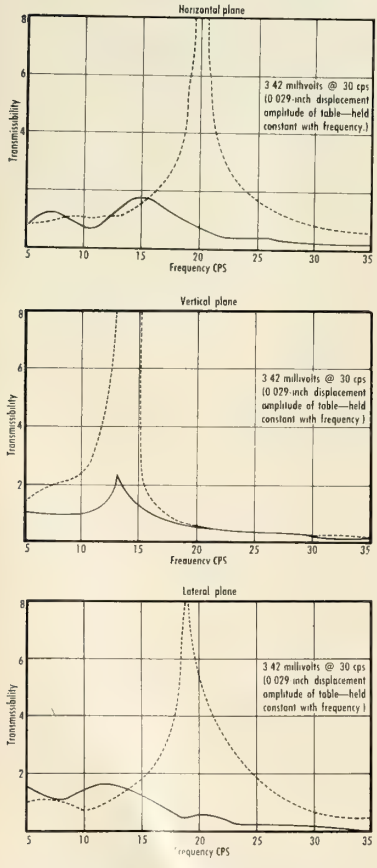
• AeroGeoAstro Corp. of Alexandria, Va., used the mounts to isolate the radar beacon altimeter carried in a *Mercury* capsule test. Fired with the Big Joe *Atlas-Able,* Sept., 1959, the equipment was recovered intact. A company spokesman said that when it was tested on a vibration table, the 12 g's applied was effectively reduced to 4 g's by use of the isolator system. As mentioned earlier, the beacon survived re-entry and was recovered intact.

• Jansky & Bailey, Inc., Washington, a subsidiary of Atlantic Research Corp., mounted sensitive electronic test chassis with the isolators on a rugged *Nike-Hercules* test console built by Bell Laboratories. A company mechanical engineer chose the isolators because of ease of installation in a tight space and because of the multi-directional protection offered.

• In exhaustive road-bounce tests of motor generator sets on the Corps of Engineers, Fort Belvoir test range, the truck driver reported (after 100 times around the course) that the equipment was fine but that he and the vehicle couldn't take any more.

• The same result occurred at the University of Michigan. Extensive vibration tests of the mounts at resonance were halted at the end of a month when a cam on the shaker unit gave way—the mounts were unscathed.

These represent a sampling of responses to M/R, but in checking out what appears to be a better "mousetrap" one thing stood out: There were no serious critics among any of those who have tested and used the new isolation mounts.



COMPARISON of transmissibility tests at resonance performed by a Navy laboratory on a typical gyro mount using Kerley cable isolation system and then standard MIL-type rubber mounts.

Recruit Center

Joint Interviews Set During WESCON Days

LOS ANGELES—An unusual approach to proselyting of scientists and engineers will be evident at the Western Electronic Show and Convention (WESCON) Aug. 23-26. A large centralized recruiting center is to be set up in the Shrine Exposition Hall, not far from WESCON's location in the Los Angeles Memorial Sports Arena.

The center will be sponsored by Careers, Inc., the same firm which undertook a similar venture at the Institute of Radio Engineers (IRE) meeting in New York last March. Company President William Douglass said the IRE effort resulted in hundreds of interviews for the 27 companies which took part.

He expects 50 companies to participate in his unusual recruiting effort at the Shrine, which Douglass admits is timed to coincide with WESCON. Free shuttle buses will operate every five minutes between the recruiting center at the Exposition Hall and the WESCON exhibition at the Sports Arena. They will carry billboards urging WESCON visitors to visit the recruiting center.

• **No objection**—Asked whether the center could be considered a violation of WESCON efforts to discourage recruitment at the meeting, Douglass cited a letter received from a WESCON official which states: "We, of course, have no objection to the fact that the career center will be conducted in the same city and on the same dates as WESCON."

Prospects visiting the Shrine hall will find a large reception and registration room containing brochure racks where each participating employer will list employment requirements and information on his firm.

At each side of this area will be registration booths where the prospect can complete a registration form. This form, identifying him only by number, is duplicated and goes to all employers taking part in the center. On the form, he may indicate those firms in which he is particularly interested.

• **Behind curtains**—Any company interested in interviewing the prospect may send his number up front where it will be posted on large call boards in the outer lobby. If the prospect wishes to talk to the company, an appointments desk will arrange an interview.

Each participating employer is provided with a 20-ft. x 16-ft. screened interviewing unit. This includes a curtained reception area and three small interview cubicles.

Cost to each employer participating is $1275, which includes rental for the interviewing area as well as administrative services. Douglass believes this will enable companies to carry out recruiting at a cost considerably below that of the usual practice of maintaining so-called "hospitality" suites in convention hotels.

"Employers like to do things in a dignified way . . . to escape dark corners and tapping men on the shoulder," says a Careers, Inc., brochure on the program. "They avoid this and achieve success by cooperating in a single center where engineers can come to see what new development in their field may be of interest to them."

Douglass says the average cost per hire for employers participating in the New York program was $200.

RCA Proposes Maneuvering Satellite-chasing Camera

Use of a maneuverable satellite-chasing camera is being proposed by RCA's Astro-Electronic Products Div., Princeton, N.J., which is currently de-

veloping a high-resolution space camera suitable for the technique.

The camera was described by Spencer Spaulding, Astro-Electronic manager, in a recent speech before the American Rocket Society in Los Angeles.

The camera could be launched either separately or with a satellite and ejected later. In either event, the objective would be for the camera vehicle to remain roughly 100 ft. from the satellite to observe satellite performance.

By preprograming and radio assist from ground tracking stations, the camera would photograph its subject from different locations. If a pulsed light source were used for control, illumination also would be provided for use in the earth's shadow, said Spaulding.

The new camera records images in the form of electrical charges on sensitive tape. Capable of storing up to 300 pictures, the equipment would transmit data to earth, using standard television techniques, on radio command after each orbit is completed.

World's Largest Antenna Getting Final Evaluation

Service test evaluation of TAHA (Tapered Aperture Horn Antenna)—reported to be the world's largest receiving antenna and the only one of its type—is scheduled to be completed next month. The tapered-aperture antenna is 1000 ft. long, 500 ft. wide, and 250 ft. high. It was developed by Developmental Engineering Corporation for the Army Signal R&D Laboratory under a $900,000 contract.

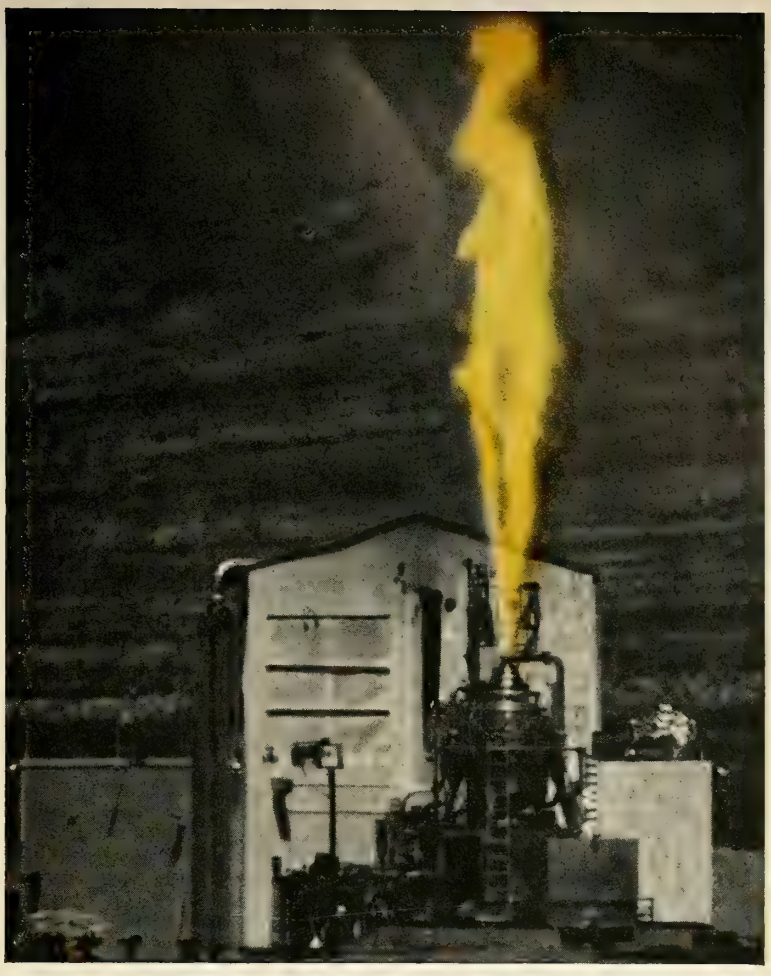
Long-Range IR Detector Made by ITT for Air Force

A new ultrasensitive infrared search system using a liquid nitrogen miniature cooler will detect enemy jets at long distances, according to the Air Force.

Developed by International Telephone and Telegraph Corp. for the Air Research and Development Command, the system will be used to guide interceptors toward penetrating bombers after initial ground-radar detection.

Actually, two units will be used, said ARDC. One is the long distance search unit. A second scanner is locked on target for continuous tracking after the search unit locates the target.

A test model of the search-track equipment, designated AN/AAR-21, has been delivered to the Air Force for flight evaluation.



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Los Alamos Scientific Laboratory has the major responsibility for research, development and testing in the AEC-NASA Rover program . . . another of the many investigations at Los Alamos into peacetime uses of nuclear energy.

PHOTO: First field test of a KIWI nuclear propulsion reactor.

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Shell Casting Produces 100-lb. Parts

New method fills gap between solid-mold and frozen mercury investment casting processes and preserves details

by John F. Judge

GROTON, CONN.—A bright new chapter in the development of investment casting is being written by the Arwood Corp. For the first time, the process is being released from its inherent size limitation.

Investment casting blossomed during World War II and has grown phenomenally, even though until now the largest part produced could be easily held in the palm of the hand.

The Arwood technique turns out intricately shaped castings—weighing up to 100 lbs.—without sacrificing detail. The process fills in the gap between the old solid-mold casting and the recent frozen-mercury method.

• **"Lost" wax**—Solid-mold casting consists of forming wax patterns in a die, placing the patterns in a flask and surrounding, or "investing" it with a ceramic material. The wax is then melted out or "lost", leaving a cavity into which the molten casting metal is poured. Size is severely limited.

The frozen mercury process replaces the wax with mercury. Liquid mercury is poured into a die and frozen. The pattern is invested with ceramic material and the mercury withdrawn. This method is best for extremely large castings.

The ceramic shell molding technique developed by Arwood fits in between these two processes.

• **Coating is critical**—Shell casting is essentially a mold consisting of successive ceramic layers deposited around a wax or wax and plastic casting setup. Initially a wax or plastic pattern is produced by injecting the material into a machined or cast injection die.

One or more patterns are assembled into a casting setup, and the ceramic coating operation begins. The assembly is dipped into the primary refractory ceramic slurry and drained to obtain a thin, uniform coating. This coating is critical: it determines the surface finish of the final part.

While wet, the coated assembly is stuccoed with a fine refractory grain. This establishes a sort of priming surface for the next coating. After the assembly is dried in a controlled temperature-humidity area, the backup coats are applied in the same manner. The number of coats depends upon the thickness required to withstand the pressure of the molten metal during casting.

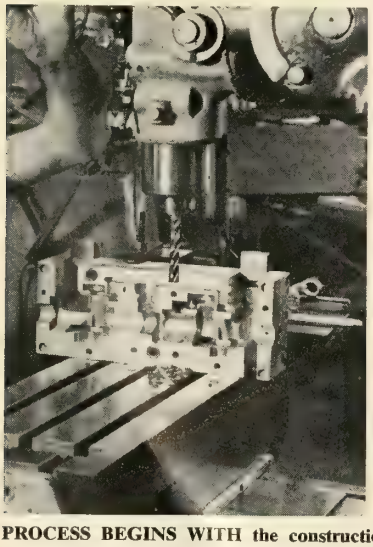
The shell is flash-dewaxed at 1800°F, and is ready for casting.

• **Reliability**—Painstaking quality checks follow each crucial step of the process. The wax patterns in a normal production run are visually examined before being set up. The castings themselves are subjected to a series of inspections beginning with a visual check. Non-magnetic alloys receive a fluorescent penetrant scrutiny. Magnetic castings are checked by Magnaflux.

A thoroughly equipped X-ray facility rounds out the quality control process. (One casting involved seven different radiographic shots.)

The initial casting in a series receives the most rigid inspection—be-

The Casting Cycle at Arwood







PROCESS BEGINS WITH the construction of the die. The wax pattern is shown being separated from the die. Water-soluble core inserts are visible in the pattern just above the operator's hand.

ginning with the pattern and running up to the finished piece. Critical dimensions are carefully measured with special gages. If an extended production run is planned, all possible trouble spots are cataloged so that the visual inspectors will know what to emphasize during their section of the process.

Heat treating facilities are available at all of the firm's five plants.

According to Arwood, castings made by the shell method have a finer grain structure, better and more consistent surface finishes, and are generally sounder than solid-mold products. The firm did not reveal the composition of the waxes and ceramic slurries.

Arwood is equipped to use all three methods, and spokesmen point out that the new development is definitely not a panacea. Process choice depends on the particular part to be cast, and the technical and economical factors involved.

Almost every missile has Arwoodcast products in it somewhere. Component chassis, instrument housings, mass balances for elevator leading edges, gyroscope components and pump housings constitute just a small portion of these missile parts.

Arwood engineers worked with the Shaw Process (M/R, June 27, p. 33) for two years, but decided that it did not satisfy their needs.

Although castings larger than 100 lbs. are possible with the shell method, the difficulty is in the necessary equipment. It seems to be a job of scaling up the current process stages.

Casting geometry and cost may well be the limiting factors in striving for larger and larger shell molds.

Beryllium Output Hiked by Deposit Discovery, Detector

The predicted big boom in domestic beryllium production seems to be under way. Indications from several sources bear out the optimistic forecasts voiced last year by mining and metallurgical experts.

• Vitro Corp. revealed the discovery of a "significant deposit" of the element in the Topaz Mountain area of Utah. The new ore is in disseminated non-pegmatic deposits, much of it lying close to the surface where it can be mined by open-pit techniques.

• A group of scientists at the University of Manitoba, Winnipeg, Canada, have developed an instrument which indicates the amount of beryllium in an ore sample. The value of the instrument, a berylometer, lies in the fact that beryllium occurs in the combined state and almost defies identification by standard prospecting methods.

• **New source**—Discovery of the Topaz Mountain deposit touched off a claim-staking race reminiscent of the early days of the uranium rush. Vitro is one of the largest claimholders in the area. The Topaz ore seems to be readily soluble in sulphuric acid and is apparently amenable to conventional hydro-metallurgical processing.

In addition, Vitro geologists say the ore contains a new beryllium mineral which they propose to name "vitroite."

• **New detector**—More than 20 of the Canadian berylometers have been sold by Nuclear Enterprises Ltd. of Winnipeg. The instrument utilizes a unique property of beryllium—its ability to throw off neutrons when subjected to radioactive bombardment.

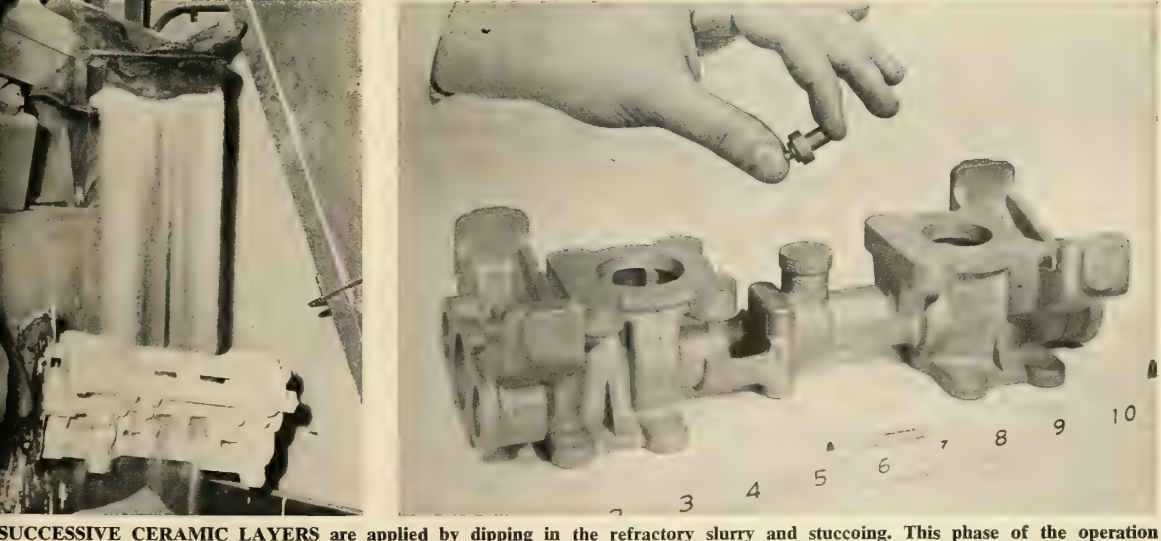
A radioactive source, Antimony 124, is contained in the berylometer. The amount of beryllium in a sample is indicated by the number of neutrons emitted. The instrument counts the neutrons, immediately informing the operator of the beryllium percentage.

The instrument cannot penetrate more than a few inches of covering material—so deep deposits will not be detected.

International Minerals & Chemical Corp. is already surveying its property holdings with the berylometer. The $2500 instrument is carried to the field in a lead vault aboard a station wagon.

The firm's survey team has already checked mineral samples from all over the world collected in libraries at Northwestern University, University of Chicago, the Chicago Museum of Natural History and the large sample library at International.

Beryllium consumption in the U.S. was about 800,000 lbs. last year—only 35,000 lbs. of it from domestic production. The U.S. has been importing the ore from 12 countries—mostly from Brazil, Argentina and Mozambique. The price averages about $300 per ton at foreign ports.



SUCCESSIVE CERAMIC LAYERS are applied by dipping in the refractory slurry and stuccoing. This phase of the operation is slated for mechanization. The final product is shown in comparison to the usual investment casting.

NASA

Atkins & Merrill West, Inc., Anaheim, Calif., for building a series of scale lunar capsule models supporting the Ranger Program. Subcontract from **Ford Motor Co.'s Aeronutronic Division.** Amount not disclosed.

$897,946—**Electronic Associates**, Long Branch, N.J., for analog computer equipment.

$149,921—**Simmons Precision Products, Inc.**, Tarrytown, N.Y., for antennas and receivers.

MISCELLANEOUS

Lear, Inc.'s Astronics Division, for an undisclosed quantity of automatic tracking telemetry receiving systems. Subcontract from **Lockheed's Missile and Space Division.** Amount not disclosed.

NAVY

Electronic Communications, Inc.'s Advanced Technology Corp., for applied research and analytical studies for the *Semper* missile program. Amount not disclosed.

The Garrett Corp.'s Air Cruisers Division, Belmar, N.J., for nearly 100 pairs of air springs designed to provide *Polaris* missiles with the softest cushion possible during transportation and storage. Subcontract from **Lockheed's Missile & Space Division** and **Beech Aircraft.** Amount not disclosed.

CWS Waveguide Corp., Lindenhurst, Long Island, N.Y., for 17 submarine antennas. Amount not disclosed.

Westinghouse Electric Corp., Pittsburgh, for launching equipment for *Bullpup*. Amount not disclosed.

$34,000,000—**Ryan Electronics, a division of Ryan Aeronautical Co.**, San Diego, for AN/APN-122(V) Doppler navigation system with spares, documentation and other special equipment.

$4,740,000—**Leach Corp.**, Compton, Calif., for high frequency power generation equipment for Missile Project and Armament Building at the Pacific Missile Range.

$2,500,000—**Aerojet-General Corp.**, Azusa, Calif., for production of the *Tartar* guided missile solid-propellant motor.

$470,479—**Midwestern Instruments, Inc.**, Tulsa, Okla., for magnetic tape recorder reproducer.

$375,000—**Beckman Instruments, Inc.**, Richmond, Calif., for high-speed EASE analog computer to be used in developing and testing of the *Polaris* missile and its components. Subcontract from **Lockheed's Missile and Space Division.**

$47,308—**Westinghouse Electric Corp.**, Washington, D.C., for engineering services in connection with propulsion control for emergency propulsion motors.

AIR FORCE

Chrysler Corp.'s Missile Division, Detroit, for design and development of a prototype of a high-precision optical aiming device for use with *Minuteman*. Subcontract from **North American Aviation, Inc.'s Autonetics Division.** Amount not disclosed.

Horkey-Moore Associates, a division of Houston Fearless Corp., Torrance, Calif., for fabrication of antenna assemblies for use with *Atlas-Able*. Amount not disclosed.

$81,576,000—**American Machine & Foundry Co.**, for construction of 36 *Titan* launcher systems to be installed in six squadrons.

$12,905,000—**North American Aviation, Inc.**, for long lead time items for GAM-77A.

$3,500,000—**Continental Electronics Manufacturing Co.** (subsidiary of **Ling-Altec Electronics, Inc.**), Dallas, for additional super power radar transmitters for BMEWS.

$3,338,258—**Chance Vought, Electronics Division**, Dallas, for continued development and manufacture of a highly advanced actuator system for *Minuteman*. Subcontract from **Autonetics.**

$1,800,000—**General Electric's Electronic Specialty Capacitor Product Section**, Irmo, S.C., for R&D on high-reliability capacitors for the *Minuteman* guidance system. Subcontract from **Autonetics.**

$855,231—**Budd Lewyt Electronics, Inc., (subsidiary of the Budd Co.)** Long Island, N.Y., for pre-production and production of quantities of multiplexers with gap-filler input converters for use at heavy radar sites of the *Sage* system.

$503,847—**Federal Electric Corp.**, Paramus, N.J., for installation and operational testing of the Time Division Data Link Subsystem for use with *Sage* system. (Two contracts.)

$500,000—**Corning Electronic Components**, Corning, N.Y., for development and testing of extremely reliable glass capacitors for the *Minuteman* and associated ground control systems. Subcontract from **Autonetics.**

$350,000—**Ets-Hokins & Galvan, Inc.**, for design and installation of the cable system for ground support equipment at the **Convair Astronautics** Test Facility at Sycamore Canyon and Patrick AFB. System is for test, launch control and instrumentation of the *Atlas-Centaur*.

$310,125—**General Precision, Inc., Librascope Div.**, Glendale, Calif., for design, development, fabrication and test of two digital celestial trackers.

$244,000—**Bulova Research & Development Laboratories, Inc.**, Woodside, N.Y., for developing a new type of safing-arming device for use in missile warheads.

$180,000—**Hydromatics, Inc.**, Livingston, N.J., for liquid oxygen Flo-Ball valves to be used in hardened sites for *Atlas* missiles.

$84,191—**Sundstrand Corp., Turbo Division**, Pacoima, Calif., for continuation of research on "Investigation of Rational Scaling Procedures for Liquid-fuel Rocket Engines".

$67,584—**Radiation, Inc.**, Melbourne, Fla., for study of feasibility of real-time-data gathering instrument.

$60,000—**Douglas Aircraft Co., Inc.**, Santa Monica, for facilities for the GAM-87 program.

$44,000—**General Electric Co.'s Missile and Space Vehicle Dept.**, Philadelphia, for research entitled "Fundamentals of MRD Flows".

$40,900—**Coleman Engineering Co., Inc.**, Torrance, Calif., for guidance test sled.

$32,000—**Hughes Aircraft Co.**, Tucson, Ariz., for calibration of GAR 3/3A weapon system.

ARMY

$18,853,460—**The Martin Co.**, Orlando, for continued production of *Lacrosse* missiles and ground support equipment, engineering services and maintenance.

$7,875,000—**Chryler Corp.**, Detroit, for *Jupiter* missile system. (Two contracts.)

$7,780,916—**Aerojet-General Corp.**, Azusa, for rockets for *Hawk* system.

$3,389,928—**Raytheon Co.**, Andover, Mass., for repair parts for *Hawk* system.

$3,235,861—**Western Electric Co.**, Greensboro N.C., for *Nike-Hercules* missile components.

$2,199,964—**Sperry Rand Corp.**, for research and development of the *Sergeant* missile system.

$2,001,944—**Sperry Utah Engineering Laboratory**, for *Sergeant* missile system production.

$1,653,082—**Raytheon Co.**, Andover, Mass. for repair parts for *Hawk* System.

$1,500,000—**General Electric Co.**, Schenectady N.Y., for safing, arming and fusing equipment for *Little John* rocket.

$993,486—**Western Electric Co., Inc.**, New York City, for research and development of the *Nike-Zeus* system.

$915,000—**Chrysler Corp.**, Detroit, for continuation of the *Redstone* missile flight evaluation program.

$637,500—**Swanson & Youngsdale**, Minneapolis, for construction of missile assembly building at Schilling AFB.

$250,005—**Chicago Bridge & Iron Co.**, Birmingham, Ala., for liquid oxygen storage tanks.

$235,365—**Electronic Systems Div., Telecomputing Corp.**, N. Hollywood, Calif., for digital control and data handling system.

$199,938—**The Emerson Corp.**, St. Louis, for industrial engineering for improved *Honest John* rocket motor.

$175,622—**Intercontinental Manufacturing Co., Inc.**, Garland, Tex., for nozzle assembly blast tubes.

$153,480—**Motorola, Inc., Western Military Electronics Center**, Scottsdale, Ariz., for telemetry set.

$145,277—**Sperry Rand Corp.**, for *Sergeant* ground handling and test equipment.

$99,992—**Firestone Tire & Rubber Co.**, Los Angeles, for engineering services for *Corporal* and ground handling equipment.

$99,970—**The Alloyd Corp.**, Cambridge, Mass., for study of electron beam welding of metals for use in large solid-propellant rocket motors.

$96,759—**The Martin Co.**, Orlando, for concurrent repair parts for the *Lacrosse*.

$96,280—**Sperry Farragut Co., division of Sperry Rand Corp.**, Bristol, Tenn., for refinement and manufacture of components for *Saturn* stabilizer platform.

$92,911—**Brown Engineering Co., Inc.**, Huntsville, for engineering and design services relating to the missile system.

$85,959—**Emerson Electric Corp.**, St. Louis, for 76 mm rocket fin.

$67,780—**Nuclear Development Corp. of America**, White Plains, N.Y., for research and development involving studies for "Analytical Investigation of Transportation and Film Cooling of Solid Propellant Rocket Nozzles."

$59,656—**Gilfillan Brothers, Inc.**, Los Angeles, for engineering services related to *Corporal* missile system.

$57,357—**Sperry Gyroscope Co., Div. of Sperry Rand Corp.**, Long Island, N.Y., for experimental study of beam-generating techniques for optical beam riding at missiles.

$55,055—**Spaco Manufacturing Co.**, Huntsville, Ala., for fabrication service, *Saturn*.

$48,450—**Western Electric Co.**, New York City, for *Nike* repair parts.

$43,570—**Clark Cable Corp.**, Cleveland, for electronic tool kit for *Hawk* missile.

$29,933—**California Institute of Technology**, for wind tunnel testing for *Nike-Zeus*.

$26,750—**Wiancko Engineering Co.**, Pasadena, for automatic pressure calibration system.

Curtis M. Lee: Former assistant manager of New Product Research and Development at Rheem Manufacturing Co., joins Wyle Manufacturing Corp. as chief engineer responsible for all phases of design and engineering.



ANSOFF



LEE

Dr. H. Igor Ansoff: Appointed vice president of Lockheed's newest subsidiary, Lockheed Electronics Co., responsible for planning, programing and market research. Since 1957 he has directed Lockheed's diversification task force.

Oakley N. Dean: Promoted to vice president-manufacturing for The Electric Storage Battery Co.'s Exide Industrial Division.

Paul E. Doucette and **Harry Shwerz:** Join the research and development staff of Hysol Corp.

J. Gordon Vaeth: Named manager of Reflectone Electronics, Inc.'s newly-opened Washington, D.C., office. Was formerly a member of the Institute for Defense Analyses.

Dr. Robert E. Wall, Jr.: Joins Electro-Optical Systems, Inc., as senior scientist in the Energy Research Division. Was formerly an assistant professor of electrical engineering for the University of Washington.

Thomas L. K. Smull: Appointed director of NASA's office of Research Grants and Contracts, succeeding **Lloyd A. Wood,** named scientist for Advanced Technology in the office of Program Planning and Evaluation.

Howard Morrison: Director of market development with Trans-Sonics, Inc., joins International Resistance Co. as marketing manager of the firm's Control Components Division.

Brig. Gen. John G. Shinkle: Commanding general, Army Rocket and Guided Missile Agency, named commanding general of White Sands Missile Range, N.M., succeeding **Maj. Gen. Waldo E. Laidlaw,** retiring. **Col. John G. Zierdt** succeeds Gen. Shinkle at Redstone Arsenal.

O. A. Linse: Former assistant to the president and sales manager of Burton-Rodgers, Inc., appointed assistant to the vice president of the Pomona Division of The Marquardt Corp.

Melvin N. Gough: Director of NASA's operations office at Cape Canaveral, named director of CAB's Bureau of Safety.

Dr. John I. Slaughter: Named supervisor of chemical research in Allis-Chalmers Manufacturing Co.'s Research Division. Previously served with Corning Glass Works and Standard Oil of Indiana.

Thomas A. Carter, Jr.: Former chief mechanical engineer for the Technical Products Division of Waste-King Corp., named manager of the Cryogenics Division of Standard Steel Corp.

John E. "Soapy" Watters (USA-ret.): Joins Motorola's Western Military Electronics Center as engineering manager.

Dr. Mandell S. Ziegler: Appointed director of research and development for the Russell Reinforced Plastics Corp. Was previously associated with the research and sales divisions of the polychemicals department of E. I. duPont deNemours & Co.

Arthur H. Williams and **Robert F. Hunter:** Elected director of research and development and chief engineer, respectively, of Shafer Bearing division of Chain Belt Co.

Patrick B. Daniels: Former Electronic Research Associates assistant to the president, named executive vice president of Pyrofilm Resistor Co.

Dr. France B. Berger: Former director of planning and requirements, named director of research at GPL Division, General Precision, Inc. **Harry J. Reed** and **Raymond Klemmer** assume the respective positions of director and associate director of planning.

H. J. "Joe" Cassidy: Appointed assistant to the marketing manager for Defense Products at Instrument Development Laboratories, Inc. He replaces **F. J. "Fran" McGinn,** opening up a new regional sales office in Chicago.

Wayne D. Moyers: Named vice president-engineering for Efcon, Inc. Recently with North American Aviation, Inc.'s Autonetics Division, he was responsible for the creation and implementation of the *Minuteman* missile-capacitor reliability improvement.

Sol Greenberg: Elected director of engineering at Lambda Electronics Corp. **Benjamin Shmurak** succeeds him as chief engineer.

Alfred F. Kaspaul: Technical Director of the Solid State Physics Department of CBS Laboratories, promoted to manager.

Hugh Boyd: Goodyear Aircraft Co. vice president named chairman-planning committee for the Anti-Submarine Warfare Advisory Committee of the National Security Industrial Association. **T. C. Smith,** vice president of Daystrom, Inc., elected chairman of the Detection and Classification Task Committee succeeding **R. A. Wilson,** vice president of General Mills, who has resigned. **Vice Adm. C. B. Momsen** (USN-ret.), a consultant for Bendix named chairman of the Decoys and Countermeasures subcommittee. **Rear Adm. C. H. Andrews,** (USN-ret.) is chairman of the subcommittee on Personnel Training Problems and **David Heebner** of Hughes Aircraft is chairman of the ASW Weapons subcommittee.

Stuart L. Dance: Former manager-marketing representative of RCA's Airborne Systems Division, joins HRB-Singer, Inc., a subsidiary of The Singer Manufacturing Co., as head of the marketing department.



DANCE



ROTH

Dr. Ludwig Roth: Joins Northrop Corp. as director of research in the company's Norair Division. Was previously chief engineer at Solar Aircraft Co. Dr. Roth was chief of preliminary design at the German rocket center at Peenemuende and later assistant to Dr. Wernher von Braun in the U.S. Army Ballistic Missile Agency at Redstone Arsenal.

Joseph L. Keefe: Joins American Potash & Chemical Corp. as a market development representative located at the company's New York office. Was previously with Texas-U.S. Chemical Co. and U.S. Testing Co.

Martin Boe: Promoted to weapon system manager of the GAM-77 *Hound Dog* program for North American Aviation's Missile Division, replacing **Dale Myers,** now the division's engineering vice president. Was previously assistant manager of the weapon system, and prior to that engineering manager on *Hound Dog* and project engineer on *Navaho.*

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Readers are invited to save the following six-month index covering M/R issues of Jan. 4 through June 27, 1960, as a reference guide to major news and technical articles published during the first half of the year.

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NORAIR SCIENTIST PROPOSES SPACE "FILLING STATION"; 3/7/60, p. 29.

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MIGHTY SATURN PROGRAM SHIFTS INTO MIDDLE GEAR; New NASA request for $98 million in program brings total FY '61 authorization to $246 million, but program still not seen as all-out, by James Baar, M/R Associate Editor, 2/8/60, p. 14.

ANOTHER SUCCESS FOR LITTLE JOE; by C. Paul Means, M/R Associate Editor, 2/1/60, p. 17.

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Engines

ARS MEET HEARS NEW NOZZLE CONCEPT; 5/16/60, p. 14.

LOCKHEED SHOWS ADVANCED AGENA; Test firing made of Bell liquid engine which will have restart capability in space. In-flight test due next month at Canaveral on Atlas, by William H. Coughlin, M/R West Coast Bureau Chief, 2/8/60, p. 34.

SMALL FIRM WINS ION ENGINE CONTRACT; Electro-Optical beats out big companies and will make first ion engine for space; NASA engine will be more sophisticated but longer in arriving, 2/1/60, p. 24.

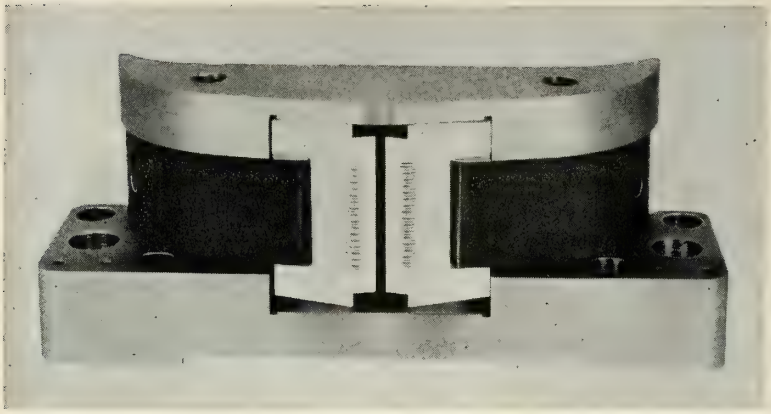
GE TELLS OF CHEAP PLUG NOZZLE ENGINE; 2/1/60, p. 46.

Nose Cones

HOW WE HAVE PROGRESSED IN NOSE CONES; A report on the work accomplished under Air Force contract by General Electric and Avco resulting in successful noses for both ICBM's and IRBM's; an examination of some of the special problems, 4/4/60, p. 32.

Rocket Cases

SECRECY, RIVALRY MARK ROCKET CASE MAKING; 5/2/60, p. 38.



Magnetic Tape Head and Tape Guide

Shepherd Industries, Inc. is marketing a digital magnetic tape head, Model DTH 2132. This head is a 32-track interlaced head for 1-in. tape, employing a unique core design which affords extremely high efficiency, both in record and playback of digital data. The gap length of this head is 10 microinches, which allows its use at extremely high bit densities in the order of 6000 flux reversals per inch in contact. The electrical characteristics of this head are also unique in that the Q is approximately 12, the write current requirements are 1 amp. turn, while contemporary heads require 3 to 4 amp. turns to saturate tape. While the head is primarily designed for digital applications, analog recording and playback is possible at frequencies up to 10 mc.

The new precision Tape Slot Guide, Model TG Series, nearly eliminates tape skew and scrape-flutter. The width of the highly polished hard chrome slot is held to the order of millionths of an inch, thus providing superior guidance while greatly reducing tape curl and wear. The Tape slot guide provides highly improved tape damping and improved start-stop characteristics as well.

Circle No. 225 on Subscriber Service Card.

Seamless Fuel Bladders

Dragon-Kote, a flexible film developed by Chemgineers, Inc. and containing Teflon, is now being used by the firm to manufacture clear, seamless fuel cell bladders. The firm reports that it formulated this material specifically to cope with temperature extremes, corrosive characteristics and other problems involved in the safe handling of today's liquid-propellant fuels and oxidizer systems. Dragon-Kote has the lowest permeability rate of any known flexible material.

The bladders can be designed in unlimited sizes and fabricated to any desired configuration.

Circle No. 226 on Subscriber Service Card.

Fast Digital Computer

Packard Bell Computer Corp. announces an ultrafast, general purpose digital computer. Designated the PB-250, it combines a large, expandable memory and a versatile command structure with computing speed in the microsecond range.

Specifications of the PB250 qualify the computer for either on-line or off-line applications. The PB250 excels as an engineer's desk-side computer, and an on-line computer for process monitoring, process control, data-logging, and alarm generation. Microsecond Speed . . . Add/subtract—12 μsec, multiply—276 μsec, divide/square root—252 μsec are some of the features.

Circle No. 227 on Subscriber Service Card.

Non-Stall Airmover

A compact vaneaxial with a "non-stall" characteristic has been designed to deliver air at high pressure for cooling tightly packed electronic components and other related applications in missiles, submarines, and aircraft, according to IMC Magnetics Corp.

Largely through the development of a special non-stall blade, the new unit successfully eliminates the dip in the pressure-flow curve inherent in normal vaneaxials.

The new non-stall blade provides steadily ascending pressure without interruption. Thus the unit can be used at any air flow in its range without producing stall effect.

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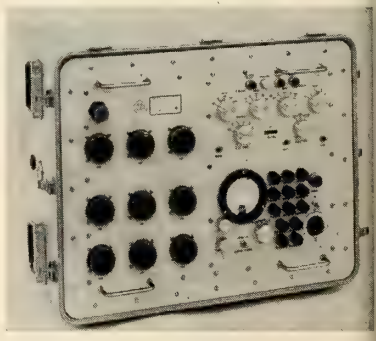
High Dielectric Ceramic

Thin sheet ceramic is now being provided by Mullenbach Division Electric Machinery Mfg. Co., in dielectric constant ranges of 1200, 1600, 1800, 1900 and 2200 for capacitor manufacture or substrate applications. Capacitance varies only plus or minus 10% for 1200°K and plus or minus 15% for higher values from −55 to plus 150°C. Leakage resistance 20,000 megohm-microfarad. Stock thicknesses are 3 to 10 mils with extended range of 1.5 to 20 mils available.

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Cable Harness Analyzer

A Model 196 Militarized Cable Harness Analyzer, developed by California Technical Ind., allows simple and complex branch circuits to be high-potted and measured for leakage to all other circuits. Simultaneously with the leakage test, continuity (conductor resistance) is measured. In automatic operation the wires under test are checked at a maximum rate of five



wires per second. When a fault occurs the tester stops and indicates the circuit and type of fault.

The Militarized (MIL-T-945A) Cable Tester will check 150 simple circuits, 75 main circuits with any combination or number of branch circuits to a total of 75 branches, or any intermediate combination of main and branches up to a total of 150.

Circle No. 230 on Subscriber Service Card.

Pressure Transducers

A high accuracy differential pressure transducer for use in extreme environmental conditions, has been developed by Servonic Instruments, Inc.

Measuring 1¼ in. square by 4½ in. long, and weighing but 16 oz., the Model H-137 is available in 16 differential pressure ranges between ±300 psia and ±5000 psia. H-137 transducers are designed to operate in the temperature range between −65° and 125°C, with case pressures to 10,000 psia.

Circle No. 231 on Subscriber Service Card.

new literature

MISSILE WEIGHT MEASUREMENT—Details are given on the six component force system used on the *Atlas* to measure thrust, pitch, roll, yaw, and side forces in a bulletin issued by Gilmore Industries. Also described is the weighing system for measuring the empty missile, monitoring fuel and oxidizer loading, and indicating take-off weight. Specifications are also included on the Field Standard Calibration System. A second technical bulletin TD-102 describes an installation at Edwards Air Force Base—designed for captive testing of all present and planned aircraft. Basic measurements of the system are aircraft weights up to 1,200,000 lbs. and thrusts up to 500,000 lbs. forward and 250,000 lbs. reverse.

Circle No. 200 on Subscriber Service Card.

SOLID FILM LUBRICATION—A four-page, four-color brochure describing "Almasizing" a solid-film lubrication and protective coating process, has been published by The Almasol Corp. The brochure explains briefly the principles of the process, outlines its basic applications and catalogs the special series of lubricants and protective coatings which have already been developed for certain extreme lubrication needs.

Circle No. 201 on Subscriber Service Card.

HIGH PURITY GASES—Properties, applications and storage of ultra-high purity gases are the topics of interest in a new 16-page booklet offered by Linde Co., Div. of Union Carbide Corp. In addition to information about each gas, the booklet contains charts and graphs showing the results of extensive testing including the areas of heat conductivity, excitation potentials, and discharge characteristics.

Circle No. 202 on Subscriber Service Card.

REFRACTORY METAL CHART—Fansteel Metallurgical Corp. has published a convenient chart showing the complete properties of the metals tungsten, tantalum, molybdenum and columbium. The reverse side contains a temperature chart for conversion of degrees Fahrenheit to degrees Centigrade or vice versa. It is scaled from absolute zero to 3600°C (6512°F) and includes formulas for exact conversions arithmetically.

Circle No. 203 on Subscriber Service Card.

COAXIAL CABLE CONFIGURATIONS—The Electronics Division of the American Tube Bending Co. has published a new four-page, two-color, fully illustrated catalog on configurations of Phelps Dodge aluminum sheathed air dielectric coaxial cable. The new processes, developed by the American Tube Company, allows the use of highly complicated shapes and configurations of Styroflex, Spirafil and Foamflex coaxial cable ranging in size from 3/8 in. to 3 1/8 in. diameter without mechanical or electrical disturbance. Unbroken "termination to termination" use is possible without affecting the cable's characteristics.

Circle No. 204 on Subscriber Service Card.

MISSILE POWER SYSTEMS—A complete line of power systems for missiles and spacecraft applications is described in a new bulletin released by Vickers Inc., Division of Sperry Rand Corp. The 11-page brochure discusses the development of complete and separate power generating systems leading up to the present Vickers line of packaged flight vehicle power systems. Four basic types of systems for missile application are described. These include the hot gas motor, hot gas servo, silver-zinc battery, and flywheel. Details are also presented on a hydrogen-oxygen system using a positive displacement engine for spacecraft application.

Circle No. 205 on Subscriber Service Card.

HANDBOOK OF THE ALLOYIST—This technical bulletin pinpoints the advantages of several groups of alloys used in the electrical and electronics industries. Prepared by technical specialists of Riverside-Alloy Metal Div., H. K. Porter Co., Inc., the eight-page pamphlet includes a discussion of the properties of each alloy suitable for use in the industry. Typical applications are also given for each alloy.

Circle No. 206 on Subscriber Service Card.

RELAY CATALOG—The most complete catalog of relays ever published is now available from Relay Sales, Inc. Over 20 leading relay manufacturers' lines are listed with complete description and prices. A new thumb-indexed table of contents speeds finding of any relay desired.

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editorial . . .

The Bright New Galaxy

What is the proper role of the government in space exploration?

Ralph J. Cordiner, Chairman of the Board of General Electric Co., dealt with this and related questions in a recent lecture at the University of California entitled "Competitive Private Enterprise in Space."

"In my preparations for this lecture," he said, "I was surprised to learn how many people have simply taken for granted that space is a natural domain of the government.

"Almost no one had looked forward to the time when space will have been explored, to ask whether its development shall be under our traditional competitive enterprise system or whether—unlike the rest of the economy—space shall be pre-empted for government enterprise."

Mr. Cordiner feels that the proper role of the government in relation to space is no different from the government's role in our other economy.

"Government," he said, "should do for the citizens, at their expense, only those things that the citizens cannot do for themselves through their private institutions.

"National defense is necessarily one of the services provided by the government, but in an age when military power depends less on standing armies than on technological maneuver, the role of private industry is vital.

"The exploration of space is a project that proceeds from a mixture of strategic motives, including military, political, economic and ideological. It, like the national defense, will necessarily require a close partnership between the federal government and private industry."

Mr. Cordiner thinks that space, like past frontiers, will be developed in three main stages: exploration, economic development, and mature economic development.

"Generally speaking," he said, "the exploratory stage is likely to be government-directed with substantial industry participation; the stage of economic development will be marked by government phasing-out and commercial industry phasing-in; and the stage of mature economic operation will—if private enterprise is to survive in the space industries—be primarily based on private ownership and operation under suitable government regulation, including some form of international law or agreement."

The first era, he noted, is already launched. It is basically a stage of scientific research and offers few opportunities for commercial business.

The second stage he sees as one of infant industries and expensive risks—with the first commercial operations being world-wide communication by satellite, private weather forecasting and high-speed earth transport by rocket.

Much of the early research and development financing will be done by the government, because of its interest in establishing U.S. leadership, but private industry must contribute also.

During the third stage—mature development—the government, Mr. Cordiner thinks, will phase itself out of economic and technical work while encouraging the growth of competitive private enterprise.

What will the industries be? Raw materials, new and rare minerals and chemicals, new sources of energy, of food, of medicines, interplanetary tourism—what limits are there?

Mr. Cordiner's lecture encompassed much more than can be told in this space—all of it in the great tradition of private, capitalistic enterprise, aided and encouraged by government. We applaud his vision. Once it was a bright new world. Now—a bright new galaxy.

Clarke Newlon



Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

- Inertial Components and Platforms
- Systems Design and Physical Design of Inertial Devices
- Digital Computers
- Servomechanisms
- Controls Systems Analysis
- Magnetic Drum and Magnetic Core Circuit Design
- Transistor Switching and Circuit Design

Polaris Guidance is but one of the many R&D programs which reflect the growing emphasis on space oriented projects at Hughes. The Engineering Division is also responsible for such projects as: Space Ferry Systems, Anti-ICBM Detection Systems, Infrared Search Systems, and Communications Satellites.

For immediate consideration, please write, wire or call: **Mr. R. A. Martin**
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Like the mythical bird of immortality which arose from its own flames to seek new life, this modern Phoenix—a space probe designed and built by Rocket Power/Talco—is seeking new information in the upper atmosphere. ◆ Designed to lift a 10 pound payload to a height of one million feet, the Phoenix was produced for the University of Maryland under a United States Air Force research program. Rocket Power/Talco accomplished the project, from design to successful firing. ◆ For information on this light-weight, portable sounding vehicle and Rocket Power's wide capabilities in solid propellants and ballistic components—write Rocket Power/Talco, Falcon Field, Mesa, Arizona.

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July 11, 1960

missiles and rockets

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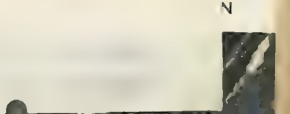


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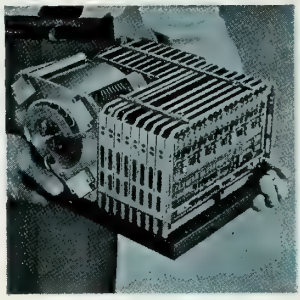
Atlas—New Target for Zeus

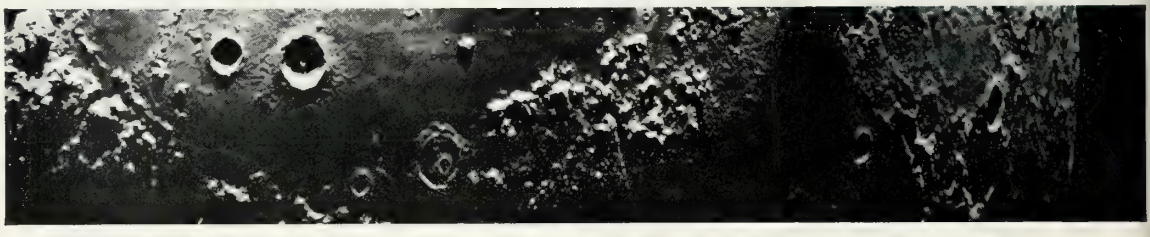




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computers that pace man's expanding mind



GPI LI 0-1

Circle No. 1 on Subscriber Service Card.



New Kinetics switch transfers battery power automatically in space craft



Part of the electronic circuitry that senses battery voltage and operates the switch to transfer the load to another power source when voltage drops to pre-set level.

For satellites, deep space probes or extended space flights, it is frequently necessary to switch from an exhausted battery to a fresh one or to solar power. Now Kinetics Corporation has combined an ultra reliable switch with a voltage-sensing element to meet this critical requirement. The new Kinetics switch is motor driven. It is more rugged and reliable than other designs and is impervious to shock and vibration.

The switch exhibits no contact chatter over the whole vibration spectrum, from 5 to 2000 cycles, 40 G's. Voltage drop across typical switch contacts is less than 10 millivolts at 22 amps. No power is required to hold the switch open or closed. High density construction permits as many as 21 circuits in less than 14 cubic inches.

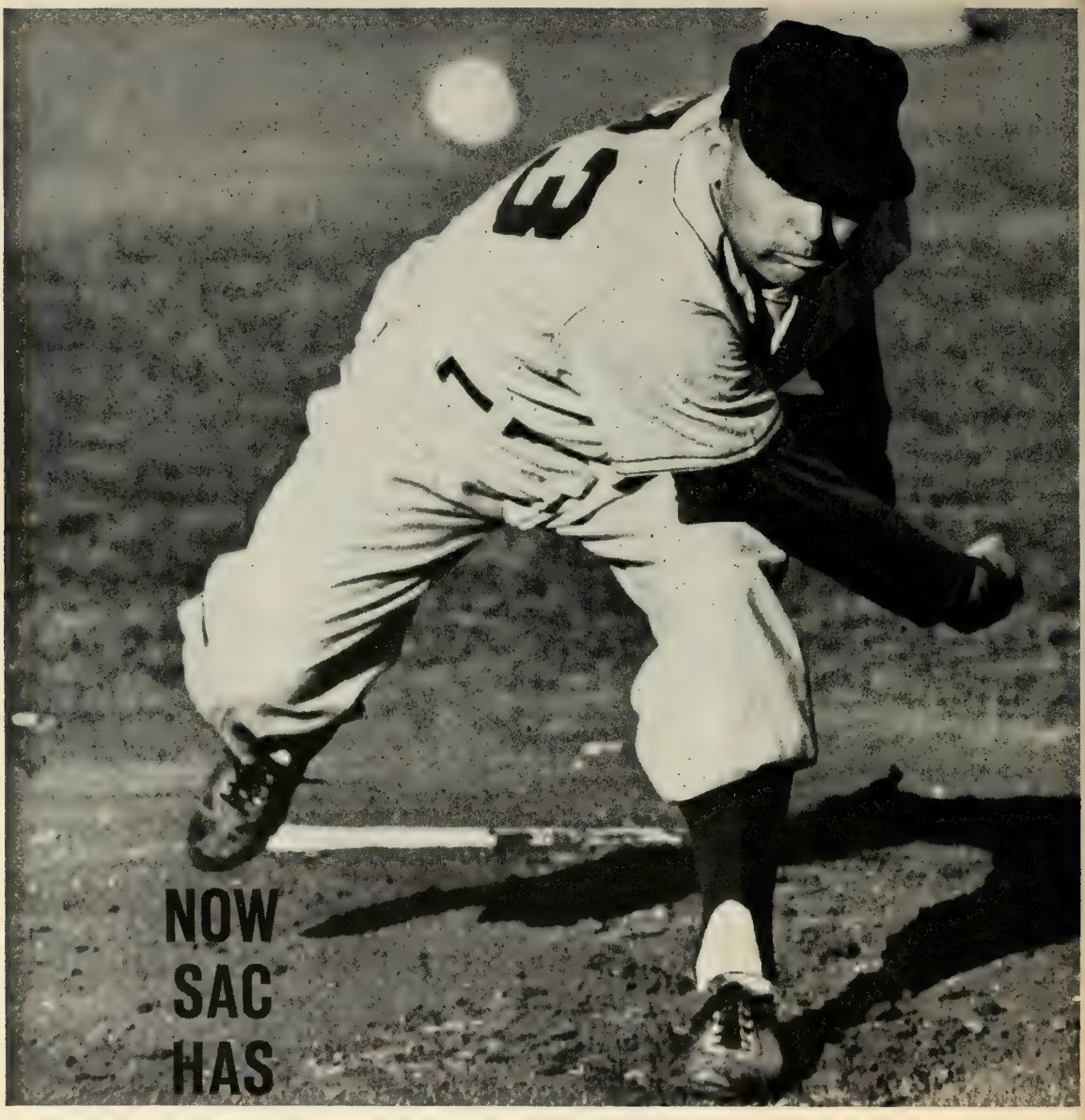
An ultra-sensitive electronic circuit measures battery voltage. When the sensed voltage falls to a pre-set level, the circuitry passes current to the switch motor, causing power transfer. It may be applied in systems where a missile is switched to internal battery power after check out on ground power. After launch, when the missile is in flight and the first battery is discharged, the same switch can transfer the load to a fresh battery or to solar cell power. For systems employing more than two batteries, additional switches can be utilized for programed or automatic power change overs.

For any switch application where absolute dependability under tough environmental conditions is essential, write or phone Kinetics Corporation, Dept. K-27, 410 S. Cedros Avenue, Solana Beach, Calif. SKyline 5-1181.

KINETICS CORPORATION

ELECTRONICS · ELECTROMECHANICS

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TWO STRIKES ON THE OPPOSITION

When SAC's B-52 crew steps up to the mound it can throw two deceptive curve balls before winding up to deliver the third strike. Two GAM-77 HOUND DOG air-to-surface missiles slung beneath the wings of the B-52 intercontinental bomber can quash enemy defense centers and clear a path to the main target.

Blazing into action at supersonic speeds, these GAM-77's can be used either on resistance points or on the main objective itself. Inertially guided, they can fox enemy radar by making passes at pseudo-targets before heading for the actual one. To further confuse the opposition, the jet-powered missiles can fly high or low on the way to the strike zone.

The GAM-77 HOUND DOG was designed and is in production for SAC by the Missile Division of North American Aviation.

THE MISSILE DIVISION OF
NORTH AMERICAN AVIATION, INC.

Downey, California

THE MISSILE / SPACE WEEKLY

missiles and rockets

July 11, 1960 Volume 7, No. 2

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THE COVER



Launch of an Air Force Convair Atlas down the Atlantic range into the Indian Ocean. The ICBM will be used, in place of Jupiter, as a target for Nike-Zeus. *(See p. 14)*

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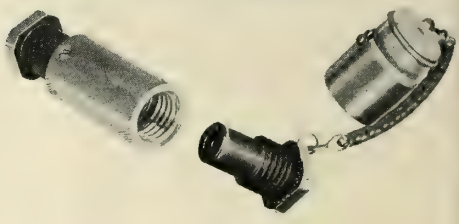
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30,562 copies this issue

Rita Roylyn Says:



"Roylyn AstroCon high-pressure valves...* help men breathe in outer space"



*STERILAB decontaminated

Sterilab decontaminated **AstroCon** oxygen valves such as these are supplied to AiResearch Manufacturing Company, a division of the Garrett Corporation, who are designers of environmental systems for men in space.

High-pressure valves are a specialty of Airaterra, designers of the popular line of Roylyn products for the aircraft and missile industry. They are engineered for pneumatic, gaseous or liquid applications, and are available in standard as well as custom sizes.

These valves as well as many other Roylyn products are decontaminated, assembled and packaged in the ***Sterilab***. Design features of these Roylyn high-pressure valves include the ability to be coupled under pressure to 10,000 psi, yet maintain zero leakage stored. Utilizing metal-to-metal valving, these components have an operating temperature range of from −65°F to over 225°F. Light in weight, they exhibit extreme vibration resistance, meeting 160 Db white noise.

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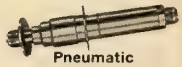
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Twin-Mounted Swivel Connector



Pneumatic Rise-Off Disconnect

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when and where

JULY

Metallurgical Society of American Institute of Engineers, Conference on the Response of Materials to High Velocity Deformation, Estes Park, Colo., July 11-12.

American Rocket Society, Propellants Combustion and Liquid Rockets Conference, Ohio State University, Columbus, July 18-19.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Management Development Seminar, Pennsylvania State University, University Park, Pa., July 24-29.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Professional Group on Communications Systems, and USA Signal Corps, (100th Anniversary) Statler Hilton Hotel, Washington, D.C., Aug. 1-3.

MIT Special Summer Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19, 1960.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Aug. 9-12.

ASME-AICHE Heat Transfer Conference and Exhibit, Statler Hilton, Buffalo, N.Y., Aug. 15-17.

XIth International Astronautical Congress, International Astronautical Federation, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Institute, Storrs, Aug. 28-Sept. 9.

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

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The Countdown

WASHINGTON

Polaris Ready Now?

Though it won't prove out its full underwater launch capability until this month with a *Polaris* shot from the Atlantic south of Cape Canaveral, the Fleet Ballistic Missile submarine George Washington is considered an operating unit now. It has been on an emergency standby status since April.

Pershing Success

Army officials are boasting about *Pershing*. They are pointing out the planned mid-air "zig-zag" shot June 30 marked the "first time in the history of the Atlantic Missile Range that a new R&D missile achieved five successes in its first five flights."

Prime for Scout

Once development of *Scout* is completed, NASA expects to move closer to a prime contractor arrangement. At present, Chance Vought assembles the vehicle under supervision of NASA personnel. When the solid-fueled bird is operational, a prime contractor (to be chosen) will assemble, install instrumentation and launch with a minimum of government supervision, if the plan goes through.

Base Delay Investigated

The Air Force—at Defense Secretary Gates' request—is now preparing a report on the six-month slippage in readying the first *Atlas* squadron at Cheyenne, Wyo. (M/R June 20; p. 11.) The delay—also said to be spreading to *Atlas* pads at Offutt AFB—appears to stem from managerial troubles. (See editorial p. 50.)

An Exact Amount

Despite all the in-fighting, or maybe because of it, NASA wound up with a FY 1961 appropriation from Congress of $915 million—just what the Administration had requested. The space agency also received money for a new office building in Washington.

It's an ALM

The Navy has let a study contract for a secret new missile named *Semper*. Wags around the Pentagon have dubbed *Semper* an ALM—standing for "air-launched marine."

INDUSTRY

Full Study

Latest word on the Army's battlefield mobile anti-missile project is that as many as six companies may be given full $250,000 feasibility study contracts. Final evaluation of industry proposals for these studies is expected to be completed by ARGMA by Oct. 1. The Army is entertaining proposals for advanced concepts as well as hardware-type anti-missile missiles.

Strike's Effect

The Machinists' strike at Lockheed has cut into *Polaris* production schedules. So far the effects of the walkout have not been too serious, but DOD officials are pressing for a quick settlement.

Mauler's Prospects High

Award of a follow-on $8-million contract to Convair-Pomona for continued development of *Mauler* is being interpreted as an indication the anti-missile/aircraft system will achieve operational status in early 1961. *Mauler* is solid-fueled, radar-guided and deployed aboard tracked vehicles.

Along Mahogany Row

Harvey Gaylord is staying on at the helm of Bell Aerospace Corp., the new division of Textron which purchased the defense divisions of Bell Aircraft. Gaylord had been president of Bell . . . Payroll at Cape Canaveral of Pan American and its major subs topped $54 million for the FY just ended. It's expected to go up another $2 million this year . . . Now that STL is separated in part from the Air Force, Thompson Ramo Wooldridge expects a substantial increase in STL $60 million volume.

INTERNATIONAL

British Push Blue Water

Following up disclosure that France's SEPR has concluded an agreement with Rocketdyne and Thiokol on a medium-range ballistic missile (COUNTDOWN, July 4) the British and the West Germans have entered into an agreement on another missile. It's the short-range *Blue Water*, made by English Electric. Both birds are competitors in the NATO market.

Japan Angling for Mighty Mouse

Persistent reports from overseas have the Japanese attempting to make a deal for a stockpile of 24,000 *Mighty Mouse* air-to-air missiles.

Caribbean Storm Warning

The Dominican Republic is now reported to be importing foreign rocket talent, apparently to counter expected Russo-Cuban missile deals. Castro has rocket fuel-refining facilities. He also hates the Dominican Republic as well as the U.S.

Peru Exhibits Model IRBM

The Peruvian Air Ministry is apparently getting ready to move into the missile to move into the missile field. It is displaying a model of an IRBM called *Manco Capac*.

Committee hits delays . . .

Group Wants Man on Moon by '70

A Congressional committee demanded last week that the United States raise its sights and set as a goal the landing of a manned expedition on the moon before 1970.

The Democratic-controlled House Space Committee lashed out at the Republican Administration's meandering space program as Congress broke up for a month's recess.

It called on the National Aeronautics and Space Administration to adopt a high-priority program to put men on the moon within 10 years. The current NASA schedule has set this goal for a vague "after 1970"—apparently about 1972.

"A firm plan with this goal should be drawn up and submitted to the Congress by NASA," the report said. "Such a plan, however, should be completely integrated with other goals to minimize total costs. . . . Particular attention should be paid immediately to long leadtime phases of such a program."

• **Conflicts recalled**—The committee recalled that Brig. Gen. Irving L. Branch, chief of the Aircraft Nuclear Propulsion Office of the Atomic Energy Commission, had testified this spring that AEC could develop propulsion for a manned moon expedition in less than 10 years if given such a requirement.

However, Deputy NASA Administrator Hugh L. Dryden testified that a manned moon expedition would be impossible in this decade regardless of progress in propulsion. Dryden said solving the problems of re-entry from a lunar distance will take longer than 10 years.

The NASA timetable, put forth by administrator T. Keith Glennan in February, is about four years behind a schedule that some of the nation's top scientists, engineers and government officials thought possible a scant 18 months ago.

In a report issued Jan. 2, 1959, the original Select House Space Committee quoted 20 experts as saying the United States could put a man on the moon by 1968—if willing to pay the price.

The experts included Dr. Herbert F. York, now Defense Department director of research and engineering; Lt. Gen. Bernard A. Schriever, commander of Air Research & Development Command; Dr. Louis G. Dunn, president of Space Technology Laboratories; and Gen. James H. Doolittle, then chairman of the National Aeronautics and Space Council.

The committee made these other points:

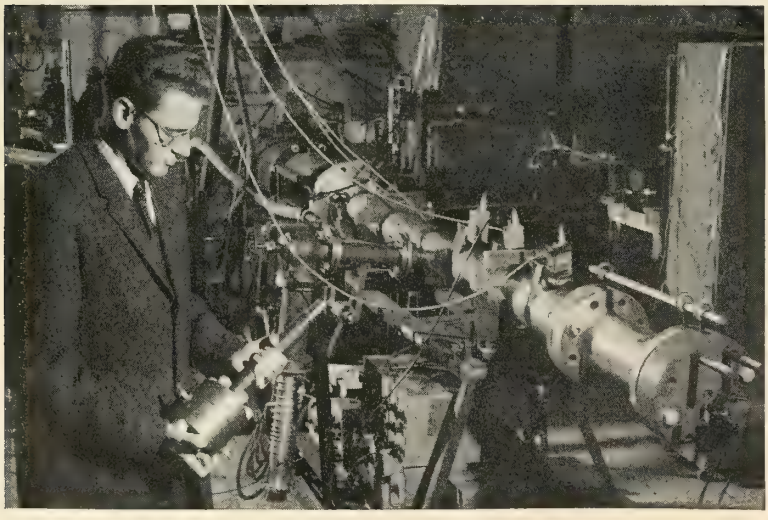
• The F-1 1 and ½-million-lb.-thrust single-chamber engine should be speeded and granted a "DX," the nation's highest priority.

• NASA should consider whether a nuclear engine "either by itself or in combination with the more conventional engines now in use or contemplated, does not offer a faster and more economical method of achieving a breakthrough. . . ." The decision should be made before large sums are committed to *Nova*, the committee said.

• Administration action in withholding $137 million voted by Congress for preproduction items for *Nike-Zeus* was unwarranted.

The Department of Defense has wasted a unique organization by failing to utilize Army in-house research and development facilities, worth $1 billion.

Gun Aids Study of ICBM Wakes



A 24-inch long hypervelocity gun developed by Avco-Everett Research Laboratory accelerates projectiles up to 18,000 feet per second. The gun was designed for the Army as a low-cost device to aid in the study of wakes left by projectiles traveling at ICBM speeds.

The device—held by Steven Georgiev, Avco scientist, in the accompanying photo—consists of a driver section, diaphragm, and barrel. Hydrogen gas in the driver section is exploded by a 20,000-volt capacitor discharge, the diaphragm ruptures, and a .22 cal. nylon pellet is fired down the long instrumented tube shown in the photo. At the far end of the tube is a window through which Schlieren photos of wakes up to five feet long have been made.

Soviets Open New Series Of Shots into South Pacific

The first in a series of long-range rocket tests being conducted by the Russians in the Pacific this month landed in its designated target area after travelling a reported 8078 miles.

Two U.S. Navy patrol planes watched the rocket plunge into the atmosphere July 5, creating a long vapor trail. The pilots were not able to say whether the payload impacted in the ocean or disintegrated during re-entry.

Pentagon estimates were that the Red rocket had travelled 7700 miles. An *Atlas* travelled 9000 miles May 20.

In January, the Russians launched a multistaged rocket into the Pacific that travelled 7150 miles into a target area 150 miles northwest of the present area. This rocket was supposed to have been fired from the launching base near the Aral Sea.

The difference in range and target area indicates that the present series are being fired from the Kapustin Iar base on the Volga.



SCOUT STANDS at launch tower, ready for launching at 85° angle of elevation.



LAUNCH JULY 1 carried vehicle 860 miles up, 1500 miles downrange.

Three Scout Stages Ignite: Fourth Blocked by Command

by Jay Holmes

The launching of the first four-stage *Scout* vehicle was a propulsion success and an apparent guidance failure.

The first three stages of the all-solid satellite launcher ignited as planned July 1. But the vehicle appeared on the radar track to have veered off course and fourth-stage ignition was prevented by command from the Wallops Island, Va., station of the National Aeronautics and Space Administration.

The burning of second and third stages was visible over a wide area of the mid-Atlantic states. *Scout* rose to an altitude of 860 statute miles and traveled 1500 miles down the Atlantic. With all four stages burning, the trajectory would have carried it to an altitude of about 2300 miles and about 4700 miles downrange. Launching was at 8:04 p. m. (EDT).

The launching had been postponed several times since it was first scheduled June 16. The first delay was caused when an umbilical failed to detach less than a minute from firing. On subsequent days, difficulties arose with the guidance. Then the shot had to wait four days because Navy vessels were active in the range area. However, it was only four minutes behind schedule on the actual firing date.

NASA propulsion specialists were jubilant about the successful firing of the rockets—particularly the third-stage *Antares*. It was the first time *Antares* had been fired in flight.

The flight of the 72-foot *Scout* was a test of performance, structural integrity and environmental conditions of the vehicle and guidance-controls system. It carried 193 lbs. of payload.

Scout, which weighs 36,100 lbs. overall, is being developed as a small, reliable and flexible vehicle designed for a variety of tasks. It will carry more than 150 lbs. into orbit or will loft a 50-lb. package to an altitude of about 10,000 miles. With a ballistic trajectory, it will be possible to obtain two hours of zero-gravity environment with a 100-lb. payload.

Because of its solid propulsion, *Scout* will be a relatively cheap means of launching satellites. The latest estimate of vehicle cost, by Maj Gen. Don R. Ostrander, NASA director of launch vehicle programs, is $750,000 a copy.

The four-stage *Scout* frame and motor transition section are manufactured by Vought Astronautics Division, Chance Vought Aircraft, which also fabricates and installs the launch tower. Stages are as follows:

• **Algol**—a-30-ft.-long Aerojet-General rocket also called *Senior*. The 40-in.-diameter polyurethane composite motor develops 105,000 lbs. thrust for about 40 seconds. It is a modification of an early *Polaris* test vehicle. NASA said this fin-stabilized first stage is the largest solid rocket flown in this country.

• **Castor**—a-20-ft.-long Thiokol motor modified from the Army *Sergeant*. A 30-in.-diameter polysulfide composite motor, *Castor* develops 55,000 lbs. thrust for about 25 seconds. On the *Scout*, *Castor* is stabilized and controlled by hydrogen peroxide jets.

• **Antares**—a-10-ft.-long rocket specially developed for the *Scout* by Allegany Ballistics Laboratory, a Navy installation operated by Hercules Powder Co. A 30-in.-diameter double-base motor, *Antares* develops 15,000 lbs. thrust at altitude for 38 seconds. *Antares* also uses hydrogen peroxide jets for stabilization and control.

• **Altair**—a-6-ft.-long final-stage rocket used extensively in satellite and space research applications. An 18-in.-diameter motor, *Altair* develops 3100 lbs. thrust at altitude for 35.6 seconds. *Antares* is a scaled-up version of *Altair*. Both use fiber glass and plastic rocket cases.

Guidance and controls were manufactured by Aeronautical Division, Minneapolis-Honeywell. The 193-lb. payload—protected by a fairing jettisoned at third-stage ignition—included:

• A 23-lb. package of flares for observing the fourth-stage flight path, attached to the skirt of the *Altair* and fired at intervals after burnout. *Altair* was attached to the payload throughout the flight.

• A 23-lb. unit consisting of four blade antennas, a horn antenna and a cylindrical collar, 20 in. in diameter and 15 in. long.

• A 110-lb. electronic package, in-

cluding 190 liquid zinc silver batteries and mountings and four radio transmitters—two for data transmission, one radio tracking beacon and one radar beacon.

• A 37-lb. item made up of a plastic dome and measuring devices.

One data transmitter broadcast five channels including external temperatures, vehicle position and attitude. The other sent eight channels including compartment temperature, motor pressures, four accelerometer readings, magnetic field, radiation penetration of the payload and aspect information from a horizon scanner and a sun seeker.

The guidance compartment is between the third and fourth stages. It is based on a system of three gyros attached rigidly to the vehicle frame—in contrast to a true inertial system based on a free-floating gyro.

Azimuth and roll orientation are maintained essentially at the initial attitude established at launch; guidance is confined to pitch. The main component in addition to the three miniature integrated gyros—one for each reference axis—is the pitch axis programer.

The programer consists of two components, a timer and a DC power supply, which sends signals to the pitch axis gyro through six potentiometers.

The first three stages are controlled; the fourth stage is spin-stabilized. First-stage control is provided by a conventional hydraulic position servo, which actuates jet vanes in the motor exhaust and movable aerodynamic tip controls in each of the four fins.

Two pitch and two yaw hydrogen peroxide reaction jets provide control in the second stage. Their nominal thrust is 450 lbs., but they yield about 600 lbs. during the first five seconds of second-stage flight. Four 20-lb. pressure jets provide roll control.

Control in the third stage is also provided by H_2O_2 jets. To allow for coasting periods of up to 10 minutes after burnout, the Antares has two sets of controls. Four 44-lb. reaction jets provide pitch and yaw control and four 2-lb. jets provide roll control during powered flight. In the coasting period, two additional 2-lb. jets provide pitch control.

The fourth stage is stabilized by spinning it up to 160 rpm by three small rockets mounted tangentially. Spinning is begun near the end of the third-stage coast.

In a related development, NASA pinpointed the cause of the ignition failure of the third-stage *Antares* in the component test last April 18. The heat shield covering the third stage became displaced, NASA said, causing a structural failure in the vehicle before third-stage ignition.

special M/R survey shows . . .

Next President Will Pre



NIXON



KENNEDY



JOHNSON

Where will the next Administration stand on the important questions of defense and space exploration?

An M/R survey on the eve of the two political conventions indicates that regardless of which of six potentional candidates win their party's nomination, the next President will take a more forceful approach to these problems than did the last.

The Summit Conference blow-up and other recent U.S. reversals have done much to throw the missile and space issues into the political arena. For better or for worse, they will be debated in a heated, partisan manner this fall.

As was expected, the survey revealed a remarkable similarity in the positions of five possible candidates (Sen. John F. Kennedy, Gov. Nelson Rockefeller, Sen. Lyndon B. Johnson, Sen. Stuart Symington and Adlai E. Stevenson), and a sharp divergence between their views and those held by Vice President Richard M. Nixon.

The Democratic Party contingent and Gov. Rockefeller uniformly assert that Administration military and space spending has been inadequate, while Mr. Nixon has consistently defended the Administration's position.

Sen. Symington wanted to increase next year's military budget by $3.5 billion, Gov. Rockefeller by $3 billion, and Sens. Kennedy and Johnson supported the Senate attempt to increase defense spending by $1.3 billion. Gov. Stevenson has endorsed the Democratic National Advisory Committee's recommendations for increased military spending.

Mr. Nixon's recent statements, however, indicate he will present a stronger approach to defense and space problems once he is no longer an Eisenhower team member and becomes his party's candidate.

This was indicated during his recent press conference in Camden, N.J., where in defending the Administration's defense budget, the Vice President was careful also to approve the "slight modifications by the very able and experienced Appropriations Committees of the House and Senate."

As noted above, the "slight modification" made by the Democratic-controlled Senate Appropriations Committee was to add $1.3 billion to the Administration's request!

According to reliable sources, the Vice President will offer a complete reorganization of the military and other "cold war" organizations, and will add additional funds to the military budget as studies indicate a need.

The only other area in which all candidates agree, with the possible exception of Sen. Symington is that the United States is today stronger than the Soviet Union.

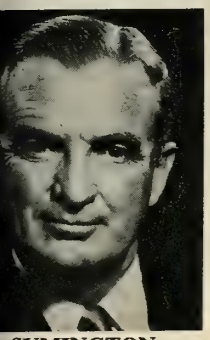
The central issue upon which the candidates disagree is whether past and present budgets will give the United States military superiority in the future, or at least an effective deterrent power.

On this issue, the candidate's views are:

Nixon: "As far as deterrent power is concerned, there is no gap today, and there will be no gap under the program (FY '61) that the President has submitted . . . I believe that militarily . . . we maintain and have a position of strength unparalleled in the history of this country."

Kennedy: "This year (1960), our 'mix of forces' is undoubtedly 'far superior.' But . . . we are today de-

.S. Missile/Space Effort



SYMINGTON



ROCKEFELLER



STEVENSON

ficient in several areas . . . in one of those areas, ballistic missiles, our deficiency is likely to take on critical dimensions in the near future."

Johnson: Criticized the military budgets of FY '60 and '61 as inadequate, and last December described the U.S. space lag as "unilateral disarmament."

Symington: "I do not think this budget (FY '61) is adequate from the standpoint of the security of our country."

Rockefeller: ". . . our position in the world is dramatically weaker today than 15 years ago . . . I believe our national defense needs great strengthening to meet the physical danger in which America lives."

Stevenson: Has consistently advocated increased military spending. Warned last December that the Russians cannot be confronted safely in negotiations with "inferior military deterrent capability."

In what areas do the six candidates criticizing present Administration defense policies believe that increased spending is necessary?

Kennedy: In supporting the Senate's attempt to increase the Administration's defense budget by $1.3 billion, Kennedy advocated funds for "an airborne alert keeping 25% of our nuclear striking force in the air at all times . . . to step up our *Polaris, Minuteman* and air-to-ground missile program . . . to step up production of *Atlas* missiles to cover the current (ICBM) gap as best we can . . . to provide funds to augment, modernize and provide increased mobility and versatility for the conventional forces and weapons of the Army and Marine Corps."

Johnson: Lead the Senate forces attempting to increase the defense budget by $1.3 billion, and has consistently advocated modernization of ground forces and giving them greater mobility, acceleration of the ICBM, military space, anti-missile defense, and B-70 programs as well as acceleration of the ballistic missile early warning system.

Symington: Believed that an extra $3.5 billion should have been spent in FY '61 to increase our "airborne alert capability, modernization of our ground forces, continuation of manned aircraft development through the B-70 program; antisubmarine warfare capability; accelerated space development—*Midas, Samos,* and *Discoverer; Minuteman, Hound Dog,* and *Sky Bolt.*"

Rockefeller: Advocated "an additional $3 billion for immediate defense needs, including additional and improved bombers, airborne alert, more missiles, more *Polaris* submarines, and modernized equipment for our ground forces."

Stevenson: Endorsed the Democratic National Advisory Committee's recommendations for increased military spending.

The Vice President, in replying to charges that present military spending is inadequate, has said that "Administration critics in Congress take only a part of the picture when it should be viewed as a whole," and that as a whole, the Administration's budget provides for "no gap in overall deterrent strength . . . and is adequate to maintain that position in the future.

Mr. Nixon seldom gets specific. But in one rare example, he did defend the decision to retard the B-70 program: "I think the President's decision that we would continue it (B-70) on a research basis, making up planes in the future and then putting them into production only if we found that they would be an effective instrument in our arsenal, is a proper one. Because the choice is between the B-70 and between the missiles."

But the Vice President has also made it clear that he is not committed to the Eisenhower program in the future, and has intimated that he would make changes once he were President. "Because we're living in an age of rapid technological advantages and advances in military science, we must submit our national security program to a searching month-to-month re-examination in the light of any new technological development and of our best current estimates of military capabilities by any potential aggressor."

It is also apparent from the candidates' statements that some reorganization of the Department of Defense and NASA may come about under a new President.

Mr. Nixon's reorganization ideas are referred to above, and Sen. Symington's ideas about reorganizing DOD and setting up a unified space organization are well-known. While not as specific, the other candidates have proposed that studies be made and that the necessary reorganization indicated be effected.

Should the national defense posture be a campaign issue?

The Democrats and Mr. Rockefeller think so. Mr. Nixon does not.

Nixon: In October the Vice President said it would be "most unfortunate if Senator Symington or others should make defense a political issue . . . Debate on national defense "can be constructive, but criticism can be destructive when emphases on alleged weakness overlooks acknowledged strengths and has the effect of making the U.S. appear to be a 'sitting duck' for an aggressor."

Kennedy: In February, Kennedy said that the nation's ability to defend itself will be the "basic issue" in November's battle for the White House.

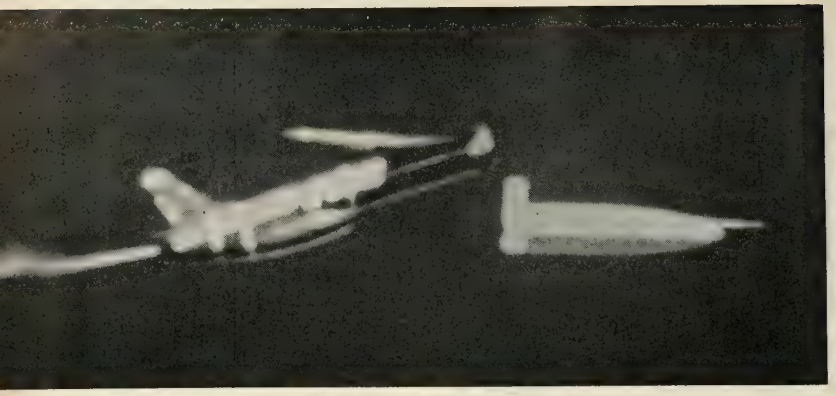
Johnson: Thinks the issue should be debated "fully, frankly, at length, and, I am sure, heatedly" . . . but with "all the maturity and the objectivity we can muster."

Symington: Has devoted a large portion of his campaign to the defense issue, and believes that it is one of the most important problems to be debated.

Rockefeller: Wanted the defense issue (as well as others) debated within the Republican party prior to the convention.

Stevenson: Made defense an issue in 1956, and since his views differ with the present Administration's on this subject, could be expected to do so again.

Snark Tosses Its Warhead . . .





FIRST PHOTOS of the SM-62 *Snark* releasing its nose cone toward a target. Frame of the 600 mph, 5000-mile missile turns upward after separation and is torn apart by air pressure to create confusing pattern on enemy radar. Now operational in the only planned squadron at Presque Isle, Me., *Snark* reportedly can carry up to 20 megatons. Warhead is released several miles from target and travels on ballistic trajectory. These photos were enlarged from motion picture film as the Northrop bird performed a test drop of a dummy warhead in the AMR near Cape Canaveral. Fifteen to 22 *Snarks* are now in combat status.

The Missile Week

Atlas To Be Zeus Target

Atlas has replaced *Jupiter* as the clay pigeon for the Army's *Nike-Zeus* anti-missile system. *Atlases* will be used during tests to be conducted in the South Pacific in late 1961 or early '62. The 18 *Atlases* DOD intends to purchase as *Zeus* target birds will be fired from Vandenberg AFB, affording Air Force training crews experience in firing the large ICBM.

The *Zeuses* attempting to intercept *Atlases* will be fired from Kwajalein Island—about 4800 statute miles from Vandenberg. Original planning called for Army-fired *Jupiter* missiles as targets—to be launched from Johnson Island in the Pacific. Approximately $7.5 million had been obligated for the *Jupiter* target birds.

The decision to replace *Jupiter* with *Atlas* raised the eyebrows of long-time Pentagon observers who remember the fierce fight the Army put up for its own missile program. The decision was made by Dr. Herbert York, DOD director of research and engineering. His reason was that the *Atlas* would provide the most "thorough test of the *Zeus* system, including such factors as re-entry velocity and associated factors such as payload capacity."

Minuteman Train Tested

The mobile *Minuteman* ICBM test train is out on a 7-to-14-day road test along the tracks of six different railroads in six states. The train's first run, concluded June 27, lasted a week. The trials are to test communications and the ability of the rails to support the trains.

Titan Blows Up

Titan billed as the first operational model to be flight-tested blew up in the attempt at Cape Canaveral July 1. The official Air Force statement said that the ICBM—which is to join *Atlas* in the operational ranks later this year—malfunctioned and was blown up by the range safety officer. This was to have been the first test of the modified *Titans* to be sent to Vandenberg AFB for use in underground launching silos.

Another Pershing Success

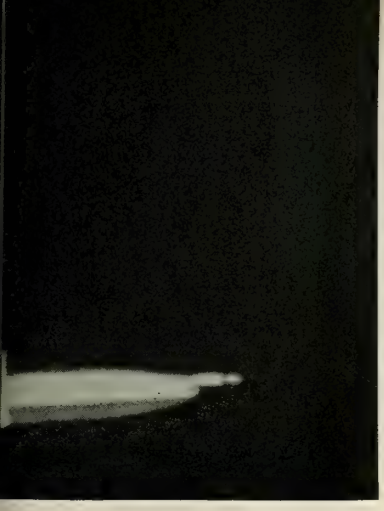
Pershing, the Army's solid-fueled successor to *Redstone,* was fired successfully from mobile equipment last week. The 400-mile-range missile's guidance system was set on an erratic zig-zag course to simulate the buffeting the weapon might get from severe upper-air winds during combat firing.

This was the sixth straight successful firing for the Martin Co. missile. The Army is campaigning to get *Pershing* adopted by NATO as the standard medium-range missile. Its competitor is the Navy's Lockheed *Polaris,* which was selected originally because it was the only missile available that met NATO Commander Gen. Lauris Norstad's specifications.

More Red Animals Recovered

The Russians are becoming adept at the trick of pulling rabbits and dogs out of missile nose cones which have just completed re-entry tests. Last year, the Russians announced that two dogs named Snowflake and Daring, and an unnamed rabbit, had been sent to "great height" by an IRBM and recovered with no ill effects. (See M/R, June 13, 1959, p. 45.) This year, preceding Soviet long-distance ICBM tests in the Pacific, the Russians announced that two dogs (one named Courageous) and another unidentified rabbit successfully completed a rocket ride to 130 miles.

Last year, the payload carrying the animals and their instruments was purported to weigh 4400 pounds, the largest object to have been thrown spaceward at that time. This year the payload was said to have weighed 4629 pounds.





Tiros I Winds Up Operating Life After Big Contributions to Science

Tiros I, the highly successful weather-eye satellite launched April 1, has reached the end of its operating lifetime after transmitting 22,952 pictures. More than 60% of these are good-quality cloud cover photographs useful to meteorological research.

The National Aeronautics and Space Administration said the data produced by *Tiros* has already made major contributions to the science of meteorology. One of the most important was the information on spiral bands and vortices in the atmosphere up to 1000 miles in diameter. Weathermen had no idea before *Tiros* of the frequency and extent of highly organized cloud systems associated with these vortices.

The weather satellite has also taken many pictures of jet streams, regions of moist and dry air, thunderstorms, fronts, and other meteorological phenomena. The U.S. Weather Bureau says *Tiros* data resulted in increased accuracy of reports on weather conditions, particularly over ocean areas.

Tiros—which was expected to have a life of about three months—actually operated for 78 days. On June 17, the wide-angle camera failed to turn off on command, apparently because a relay malfunctioned. As a result, batteries serving the camera and related equipment ran down.

After giving the satellite equipment a rest in hopes that the batteries might recharge, scientists made new attempts at interrogation on June 28 and 29, but without success.

The narrow-angle camera and the 108 mc tracking beacon remain operational. However, it is considered impractical to attempt to identify narrow-angle pictures without the use of wide-angle pictures for reference. These often include some easily recognizable geographic features which aid in orienting narrow-angle cloud cover photos.

Of the total photographs transmitted by the satellite, the station at Ft. Monmouth, N.J., received 17,449—4698 from the narrow-angle and 12,751 from the wide-angle camera. Kaena Point, Hawaii, received 5503 frames—1117 narrow-angle and 4386 wide-angle photos.

NASA plans to launch a second *Tiros* in the final three months of 1960. *Nimbus*, an advanced weather satellite, is scheduled to be launched in the last quarter of 1961.

Britain Plans Limited Effort in Space Race

Indications are that Britain will soon decide to join Russia and the United States in the space race, but with strictly limited objectives.

The initial emphasis will probably be on communications and weather-forecasting satellites.

Although *Blue Streak* has been abandoned as Britain's nuclear deterrent, work has been completed on the missile's No. 1 launching pad at the Woomera range. This is taken to mean that at least some of the completed vehicles will be fired. Plans under consideration involve expenditure of about $250 million over several years and conversion of *Blue Streaks* into two- and three-stage satellite launchers.

A team of British scientists, Aviation Ministry experts and Treasury officials is in Australia to discuss the future of the Woomera range. Until a decision has been reached on the space research programme, work on two other *Blue Streak* launchers has been suspended.

Computers for Mauler To be Built by Burroughs

An electronic computer system for *Mauler*, Army's mobile battlefield air defense system, will be developed by Burroughs Corp. under an Army Rocket and Guided Missile Agency contract just awarded. The computers will be designed to be transported by aircraft and dropped by parachute into battle areas.

The *Mauler* missile system is a compact, mobile weapon which will use solid-fuel radar-guided missiles to destroy short-range tactical missiles and low-altitude aircraft. Each *Mauler* unit will be entirely contained in a single vehicle designed to deliver accurate fire while moving over rough terrain.

NATO Supply Center Now Supports Nike, Honest John

The NATO Supply Center at Chateauroux, France, is providing support for the *Nike* and *Honest John* missiles now in use in the European NATO countries. This was disclosed at the same time that it was announced that first shipments of some $9 million worth of aircraft spare parts to Germany, France and Italy were made at the beginning of June.

The newly established Supply Center was formed by the NATO countries as a cooperative international logistics enterprise intended to improve the efficiency of support operations and to achieve economies. In addition to providing support for *Nike* and *Honest John*, the NATO Supply Center supplies and maintains NATO planes.

First Polaris Sub Tender Is Unique

by Charles D. LaFond

CHARLESTON, S.C.—The Navy's first *Polaris* submarine tender, USS Proteus (AS-19), was commissioned last week after a 19-month shipyard conversion of unprecedented magnitude and complexity.

The seagoing maintenance facility, capable of any repair or replacement—short of complete overhaul—for the nuclear sub fleet-to-be, will join the fleet operationally in early 1961. Meanwhile, she will undergo extensive shakedown cruises, starting next month, and equipment installation and checkout will continue throughout the rest of '60.

Although similar to conventional sub tenders in many respects, the oversized vessel has many unique facilities. These include a massive bridge crane to handle *Polaris* IRBM's, a 4-deck storage area for 20 missiles, a 120-ton container to store nuclear waste (spent elements), and a $5-million navigation system repair center.

Proteus and her successors (the AS-31 is now under construction at Portsmouth Naval Shipyard) will be an integral link in maintaining a large number of nuclear missile-packing submarines on station at sea.

• **Stern outdistances bow**—The lengthening of Proteus by 44 feet represents a fantastic achievement by the Charleston Naval Base shipyard workers. It also introduced a believe-it-or-not oddity in the reconstruction sequence: Proteus is probably the only ship in the world whose stern has travelled farther than its bow.

The vessel, in drydock, was cut in half. The stern section was then sealed and the dock flooded. While the bow section remained sunk, serving as a benchmark, the stern was floated down ways 44 feet.

The water was then pumped out of the drydock and the stern settled to the bottom within its massive chocks. Alignment of the two sections was well within tolerance—reportedly the stern was only 1/32 in. out of alignment.

Just floating the after end of the vessel was a difficult task, for its stability had to be determined without the aid of the ship's weight curve. Nevertheless, weight, size and unsymmetrical mass distribution were successfully surmounted. By June 8, 1959, the precedent-making relocation was accomplished—all within two days following application of the first cutting torch.

• **Expansion problem formidable**—In normal ship construction, variations in hull expansion and contraction is dissipated in each smaller piece as it is joined to the hull. But to join two massive hull sections in the middle introduces conflicting natural forces of movement.

The 30° daily temperature change was licked by combined tactics. Exposed hull and deck areas were painted white to increase heat reflection. Water was piped over these areas to further minimize heat effects.

Finally, one tenth of the welding job was performed at night in four hours to provide sufficient strength to withstand the expansion forces.

• **Shakedown in August**—First builder's sea trials were performed in April of this year and reoutfitting has continued ever since. The first shakedown cruise will begin August 1; sea tests will be carried out between Charleston and Cuba during the next few months.

The vessel when completely outfitted will carry an unusually large provisioning of electronic spares. Much of these will be for support of the complete navigation repair shop. Designed by Sperry Gyroscope Company, over $5 million in highly precise equipment for the repair and adjustment of SINS (Ship Inertial Navigation System) is housed in a 34 x 20 ft. room.

Duplicating everything carried aboard submarines plus simulation gear, Proteus' binnacle-mounted SINS—both types, Sperry Gyroscope and Autonetics Div. of North American Aviation—will serve as "standards" against which operational systems may be compared.

• **Proteus employment record**—The third U.S. Navy vessel to bear the name Proteus, the ship was formerly an AS-11 class tender. She was originally commissioned in June, 1944.

Mothballed in 1947, she had a 12-year rest at New London, Conn. In January, 1959, rehabilitation began.

Indicative of the stature of the "new" vessel is the recent assignment of Captain Richard B. Laning as skipper. He was the first commanding officer of the nuclear sub Sea Wolf.

POLARIS Submarine Tender Proteus (AS-19): Vital Statistics

Time Table

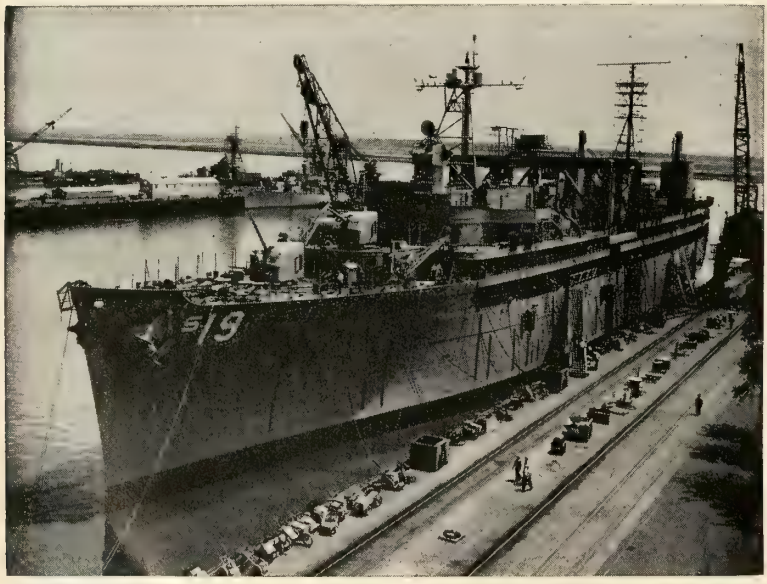
Navy Yard (Charleston) sea trial—*April 29, 1960.* **Inspection and Survey**—*July 6, 1960.* **Recommissioning**—*July 8, 1960.* **Basic facilities completed**—*July 24, 1960.* **1st Shakedown Cruise** *August 1, 1960 (Continual shakedown thereafter between Charleston and Guantanamo Bay, Cuba).*

Dimensions

Length: *573 ft., 10 in. (was 530 ft.)* **Beam:** *73 ft., 4 in. (was 63 ft.)* **Displacement** *(full load): 18,500 tons (was 17,200 tons).*

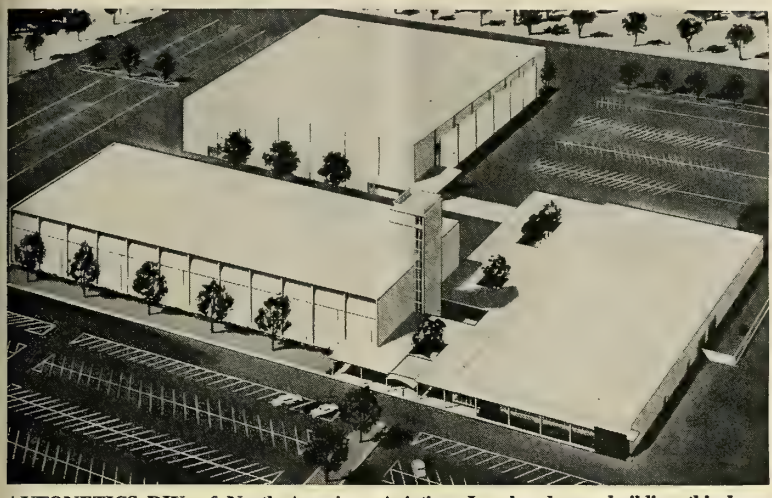
Ship's Complement

Officers—*45.* **Enlisted**—*850.* **Total Normal Complement**—*895. (Repair and Engineering Dept.—roughly 500 personnel).* **Total Reinforced Complement**—*1297.*



SUBMARINE REPAIR tender Proteus undergoes completion at Charleston Naval Base. The massive bridge crane above deck amidships will be used to handle 28,000-lb. *Polaris* IRBM's and a 120-ton nuclear waste container.

mergers and expansions



AUTONETICS DIV. of North American Aviation, Inc. has begun building this large electronics complex near Anaheim, Calif. The division's Armament and Flight Control Operations will be housed in three buildings totaling 400,000 sq. ft.

WESTINGHOUSE is expanding its West Coast facilities with a new Astro-electronics Laboratory, scheduled to start operations this month. The lab—part of the Defense Products Division—will be located in the Rancho Conejo light manufacturing and research center 40 miles northwest of Los Angeles. It will concentrate on developments in semiconductors, molecular electronics, thermoelectric devices, and sensing tubes for missile/space applications. Manager will be J. E. Darr, formerly electronic warfare projects manager at Westinghouse Air Arm.

TENNEY ENGINEERING, INC. has organized an Aerospace division to coordinate advanced R&D and initiate new programs. Tenney President Monroe Seligman also said that the new division would be available for contract assignments. PAM, an affiliate of the environmental test chambers manufacturer, has moved to larger quarters in Baltimore. PAM specializes in noise control and acoustic and vibration equipment.

CALLERY CHEMICAL COMPANY will establish a new R&D laboratory in Encino, Calif. The lab will conduct basic research on new energy source concepts, and other related propulsion and non-propulsive aspects of space technology.

M-H's BROWN INSTRUMENTS DIV. has created a planning and procurement department with William B. Shellenberger as manager. Shellenberger will continue to serve as consultant to the six-division Industrial Products Group on production planning and procurement.

INTERNATIONAL RECTIFIER CORP. has acquired Dallons Laboratories of Los Angeles through an exchange of stock. Dallons produces aerospace medical instrumentation for Project *Mercury*.

BENDIX CORP. and Telefunken GmbH of Germany have jointly formed Teldix, in Heidelberg, Germany. The new firm will handle R&D, manufacture, sale and service of aircraft systems and equipment, flight control equipment and navigation instruments, including airborne computers.

FANSTEEL METALLURGICAL CORP. has opened another semiconductor building to be devoted exclusively to the production of silicon rectifiers.

SOLAR SYSTEMS, INC. has been formed in Skokie, Ill., to manufacture silicon solar cells, silicon readout assemblies and silicon photocells. Jerome Kalman, General Manager, and Chief Engineer Walter A. Hasbach both were formerly with Hoffman Semi-conductor.

LAMART CORP. of Clifton, N.J., has moved to larger quarters in the same city.

LITTON INDUSTRIES INC. has purchased a majority interest in Fritz Hellige & Co., Gmbh, electronics equipment manufacturer in West Germany. Hellige will continue its present line of goods as well as produce Litton products for Germany.

AMPEX CORP. is considering merger plans with Telemetering Magnetics Inc., through an exchange of stock. Ampex would be the surviving company, giving one share for two shares of TMI stock.

AVIEN, INC. is finalizing negotiations to acquire Electrol, Inc., manufacturers of precision hydraulic components and systems for private, corporate and military aircraft markets.

JEFFERSON ELECTRONIC PRODUCTS, manufacturer of custom cables, harnesses and related devices for the missile industry has opened a jacketing site in Goleta, Calif.

EXPERIMENT INC., a Texaco subsidiary engaging in propellant research and development, has changed its name to Texaco Experiment Inc., and will be known as TEI.

RAYCHEM CORP. of Redwood City has purchased the Bentley-Harris Manufacturing Co., producer of sleevings and tubings for electrical insulation for 50,000 shares of Raychem stock.

LORAL ELECTRONICS CORP. has acquired Hillburn Electronics Products Co. of New York. Chief executive Bernard Gilman will remain with the company, which will be operated as a subsidiary of Loral.

FXR, INC. has planned considerable expansion of its Woodside, N.J., quarters. The firm recently moved its executive offices and some manufacturing operations to a 25,000-sq.-ft. new building adjoining its original plant, and this summer will finish a 100,000-sq.-ft. building across the street.

PACIFIC AUTOMATION PRODUCTS, INC. has expanded its Reliability Laboratory at Glendale, Calif. . . . Epoxylite Corp., moves to larger quarters in South El Monte, Calif., . . . Airborne Accessories Corp. has located its West Coast branch in a new office in Los Angeles . . . Sterling Transformer Corp. has moved to a new 18,000-sq.-ft. plant in Brooklyn, tripling its facilities . . . Tracerlab's Western Europe office located in Holland has been expanded.

Expert Advice on Diversification: Better Not Do It Unless You Have To

Lockheed's diversification chief calls it a last-resort strategy to be adopted only if nothing else works

Editor's note: The technological revolution in the aircraft industry in changing from manned aircraft to missiles has seen many airframe companies diversifying to meet the problems which have arisen. New firms have entered the field. Others on both sides of the fence still are considering diversification into or out of the industry.

Dr. H. Igor Ansoff has headed Lockheed Aircraft Corp.'s diversification task force for the past three years and has just been elected vice president for plans and programs of Lockheed Electronics Corp. In this article, condensed from a recent speech before the Los Angeles Chamber of Commerce, he gives his views on diversification and warns of some of the pitfalls.

by Dr. H. Igor Ansoff

The so-called airframe industry is having serious problems. It is going through a technological revolution, a change from air-breathing vehicles to rockets, which has made obsolete many of its skills. To meet this rapid obsolescence, firms in our industry need to diversify as a matter of simple survival.

Does this necessarily mean that diversification is the solution to all growth problems, that a firm should diversify regardless of its particular industry, or its position in that industry?

There is considerable evidence to suggest a strongly negative answer, that indiscriminate and unplanned diversification can do more harm than good. I'm reminded of a very successful firm, one of the 100 largest in the U.S. economy, which some 15 years ago decided to diversify in a major way into the defense industry. Over a short period of time, through a combination of acquisitions and reorganizations, this firm set up a very impressive complex of activities: an electronics division, a propulsion division, and a ground support division.

But something was wrong, some lack of a careful plan or a realization of its purpose, for in the past three years we have seen this firm gradually dispose of these activities to a point where now it is exactly where it started 15 years ago.

Here, as in all other phases of business, one man's meat can be another man's poison.

• **Most radical approach**—Diversification is one of four basic growth strategies which a firm can pursue.

One growth strategy available to a firm is to increase its share of its current markets. Another strategy is to develop new markets for the firm's present products. A third is to develop new products for the present markets.

Springs for Polaris



"HOT DOG" air springs will cushion the Lockheed *Polaris* missile during transportation and storage. The rubberized-fabric cushions—manufactured by Air Cruisers Division of Garrett Corp.—are installed in the bottom and overhead curvatures of *Polaris* transportation containers. They are inflated by simple inlet valves. Lockheed and Beech Aircraft have ordered nearly 100 pairs.

The fourth, and most radical, growth strategy is to diversify; to develop new products and to sell these to markets to which the firm has not sold before.

In market penetration, market development, or product development, a firm has a basic strength to carry over to the new endeavor. For example, in product development it has a knowledge of the customer, his requirements and his idiosyncrasies; in market development, it knows and understands the capabilities and limitations of its product.

• **A last resort**—In diversification, on the other hand, a firm is attempting to do something it has never done before. To be sure, diversification, when properly conceived, still involves a carryover of basic skills to the new endeavor, but this carryover is much weaker, less tangible than it is in the other growth strategies.

A basic operating rule, which I firmly believe to be the keystone to success in diversification, is:

"Don't unless you have to."

Do not undertake diversification until you have convinced yourself that the objectives of your firm cannot be met through the other growth strategies. Even then, diversification should be viewed as supplementary to the other strategies, a method for solving your firm's problems and not for running away from them.

• **Reading the handwriting**—Suppose that, after a careful analysis, you conclude that your industry is going to hell, or at least it doesn't have the characteristics needed to satisfy your growth ambitions. What do you do then? Under these circumstances, you find yourself faced with diversification outside the confines of your industry.

Or suppose that the firm's industry has passed into the maturity stage. It still appears to be doing well, in fact, trade periodicals predict a good growth rate for the next year and the year after. If the management of the firm is astute it will note however, that, while this growth rate is still high, it has

slowed down from the growth of the past; it will note disturbing signs of saturation of demand, needs for additional emphasis on product promotion, and appearance of substitute products.

This is the time for serious soul-searching on the subject of diversification. Many people in the top management, particularly those concerned with manufacturing and sales, will probably feel that the firm should not divert its resources away from a good market, that it should not spend money on product diversification or acquisitions while this money can still be spent profitably on present product improvement and merchandising.

It will take a great deal of foresight and fortitude to embark at this time on the expensive and risky course of diversification. As a matter of fact, this decision is so difficult that many very good firms refuse to see the writing on the wall until it is too late.

Some of you will recognize in this description several local important firms in the defense industry which had refused to see the writing which was there for all of us to see as far back as five years ago. These firms had some wonderful programs and they were busy, too busy to concern themselves with diversification. Now they have a very difficult problem of having to come up from behind.

And make no mistake about the difficulty. If you allow your firm to face a decline in sales before facing up to diversification, your management will probably be beset by self-doubt, you are likely to have financial problems, and you're not going to appear very attractive to a potential diversification partner. In short, you'll have to pay higher than the going price for any diversification move.

• **Impact of breakthroughs**—So far we have talked about reasons for diversification which can be inferred from economic growth data which is available in the form of industry, trade, and economic statistics. I would next like to touch upon a reason which is less tangible but no less potent. It is commonly known as a "breakthrough": a sudden and dramatic change in economy or technology which upsets the growth cycle of an industry and sends it into early maturity.

The last fifty years have witnessed many dramatic examples of such "breakthroughs": the impact of trucking and airline industries on railroads, of synthetic fibres on the textile industry, of television on the movie industry, to name just a few.

To a firm contemplating diversification, this means that even if it finds no concrete economic impetus to diversify, it may need to do so in order to reduce its vulnerability to potential breakthroughs. Whether the firm has this need depends on the breadth of its technological and marketing base. If it is a one product-one customer firm, it certainly needs to diversify; if, on the other hand, it has already prudently spread its product and market base to different product technologies and economic demand patterns, it can feel reasonably secure that no single breakthrough can seriously jeopardize its growth prospects.

• **Proceeding with care**—How does a firm maximize its chances of success in diversification?

First and foremost the firm must be very clear about its basic strategy, and it must relate this strategy to its needs. I know from my own experience that once you embark on a program, you become virtually besieged by well-wishing people who have just the right diversification opportunity for you.

You must know your requirements, you must know where you are going, and you must resist extraneous temptations. This is not to say that you have to be hide-bound by a set of rules, but you must avoid creating a hodgepodge of unrelated interests, rather than a well-rounded diversified company.

The choice is basically between what we at Lockheed have described as a *concentric* and a *conglomerate* strategy. In a concentric approach, a firm seeks opportunities with some measure of common thread, some business characteristics which will permit a *joint* utilization of resources between the old and the new business such as common research skills, or manufacturing techniques, or basic management practices. Concentric diversification thus holds a potential of what is commonly known as 2 plus 2 equals 5 effect—a combined business performance which is better than a simple sum of the two performances.

At the other extreme, the conglomerate approach places no requirements on the common thread and selects new business areas according to rules based on the economic characteristics of the new industry.

Whether a concentric or a conglomerate strategy is appropriate for a particular firm is a very difficult choice which is influenced by many factors: its reasons for diversification, urgency, capabilities of the diversifying firm, and management preferences. The investment community generally tends to favor companies which have taken the concentric approach. However, there are examples of firms which have made a very good thing of a clever conglomerate strategy.

• **Picking your spots**—Let me pass to the second requirement for success. It is essential to make sure that the economic climate of the new industry offers a potential for solving the firm's diversification problem.

If the firm is diversifying because of cyclical nature of its industry, it must make sure that the new industry is more stable; if it is seeking growth, it needs to be sure that the new growth perspectives are high enough to give it a desired average growth rate. Thus, if growth is its objective, it would make little sense for a locomotive manufacturer to merge with a manufacturer of railroad signaling equipment.

It has been a puzzle and a surprise to me to count the number of times Lockheed had been offered, in glowing terms, opportunities to enter either a declining or a dying industry.

• **Capability confusions**—The third and the most essential requirement for success is to be sure that you lead from strength. This requirement is particularly imperative when you seek to diversify through new product development, but it applies almost as strongly in many acquisition programs.

It can be fatal to confuse capabilities which a diversifying firm has in abundance with the capabilities which are required for success in the new field. A vivid example of such confusion is provided by the efforts at diversification by many airframe manufacturers at the end of World War II. You may recall that several of them tried to diversify by offering a variety of aluminum products to consumer industries. You may also recall that none of them succeeded.

In looking back on that experience, it seems apparent that the failure was due to a confusion between skills which these companies had in abundance and skills which were needed to make a success of their venture. To be sure, nobody can bend aluminum like we can bend aluminum in our industry, but advanced manufacturing skills have very little to do with success in consumer industries. Success depends on merchandising: distribution channels, competitive pricing, and aggressive product promotion. And the firms which were trying to sell aluminum skis, coffins, canoes, and wheelbarrows had none of these skills.

We have not discussed the choice between product development and acquisition, the techniques by which one selects a particular new industry, the problems of proper organization for diversification, nor several other relevant topics. I do hope, however, that I have been successful in sketching out for you the principal dimensions of the problem.

(Copies of the full speech by Dr. Ansoff may be obtained from the Lockheed Aircraft Corp., Public Relations Office, Burbank, Calif.)

Bendix cermets (ceramic-metallic materials) beat the inferno-like heat of rocket launching and re-entry. Sub-scale and full-scale motor tests, using the latest types of aluminized propellants, consistently show zero erosion in the throat areas.

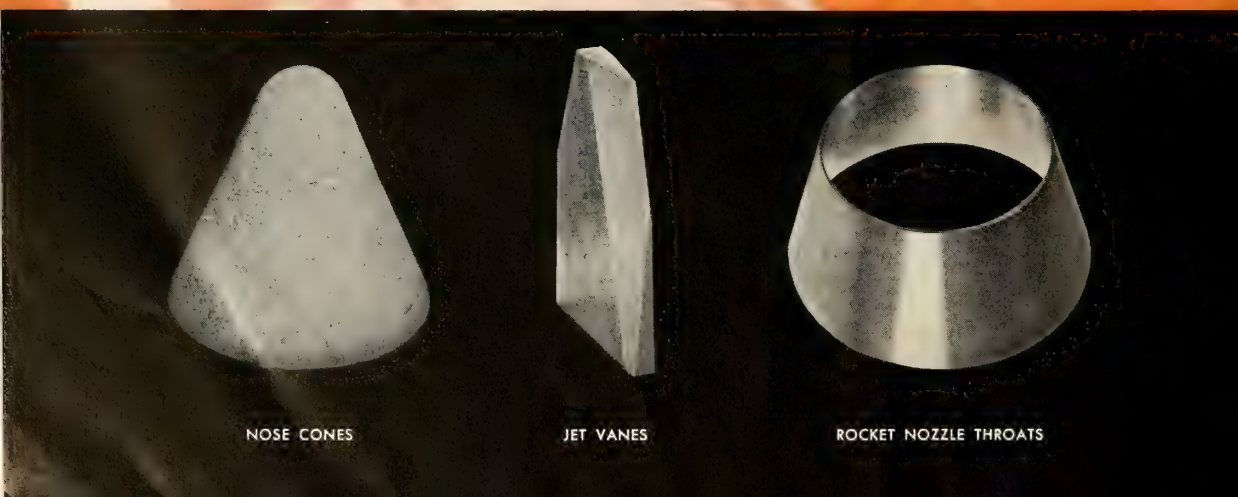
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NOSE CONES

JET VANES

ROCKET NOZZLE THROATS

ELECTRONICS

Computer Development to Leap-frog

IBM's next-generation computer should startle the entire industry. Expected to be ready in about two years, the new system promises to outperform today's best in solid-state high-capacity equipment. Size will be about 75% smaller than the highly touted 7090. The advancement will result from IBM's work in thin-film techniques.

Radar for Satellites

Radar for space reconnaissance is feasible, according to some researchers. They say a 200-lb. system with 300-ft. resolution at satellite altitudes could be built. Needed now is a program to put radar on space vehicles for experimentation.

Tracking by "Roberts Rumble"

A phenomenon known as "Roberts Rumble" may provide a method of tracking passive satellites. It was first noticed during early orbits of *Discoverer I;* scientists connected certain radio disturbances with passage of satellites through earth's ionosphere. General Electric is working on an AF contract to study the possibilities of using the effect to track and time non-transmitting satellites.

Tunnel Diodes for Computer Storage

Tunnel diodes may be the answer to problem of computer storage in the 2000-3000 bit range. Storage range is particularly troublesome because it is too large for standard shift registers and too small to be economically and physically feasible for drum storage.

New A-D Conversion Techniques

A unique hybrid computer converts analog to digital by multiplying the two together. Advantages are increased speed and accuracy.

Solar Mystery Investigated

A recent extremely severe radio blackout—without the usual coincident solar flare—has set Bureau of Standards solar researchers on a critical appraisal of current observation techniques. Further adding to the mystery is the fact that no major geomagnetic or ionospheric storms followed the radio disturbance.

Infrared

Infrared for USW?

Infrared continues to be mentioned as a practical method for airborne detection of underwater objects. While many seem to feel it has absolutely no application in USW, others refuse to discount its feasibility. It's a fairly safe bet that some top-level thinking is being centered on the possibility.

IR Sensitivity Multiplied

An infrared sensor tube 100 times more sensitive than any presently in use is reported to be in development. The advance is based on new materials processing techniques.

Sensor Has No Moving Parts

A new IR horizon sensor that contains no choppers or other moving parts is being researched by General Electric. An extension of its "Cat" family (Tom-, Bob-, and Wild-), the new sensor uses camera scanning to eliminate conventional moving components.

More Sensitive IR for Sidewinder

Newest infrared detector for *Sidewinder* is reportedly able to track on the skin temperature of a target. The more complex and sophisticated system would thus make the airborne missile effective for frontal attack, overcoming what has been its most serious limitation.

MATERIALS

Little Money, High Vacuum

A novel vacuum pump for environmental test chambers that can be built for less than $10 was disclosed recently by General Atomic scientists. Its theory of operation is not fully known, but the rugged device can draw a pressure down to 2×10^{-5} mm Hg. (See story, p. 28)

Money for Materials Research

Contracts totaling almost $14 million recently went out to three universities to set up laboratories for advanced research on materials needed for military purposes. The Pentagon awarded Cornell $6.1 million, U. of Pennsylvania $4.4 million, and Northwestern $3.4 million.

Distilled Refractory Metals

A distillation process is being adapted to refractory metals at the General Chemical Division of Allied Chemical. The process is part of the company's uranium hexafluoride production facility at Metropolis, Ill., a raw-material source for the AEC.

Radiation-sensitive Glasses

Lenses which turn opaque almost instantaneously after exposure to the flash of a nuclear blast are being researched at Bausch & Lomb. The "solid-state viewing device" would protect wearers' eyes from flash blindness and thermal burn from unexpected blasts.

PROPULSION

Variable-thrust Rocket Sled

Calibration of a missile guidance system at constant acceleration will be possible with a rocket sled designed by Aerojet around its variable-thrust (50,000-150,000 lbs.) engine. The sled will accelerate a 3000-lb. payload to more than Mach 2 and at a negative rate up to 20 g. Hypergolic propellants are N_2O_4 and UDMH. Area ratio: about 6:1.

Advanced Solids Research Contract Extended

Research on high-energy oxidizers for solid propellants has been extended at Allied Chemical. Redstone Arsenal granted the 12-month extension which bring the total funding for the two-year effort to $1.4 million. The nature of the work is classified, but it is known to include fluorine-containing materials.

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breaking the language barrier . . .

Auto-Translation Effort Lacks Focus

House Space Committee report scores failure to coordinate mechanical translation projects, predicts workable models by 1961

"And the Lord said, 'Behold, they are one people, and they all have one language; and this is only the beginning of what they will do; and nothing they propose will be impossible.'

. . . Therefore its name was called Babel, because there the Lord confused the language of all the earth; and from there the Lord scattered them abroad over the face of the earth."—Genesis XI

by Paul Means

The U.S. effort to overcome the language barrier in this post-Babel space era by developing an automatic mechanical translator is held back by lack of coordination.

This conclusion is reached in the House Space Committee's report, "Research on Mechanical Translation," and is also apparent from testimony taken by the committee.

Now is the time, according to the Report, to combine the good features of the various programs carried on by six government agencies, and to come up with the best workable program.

Under present scheduling, a machine rendering crude translations with some degree of accuracy will be available in 1961. An improved model should be ready by 1963.

A machine accurate enough and efficient enough to replace human translators, could be ready during the next five years.

To accelerate the program, the Committee has recommended:

- That more information be disseminated among the various governmental agencies and academic institutions conducting research in this area;
- That the National Science Foundation make a greater effort to establish a coordinated program;
- That the Department of Defense centralize the present efforts of the Army, Navy and Air Force in one service, "with the requirements of the other services being met by the responsible agency."
- And that serious consideration be given to the proposal made by Georgetown University mechanical translation experts to form a National Academy of Language Sciences, responsible for all of the mechanical translation programs.

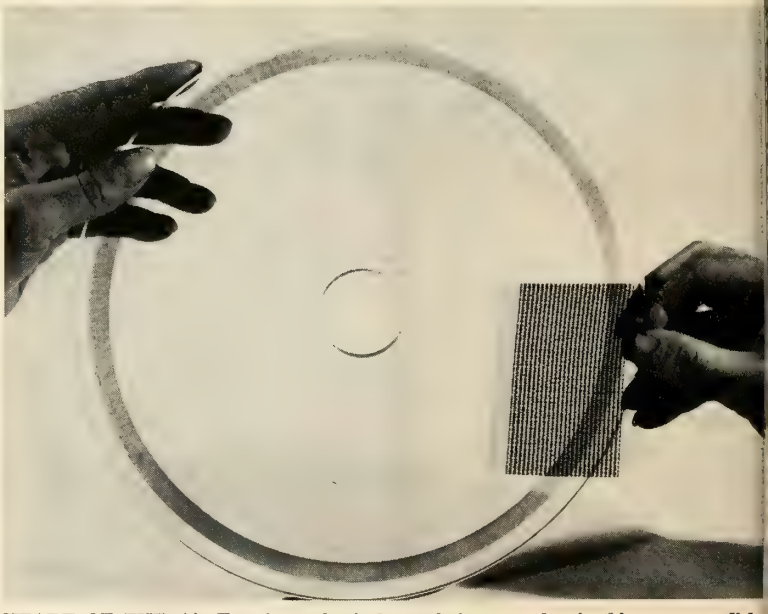
• **Big Russian lead**—The need for an efficient, accurate mechanical translator can be shown by comparing the annual available output of Russian scientific and technological literature (780 million words) with the amount that is presently translated into English (53 million words). In some areas, there is a five-to-eight-month lag between receipt of the Russian text and its translation and dissemination.

The Soviet Union maintains an information bureau manned by nearly 50,000 scientists, engineers, translators and librarians, 14,000 of whom are employed on a full-time basis. Th Soviet information center receive publications from 95 countries writte in 65 languages, and each day scan translates, catalogues and distribute 2500 to 3000 technical articles.

And the Russian effort takes o greater proportions when it is realize that a majority of Russian scientist and engineers can read English, bu only about 7% of American scientist read Russian.

• **Race for translator**—How fa along is the Russian program to buil a mechanical translator?

A CIA witness stated that "th Soviets have a program which con siderably exceeds our own in scop and size, and . . . they are doing ver good theoretical work, though restric tions on the availability of compute time has limited (their) opportunitie



HEART OF THE Air Force's mechanical translation complex is this memory disk.

o apply theory to practice."

Present U.S. efforts are being conucted by the National Science Foundation, the Central Intelligence Agency, he National Bureau of Standards, the rmy, Navy and Air Force.

Under provisions of the National Defense Education Act of 1958, the National Science Foundation was given he responsibility for coordinating hese activities.

According to the Committee's Report, the program being undertaken y the Air Force should produce the ost immediate practical results, and he program conducted by the Army n conjunction with the National Bureau of Standards has the most longange promise.

• **Difficulties**—One of the basic roblems in attempting to devise a ystem that will translate a foreign anguage into English and vice-versa s that the meaning of a single word an be confusing even to a human ranslator depending on its form and ts position in a sentence.

For example, the English word b-o-r-e," can be (1) a noun describng a feature of a gun; (2) a noun haracterizing a certain type of human eing; or perhaps (3) the past tense f the verb "to bear," which in itself as various meanings.

There is the added difficulty of levising a system which can transfer he foreign language text to the transator, and then receive its output of English text.

The three basic elements of any nechanical translating system are: inut, logical processing, and output.

The bulk of present research is centered on the logical processing phase of the system, according to the report "as the input and output problems are mainly of a technological nature."

Almost all of the present programs use high-speed computers to store the information, though many different systems have been devised as to what information should be stored.

Input to the computer presently is handled by punching the foreign text onto cards, but future systems will use optical print readers in order to increase speed.

There are many commercial products capable of providing a high-speed output for printed text. The task is to combine the high-speed output with the original equations, charts, graphs, and pictures, so as to maintain the format of the original text.

A review of the current programs, and the various approaches taken follows:

• **The National Science Foundation**—While not conducting "in-house research," the National Science Foundation is sponsoring a research program through grants to various academic institutions.

1. Massachusetts Institute of Technology—Begun in 1954, the MIT program has made advances in the areas of generative grammar and the theory of grammatical transformations, making possible more precise descriptions of language, and shedding light on the relationship of syntax to some aspects of meaning.

An early effort at MIT showed the necessity for sentence-for-sentence rather than word-for-word translation.

The MIT group has prepared detailed grammars of English, German and French, and has devised techniques for the translating (computing) machine to aid in their research.

2. Georgetown University—One of the pioneers in the mechanical translating field, Georgetown in conjunction with International Business Machines has carried three experimental procedures for translating Russian texts on organic chemistry to the point of testing them on computers.

One of these methods dealt primarily with the analysis of Russian syntax; the other two were aimed at actual translation. These methods were able to produce a crude output in English words, which, though subject to error, could be generally understood.

Presently, a corpus of 268,000 running words has been used in preparing a dictionary of 10,800 entries. Some 115,000 words of Russian text have been processed by the computer.

A code-matching technique recently devised by Georgetown is being continued by the Corporation for Economic and Industrial Research, and the experimental procedure for analyzing Russian syntax is being continued by Thompson Ramo Wooldridge.

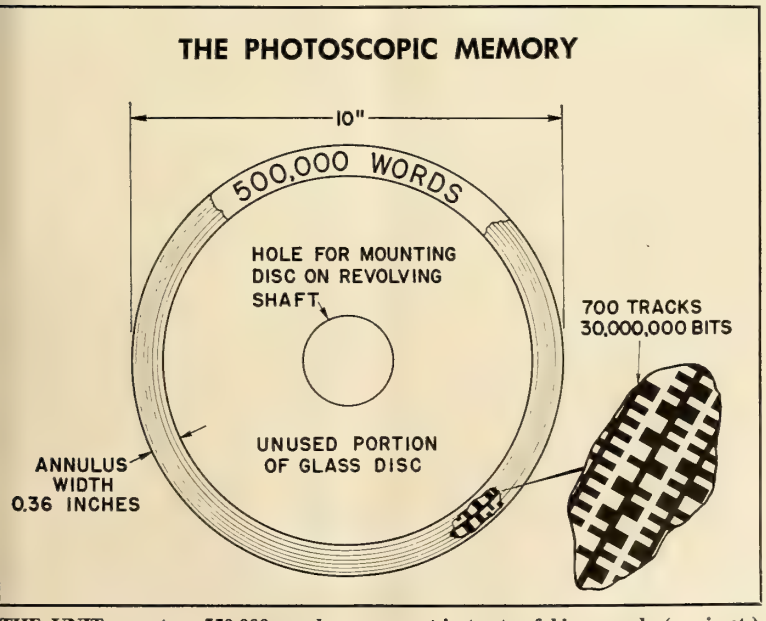
3. The Cambridge Language Research Unit—Principal study has been devoted to the ways that words are semantically related to each other, and transforming these relationships into a specialized mathematical system.

4. Harvard University—During the first two years of research, programs for the computer were written to permit the operation of an automatic dictionary containing about 15,000 words.

The programs make it possible to recognize any of these words in any one of their forms, enabling the processing of more than 150,000 distinct Russian word forms.

This automatic library has been used to produce word-for-word translations of scientific Russian texts, which are not true translations since they fail to take account of the grammar, but which have proved useful for some purposes in lieu of actual translations.

5. University of California, Berkeley—Concentrating on the field of biochemistry, a system has been devised which includes (1) a segmentation system for splitting Russian words into component parts; (2) a coding system for Russian grammar; (3) a Russian-to-English dictionary with a vocabulary coverage of over 300,000 words; (4) an automatic dictionary which can look up and segment at a rate of 7500 words per minute when used on an IBM 704 computer; (5) a system for analyzing Russian text; (6) a linguistic data-gath-



THE UNIT can store 550,000 words on concentric tracts of binary code (see insets).

The Mechanical Translator Budget

	All Prior Years	Present Year	Next Year
ARMY	$ 109,000	$ 170,000	$ 225,000
NAVY	50,000	50,000	70,000
AIR FORCE	3,400,000	1,400,000	1,500,000
CIA	315,000	177,000	922,000
NSF	1,063,300	325,000	490,000
TOTAL	4,937,300	2,122,000	3,207,000

ing program for obtaining information from analyzed text by means of an IBM 704; (7) a system for coding Russian scientific text for input; and (8) a method for automatic parsing of Russian text.

Central Intelligence Agency—First government agency in the mechanical translating program (1952), the CIA has supported the efforts of Prof. Leon E. Dostert at Georgetown Univ. (See preceding).

Of particular interest is the Georgetown experimental system developed for French-to-English translation which has been brought to the point where French nuclear physics texts can be converted into English words which in many cases convey the thought of the original.

• **Army**—Two projects are presently being supported by the Army, the first of which, according to the Committee's report, has the most long-range promise:

1. National Bureau of Standards —Under the direction of Mrs. Ida Rhodes, this Army-financed project is making a program for machine translation of Russian to English by a method called predictive analysis. An operating model should be ready by 1963.

According to a description in the report, "Russian words have many 'handles'—prefixes, affixes, grammatical endings and especially word agreements. A machine can be programed to identify these 'handles' and make predictions of what else must be in the same phrase, clause, or sentence. If it doesn't find them, it stores the predictions and goes on with an eye cocked. If there are multiple choices, the machine makes a choice but stores the other choices to try if the first proves wrong.

"Some predictions must be fulfilled such as having a subject and a verb, expressed or implied. Others may be fulfilled or may not. When the machine reaches the end of a sentence, it examines its hindsight pool where unfulfilled predictions are stored. If it finds any that are labeled 'must be fulfilled,' then it knows that the translation is probably faulty."

At the present time, according to Dr. Edward W. Cannon of NBS, this system is "able to cope with the syntactical aspects of the mechanical translation problem" though "we wish we could say as much for the semantic or multiple meaning aspect."

The final translation, according to Dr. Cannon, will be "quite inelegant, . . . even in pidgin English," but "we do feel that the crude translation yielded by our method will give the reader a correct image of the meaning in the foreign text."

2. University of Texas—Under the direction of Prof. W. P. Lehman, the Texas project is a long-term research effort based on computer analysis of parallel German and English texts.

Described as a tedious, systematic, objective approach, this system examines the parallel text in German and English and derives rules for translation by means of the computer.

The advantage of the system is that it is equally applicable in either direction for a pair of languages.

• **Navy**—Research in machine translation of a general critical nature at Hebrew University in Israel and at Wayne State University is being supported by the Navy.

The Wayne State group is attempting to program the translation of mathematical literature from Russian to English.

• **Air Force**—The Air Force is conducting a large program in mechanical translation at ARDC's Rome Air Development Center which is equipment oriented, with the objective of attaining a complete automatic language translation complex.

This program includes development of input, processing, and output machines, and integration of these units should be accomplished by the fall of 1961.

Principal contractors in the Air Force program are Indiana University, Thompson Ramo Wooldridge Inc., University of Washington, Syracuse University, IBM, Baird-Atomic, Inc., University of Milan, Italy, Intelligent Machines Research Corp.

The greatest effort is with IBM, and has resulted in an experimental model of a "fully automatic dictionary look-up technique," which "accepts Russian word input, searches for the English equivalent, and produces these English equivalents at the rate of a proximately 30 words per second."

Key to this system is a glass di storage device invented by Dr. Gilbe King of IBM. (See picture.)

Input into the Air Force unit, t fastest yet devised, is accomplished b an optical print reader developed b Baird-Atomic Inc. This unit is capab of recognizing and distinguishing large number of different type fonts i various alphabets, including Englis Cyrillic, and Greek characters.

The reader has recognition capabi ity independent of the spacing betwee lines, the position of the text on th printed page, and the occurrence c randomly interspersed graphic materia

The present design objective is t provide an instantaneous reading rat of about 1000 characters per second and is accomplished by an optical sys tem permitting comparison of an un known character, printed letter or num ber simultaneously with each of a larg set of reference characters.

The text is fed into the reader or film, and is fed out into the compute on magnetic wire.

Any words which cannot be found in the lens disc dictionary are converted from Cyrillic to Arabic alphabet and bypassed to the output, which prints it in red. Thus the output copy shows all transliterated words in red and the translation in black.

• **Unification**—As the descriptions of the various programs would indicate, there are areas in which the independent research overlaps.

Many of the technical witnesses from the various projects working on the problem of mechanical translation either did not know the details of the competing projects or had misinformation about them.

This slowed up the entire effort, the Report states, because of duplication and research into problems which have been solved elsewhere.

The Report points out, for example, that the equipment-oriented Air Force program "provides a unique tool for the checking out of the complex fully automated system of input, logical processing, and output. This program provides for the inclusion of modification derived from other research as the results are made known to the overall mechanical translation family."

"With so many government agencies conducting research in this field," the report warns, "it will eventually make coordination of the total effort more complicated . . ."

"It is now time for the mechanical translation research community to start combining the good features of the several programs and come up with the best workable program for the first application," the report concludes.

Colloids May Cut Space Travel Time

Little-discussed acceleration of particles provides thrust superior even to ion propulsion for a trip to Mars

by Milton Farber and Stanley Singer*

PASADENA, CALIF.—A relatively unexplored concept, the electrical acceleration of colloidal particles, gives promise of bridging the gap between the chemical and other varities of electrical propulsion.

Colloid propulsion provides higher thrusts than other electrical methods with equivalent consumption of power. And like all electrical systems, its specific impulse is much greater than liquid or solid chemical systems or nuclear propulsion with a chemical working fluid.

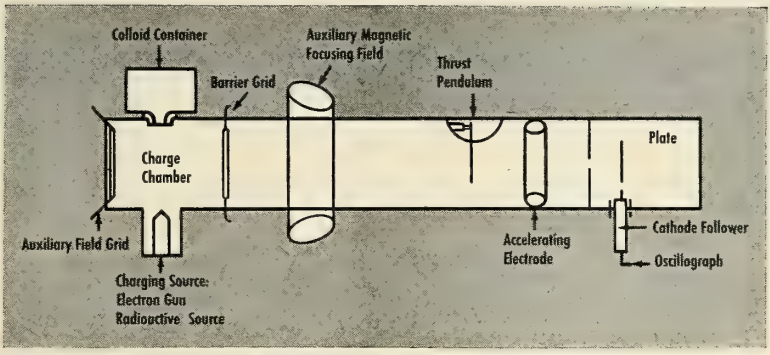
The specific impulse of colloids, although greater than for chemical or nuclear systems and approximately equivalent to the arc jet and magnetohydrodynamic methods, is not as great as that obtained with ion devices.

For example, here are the relative propellant requirements for a 5-lb.-thrust device, which would give an acceleration of 10^{-4} g to a 50,000-lb. vehicle:

Method	Specific Impulse (seconds)	Mass Flow rate (lbs./sec.)
Ion	10,000	5×10^{-4}
Plasma Jet	2000	2.5×10^{-3}
Colloid	1500	3.3×10^{-3}

An advantage often cited for electrical systems such as ion propulsion is weight economy on a long space flight —for example, a trip to Mars. Because of the high specific impulse of the ion system, less propellant is consumed than if chemical propellant is used in a high-thrust burst of power at the beginning of the journey.

• **Shorter journey**—The advantage of high thrust, of course, is that it shortens the journey somewhat—an important consideration both from the standpoint of any passengers aboard and the operating lifetime of the equipment.



SCHEMATIC OF an experimental colloid apparatus designed by Rocket Power/Talco, to allow determination of charge-to-mass ratio and available thrust.

Our calculations show that a shorter trip time to Mars is possible with colloid propulsion than with an ion system, since the thrust is higher. If we assume complete consumption of the colloid propellant on the trip to Mars, a comparable ion vehicle with exactly the same mass of propellant would continue to accelerate as far as Jupiter.

The difference between any two electrical propulsion systems in the results shown in the following table is partially obscured by the fact that both begin from an orbital velocity that is generated by another means. However, given comparable conditions, the colloid rocket will enable a vehicle to reach Mars sooner but the ion rocket will require less time for a trip to Jupiter. Here, for example, are flight times for missions to Mars and Jupiter for a 100,000-lb. vehicle powered by a system drawing 100 kilowatts with just enough propellant aboard to keep the colloid rocket accelerating all the way to Mars:

System	Thrust (lbs.)	Days to Mars	Days to Jupiter
Colloid	2.5	44	344
Ion	0.6	53	300

The advantage in specific impulse that all electrical systems have over chemical propulsion is due, of course to the high exhaust velocity of the ejected particles. This results in turn partly from the small size of the particles. Colloidal propulsion, however, is based on particles much larger than individual ions. Charged colloids are electrically charged smokes or fogs produced from particles with diameters varying from 10^{-7} to 10^{-4} in. Thus their velocities in a given electrical field are much smaller than those of ions and individual molecules.

Here is a table that indicates the position of colloids with respect to present and future propellants:

Rocket	Specific Impulse
V-2	225
Advanced Chemical	300-350
Nuclear with Chemical Working Fluid	300-800
Colloid	500-2500
Plasma	1500-5000
Ion	5000-10,000
Photon	1,000,000

All the electrical methods of propulsion—use of neutral plasmas, ions and charged colloidal particles—have been considered theoretically and, to a limited extent, experimentally. However, the electrical propulsion rocket is

* *The authors are with Rocket Power/Talco Research Labs. Pasadena, Calif.*

of necessity bulky when constructed with components fabricated according to current technology.

Charged colloids present a means of effective application within the limitations now faced. They appear to present the most readily developed electrical propulsion method available at present to bridge the gap between advanced chemical propellants and the ion motors under study.

• **Powerplant limitation**—The use of electrical propulsion methods introduces characteristic problems in addition to the usual one of propellant selection. Some of these result from the use of a power source independent from the working fluid. The high weight of powerplants presents a marked limitation; the total flow and beam density of a current of charged ionic particles is limited; and the generation of plasmas or ions involves problems of high temperature, power utilization and ionization.

Power sources available at present or in the near future supply a relatively low quantity of power per unit mass (specific power). Existing units supply somewhat less than 0.1 horsepower per pound (ca 0.1 watt per gram).

Since the ion current which provides thrust is a function of the power available, ions exhausted with limited power have low velocity. In similar terms, inadequate thrust is provided for a vehicle of large mass resulting in great part from the mass of the power source. This appears to be the most significant limitation for electrical propulsion at present.

This is particularly true of the plasma jet, a method of electrical propulsion in which a neutral fluid is generated by heating a metallic or gaseous propellant to a high temperature. Consequently, the working fluid includes significant concentrations of electrically charged ions and electrons. This plasma of neutral gas and electrically-charged particles permits magnetohydrodynamic control with which additional performance is obtained. Although a high specific impulse is obtained by this method, a large amount of power is necessary to produce the plasma.

In ionic propulsion the magnitude of the ion current which can be obtained is determined by the accelerating voltage and the current density. The current density, ie., the cross-section of the ion-beam, is limited by the total electrical charge produced in the beam.

This "space charge" limitation, although directly related to parameters determined by the powerplant, does not appear as serious as the lack of suitable power plants. The ion currents available with the low power obtained from present or foreseeable power sources can be readily utilized within space charge limits.

• **Charge-to-mass ratio effects**—The performance limitations for ionic propulsion can be mitigated by use of appropriate propellants. Since the power available is low and the density of charged particles of like sign in the ion beam is limited, reasonable thrusts must be obtained by using particles which provide a high mass flow in a relatively low current.

This goal is achieved by use of particles with a low charge-to-mass ratio. Monatomic hydrogen and cesium ions present readily available examples of the wide variation in this parameter. Both elements provide monopositive ions, the first with an atomic mass of approximately 1, the second with a mass of 133. To obtain high thrust with limited current it is apparent that the higher ionic mass is desirable.

An extreme variation in the charge-to-mass ratio can be obtained by using particles ranging from electrons to large colloids. Protons (2.9×10^{14} esu/gram) can be generated efficiently in a suitable ion source, and simple atomic ions such as cesium 2.2×10^{12} esu/gram) can be obtained readily in pure form from application of the work function for ionization on metallic surfaces. Colloidal particles have been obtained with charges on the order of 10^5—10^7 esu/gram. Therefore, the size of the charged colloid particle is on the order of a million times greater than the cesium ion.

Ionization of atomic and molecular propellants is achieved by two general methods. In thermal ionization, a metal, usually an alkali metal such as cesium, is converted to its ion by contact with a hot metal surface, such as tungsten. This method is most effective with readily ionized metals as propellants. Specific ionizing surfaces are necessary even at temperatures of 1500°K.

Ions can also be prepared by placing propellant material in an electric arc. Accurate placement and stabilization of the arc, which is essential to most promising acceleration systems (and ion optics) is difficult, requiring auxiliary magnetic or electrical fields. However, the arc is very effective at causing ionization. Voltages considerably higher than the minimum ionization potential of the ionizing material are required to establish the arc. The power requirements of both contact and arc ionizing sources in practical form for rocket propulsion would be high, especially for start-up.

• **Application of Colloids**—The advantages of colloidal propellants may be compared briefly with other electrical and "thermal" working fluids. On the basis of preliminary consideration of available materials, potential power sources, accelerating devices, etc., it seems clear that such propellants are the most readily developed working fluids for electrical means of reaching reasonable velocities for certain interplanetary flights.

Colloidal propulsion appears most likely to permit attainment of both sufficient thrust level and high exhaust velocity to allow flight in moderate gravitational fields and reasonable flight times for interplanetary trips. The colloid rocket gives many variables adjustable to a specific rocket mission. Since any substance can theoretically be dispersed as a colloid, many materials are potential propellants.

Obtaining low charge-to-mass ratios with ionic colloids apparently presents no difficulty. Charge-to-mass ratios which are excessively low may actually be obtained, resulting in low exhaust velocities. It should be noted that a range of ratios is provided by control in charging a single colloidal material, as compared to charging atomic or molecular ions with which only a given ratio can be obtained. Ability to vary the charge-to-mass ratio in flight may prove desirable for certain trajectories. An additional advantage of charged colloids for electrical propulsion lies in their exit from the rocket at low current density so that the problem of neutralization of the particle in space is minimized.

The colloidal material can be prepared for use by several methods. Chemical reactions (including photochemical) frequently provide colloidal products dispersed in a gas phase. Condensation of vaporized metals, liquids, or sublimed solids are also suitable. Fine dispersions may be prepared by spray atomization of liquids and by applying an electrical potential to either liquids or solids.

• **Gold as propellant?**—For rocket propulsion, a powder of colloidal dimensions may be carried in the vehicle. It is desirable to have small particles in order to obtain high velocities. Colloids have been reported with radii ranging from 10^{-4} cm to 10^{-7} cm. The unusually uniform polystyrene spheres useful as dimensional standards in electron miscroscopy are approximately 10^{-5} cm in radius, and gold particles with radii somewhat less than 10^{-7} cm have been prepared.

Force Field Shows Propulsion Promise

SAN DIEGO—A promising research approach to force field propulsion is reported by the Electronics Div., Ryan Aeronautical Co., San Diego, Calif.

The system is being studied for possible application in a series of manned watch satellites for detection and intercept of hostile ICBM's.

Martin N. Kaplan, a senior research engineer at Ryan Electronics, does not think present-day chemically fueled rockets have the duration required for an orbital mission. More exotic propulsion methods—nuclear, ion or plasma-type systems—can be ruled out because of weight or very low initial velocities, he says.

The need, according to Kaplan, is for a new approach to propulsion which would furnish very high speeds along with high initial velocities and long duration.

Ryan research in force fields is running along two paths that "look promising." One is termed "unified field theory," the other a "quantum mechanical theory of free space." The latter approach, derived from a quantized model, has led to successful experiments, Kaplan says. Additional experiments are being set up.

A more comprehensive research program is planned which, if successful, will produce either "restricted" or "general" results. Either would be a revolution in propulsion.

Restricted results might be dubbed antigravitation. This would permit an acceleration force which could be directed only toward, or away from, a second body. A general result would permit a reaction against free space.

The general result is anticipated. But this would still require one major breakthrough—development of a means of converting potential energy (perhaps nuclear) to kinetic energy in the form of a rectilinear momentum without expelling mass. Such a breakthrough seems possible, Kaplan believes, when there is a better understanding of the mechanism by which matter is converted to energy.

• **100-g acceleration**—In practice, the thrust produced by engines of this type would be directly proportional to their energy conversion rates. Neglecting energy losses, the vehicle's rate of change of momentum would be limited only by its peak energy conversion rate.

Kaplan believes these conversion rates could be safely employed to achieve space accelerations of 100 g or more. This is not so fantastic when compared to recent ultracentrifuge tests which have produced reactions against space of nearly 500,000 g. Once requirements for rectilinear reactions against space are discovered, 100-to-1000-g propulsion should be attainable.

A complete cycle of acceleration and deceleration at 100 g would take a vehicle from the earth's surface to a 1000-mile altitude in 80.8 sec., disregarding atmospheric drag. Although this extreme acceleration rate might be no problem for the vehicle structure, it would hardly create a friendly environment for its occupants or their instruments.

The same principle used for vehicle propulsion could be used to give the vehicle's occupants a g-controlled environment of a less disastrous character.

• **Putting it to work**—So where's the practical use if it all works? Kaplan proposes a system of six "stacked" counterorbiting fleets of 24 manned ICBM detection-pursuit vehicles per orbit and counterorbit. Vehicles in each orbit (12 in each direction) would be spaced about 2075 miles apart. Each fleet would patrol an area at least 2000 miles wide, extending completely around the world. Thus, 144 patrol vehicles would have to be in space at all times to give continuous early warning coverage of the entire earth's surface.

If, for some reason, orbiting vehicles could not be used, the vehicles might be placed in a hovering position, deployed to form a space blockade about a potentially hostile power.

The early warning system could double as repeater stations in closed communication links, separated by slightly over 2000 miles. Tandem vehicles of each orbit, or the vehicles of a hovering blockade, would be within line-of-sight of each other. Thus, they could relay information originating in any one station or from an earth station in contact with any one space point.

Method in Madness



BULGES AND BUCKLES with a purpose were built into this room at Republic Aviation's new Farmingdale, N.Y., Research and Development Center. Gibson-Girl build of walls makes almost completely echo-free environment for testing antennas.

Do It Yourself: A $10 Vacuum Pump

Phenomenon still not entirely understood has been harnessed by two researchers to provide a low-cost lab system

by William Beller

Two researchers have hit upon a cheap substitute for usually expensive laboratory diffusion pumps.

You have to build it yourself. The cost: less than $10.

Its an "ice-pumping" system. Its discoverers aren't quite certain why it works. But they report it can rapidly bring a chamber down to 2×10^{-5}mm Hg pressure.

The discovery is a by-product of some basic research for the Air Force Office of Scientific Research.

W. L. Fite and R. T. Brackmann of the General Atomic Division of General Dynamics were studying the effects of bouncing a beam of hydrogen molecules off very cold surfaces. The men noticed that when hydrogen particles and water vapor simultaneously hit a cold surface, the hydrogen was not reflected. Instead, the gas stuck to the surface.

This was true even though the surface's temperature was considerably higher than the boiling point of the hydrogen.

Seeing that the gas was being "pumped" out by a condensing water vapor, the experimenters asked whether nitrogen might behave the same way. If it did, then a new and exceedingly cheap way of getting a vacuum was at hand. The nitrogen experiment gave positive results.

• **Phenomenon not understood**—Later work showed that relatively crude equipment could replace diffusion pumping by the condensing water technique, "ice pumping." The pressure could be reduced to 2×10^{-5}mm Hg.

All the system needed for pumping air was an aspirator costing about $2.00, a nitrogen trap for $5.00. 10 cents worth of liquid air, and a clothespin if a hose clamp were not handy. Total cost: $7.10.

Why the system works is not fully understood. However, at least two phenomena are believed to be involved. The first is the brute force trapping of air molecules by the condensing water vapor. This is a very rapid pumping action.

The second action is a slower one. Here the air is pumped by a surface of stationary frost just sitting in the vacuum. This may involve an equilibrium condition. It was noticed that after the water vapor was taken out by freezing, the pressure slowly crept upward unless the ice were isolated from the rest of the system.

Diffusion pumps are normally used to push pressures below 1×10^{-2}mm Hg. These pumps spray either a mercury or an oil vapor to carry away a volume of gas particles that have drifted out of the chamber being evacuated. The vapor's action is similar to that of rain cleansing the atmosphere of dust.

In practice, the exhaust from the diffusion pump is led into the inlet of a mechanical back-up pump. This last pump is needed to provide the intermediate operating pressure the diffusion pump requires.

To get extremely low pressures, technicians hook two or more diffusion pumps in series. A cold trap between the chamber and the pumps is generally installed to thwart any migrating oil or mercury vapors.

• **Helium takes out H_2**—The ice pump can take pressures below 1×10^{-2} mm Hg without using diffusion pumps or associated equipment, according to the experimenters. It can get these pressures by using a few pieces of generally available laboratory equipment.

In the method disclosed in the patent application by Fite and Brackmann, a closed system is first partially evacuated to a few millimeters of mercury. Then the system is opened to a surface that has been cooled below the freezing point of water.

For best results, the surface's temperature should be brought down to roughly the boiling point, at atmospheric pressure, of the lowest boiling point gas that is to be removed from the system.

Water vapor is then ejected into the system, or it may be that enough water is already present. When the water freezes upon contact with the cold surface, the system's pressure will be materially reduced.

For example, suppose air is to be removed from a chamber. Then communicating with the chamber, perhaps by way of a glass hose, would be a relatively small cooled surface. Conveniently, the lower part of the surface, (the one not open to the chamber's atmosphere) would be soaking in a bath of liquid nitrogen.

If the system contained large quantities of hydrogen, the cooled surface would have to be in contact with liquid helium. This lower temperature would then be in the area of the boiling point of hydrogen.

If enough water vapor is present, the continuing condensation will bring the chamber's pressure down to the range of 2×10^{-5}mm Hg. This reduced pressure is of far greater magnitude than can be attributed to the removal of the water vapor alone.

• **Water is injected**—Explanation of the phenomenon does not lie in the cooling effect exerted by the surface on the chamber's atmosphere. This effect is limited to the gases in the immediate neighborhood of the surface, which leaves most of the contained gases very close to ambient temperature.

Except for water and carbon dioxide, the dew points of the gases at the reduced pressure in the chamber are still well below the temperature of the cold surface. Thus the pressure reduction can not be explained on the basis of condensing the residual gases.

The experimenters empirically discovered that to get a pressure in the range of 2×10^{-5}mm Hg, the system should contain about 50 molecules of water for every molecule of non-condensible gas present before the ice deposition begins. This calls for supplying water to the system. One way to do this is to inject water before the evacuation begins; another, to inject the liquid during evacuation.

In one method (see Figure 1), a chamber is first reduced to a pressure of about 5 to 1×10^{-2}mm Hg by a mechanical pump. Then a valve isolates the pump from the rest of the system.

A series connection runs from a water reservoir, past a cold surface, and into the chamber. The surface is

There've been some
CHANGES....

A new name and a new organization have been established for a well known defense team!

Bell Aircraft's military and government products operations, founded 25 years ago, now form the new Bell Aerospace Corporation, a wholly-owned autonomous subsidiary of Textron Inc.

Each division of Bell Aerospace takes on new breadth under this new arrangement...new capacity for research and development, new operational stability and new resources with which to work efficiently and economically with civilian and military contractors.

Bell Aerospace has strengthened its management and improved its production capabilities while retaining the scientific and technical personnel and facilities of the three former Bell Aircraft defense operations. These divisions, each prominent in its own right, are:

Bell Aerosystems Company (Formerly Bell Aircraft's Niagara Frontier Division), Buffalo, New York, a recognized leader in the diversified fields of rocket propulsion, avionics, aircraft and space techniques and systems.

Bell Helicopter Company, (Formerly Bell Helicopter Corporation) Fort Worth, Texas, pioneer developer and one of the world's largest producers of rotary wing aircraft.

Hydraulic Research and Manufacturing Company, Burbank, California, outstanding designer and builder of electro-hydraulic servo control systems and valves for advanced aircraft, missiles and satellite projects.

BELL AEROSPACE CORPORATION

BUFFALO, NEW YORK

Circle No. 4 on Subscriber Service Card.

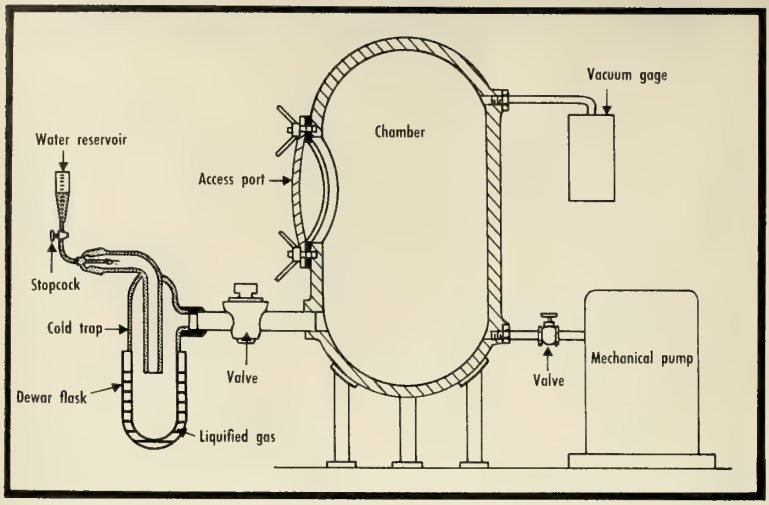


FIG. 1—Mechanical vacuum pump performs first-stage evacuation in one "ice-pumping" method. There is no upper limit on the size of the chamber.

kept cold by being inside a Dewar flask that is being cooled by a height of liquid air.

In operation, a stopcock is opened to admit a small amount of water into the partially evacuated system. Thus a vacuum is drawn by the water condensing on the cold surface. When the desired vacuum is reached, as shown by a connected gage, a valve isolates the chamber from the surface.

If the pressure within the chamber should begin rising, then the cycle can be restarted; and stopped, when the desired pressure is reached.

• **$10 vacuum pump**—The experimenters found that (1) when a chamber having a volume of about 400 liters is initially evacuated to about 0.5mm Hg pressure, and (2) liquid nitrogen is added to the Dewar flask so that about 500 square centimeters of cold surface is exposed to the atmosphere in the system, and (3) one milliliter of liquid water is put into the system—the system's pressure will be brought down to about 2×10^{-5}mm Hg.

The second method is the one that can be put into hardware for less than $10.00, provided some standard laboratory pieces are available. In the apparatus (see Figure 2), a series circuit connects the following elements in sequence: a water aspirator, stopcock, U-tube, hollow jacket used as a cold trap, another stopcock, and a forked path one leg leading to a bell jar and the other to a vacuum gage.

Operation begins by putting about one milliliter of water into the U-tube, all stopcocks being open. The system is then partially evacuated by means of the water aspirator, which is regulated by a water valve.

When the water stops bubbling in the U-tube, the aspirator has lowered the pressure as much as it can. The device is isolated by closing a stopcock.

Liquid air is now poured into one surface of the cold trap. At the same time, the water contained in the U-tube is supplying the vapor needed for the final evacuation. When the desired pressure is reached, a stopcock is turned to isolate the system from the bell jar.

• **Advantages of ice pumping**—There appears to be no theoretical upper limit to the size of the chamber that can be evacuated by the ice-pumping method. There perhaps is a lower limit, in the microscopic range. Thus, besides using the method as an inexpensive laboratory technique for getting a vacuum, technicians might also find applications to environmental chambers, and for generating low-pressure ambients for rocket engine work.

The economic advantage of the ice pump over the diffusion pump to reach pressures down to 2×10^{-5}mm Hg is apparent, Fite and Brackmann say. Further advantages are the absence of potential contaminants such as the mercury or oil found in a diffusion pump; the relatively simple operating technique of the ice pump; and its adaptability to compactness, and quick and varied applications.

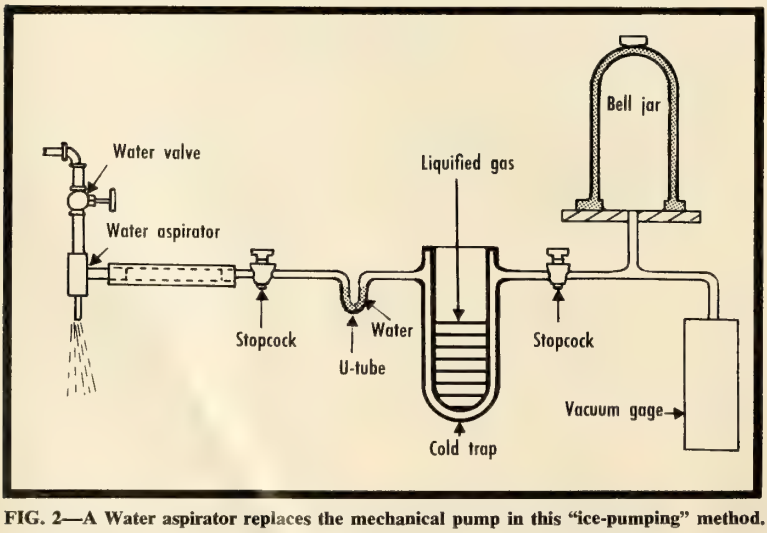


FIG. 2—A Water aspirator replaces the mechanical pump in this "ice-pumping" method. This is a highly economical type of installation.

Spacelabs at Work on Two AF Biomedical Contracts

LOS ANGELES—Spacelabs, Inc., has received Air Force contracts for developing a vest for the AF School of Aviation Medicine to monitor human physiological conditions via radio and providing the AF Ballistic Missile Division with instrumented animals for space research.

The vest being designed for AFSAM is intended for use in checking the condition of astronauts; it will include an electrocardiogram, respiration data, temperature and other physiological parameters.

Designated "Biotel," the unit is worn in a lightweight vest-type garment containing a tiny radio transmitter and rechargable battery power supply. Sensors are held in place by the skin-tight elastic garment.

Another contract, the result of a joint proposal submitted to AFBMD by North American Aviation, Wiley Laboratories, and Spacelabs, calls for instrumenting two American rhesus monkeys supplied by the Air Force. The Biotel unit will be surgically implanted in the monkeys in a manner similar to techniques proven in past programs. No dollar amounts of the contracts were given.

TV Camera Photographs At Night

Television equipment sensitive enough to take nighttime pictures and said to be rugged enough to be used in a surveillance drone is now in advanced development.

The manufacturer also sees ASW uses for its equipment, particularly as an aid to vessels on mapping and mine detection missions. Looking further ahead, the company believes that low light-level television will have high scientific value for spacecraft seeking astronomical data, or for such craft using the stars for navigational purposes.

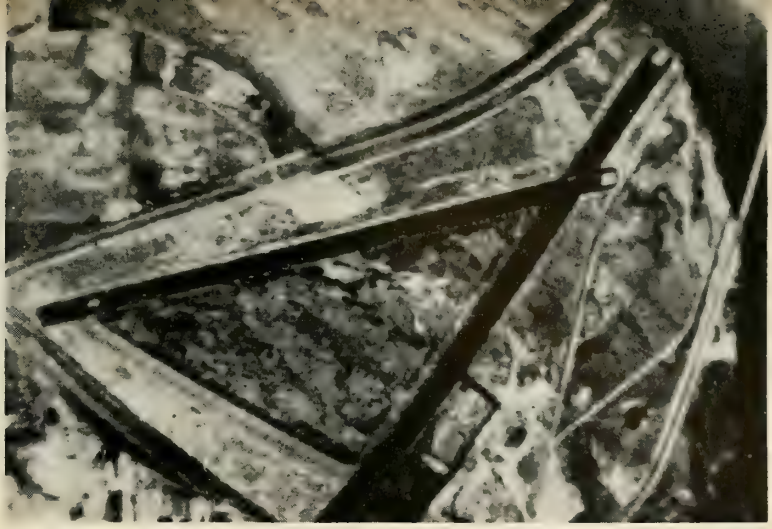
Made by Allen B. Du Mont Laboratories, Clifton, N.J., the TV camera is 8.5 inches in diameter, 17 inches long. Its weight, less optics but including sync generator, pre-amp, video processing circuitry, high-voltage supply and deflection circuitry, is only 30 pounds.

• **Pictures in the dark**—The three photos on this page showing the camera's work were taken at a simulated altitude of 10,000 feet. The target was a floor-mounted, giant map of a 36-million sq. ft. section of Burley, Idaho, which displayed an airport, railroad, highway, two bridges and a river.

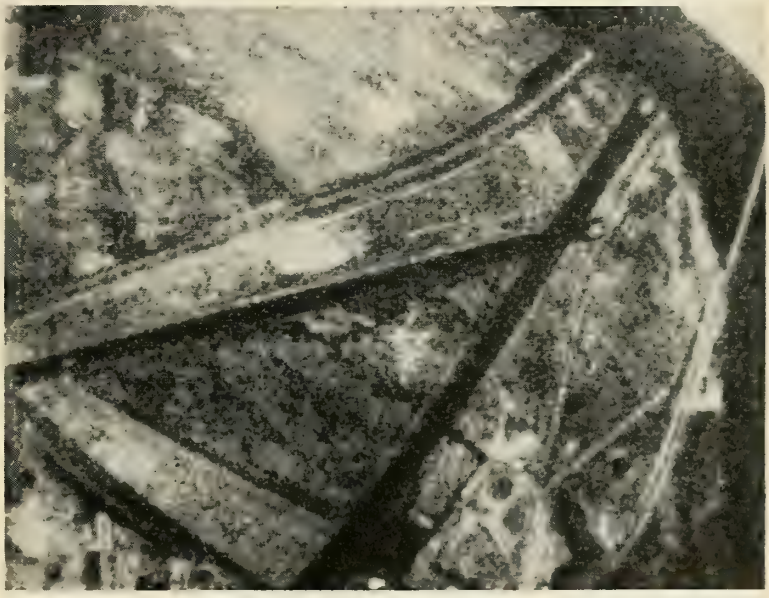
Three illumination levels were used, $8x10^{-3}$, $8x10^{-4}$, and $8x10^{-5}$ foot-candles on the ground. These levels respectively correspond to the light given out by a moon at 50 degrees elevation five days before it is full, ten days, and finally when the night is moonless and cloudy. The exposure time of the photographic camera making the pictures was 1/10 sec.

Du Mont work in the low-light television field started in 1957 under an Army Signal Corps study contract. The company was asked to set up a detailed specification for a television reconnaissance system for Radioplane's *RP-71* surveillance drone.

Prior to this time, most attempts to put television sensors in aircraft simply involved modifying commercial equipment, which was heavy and had technical weaknesses. At the time of this study, even though the potential

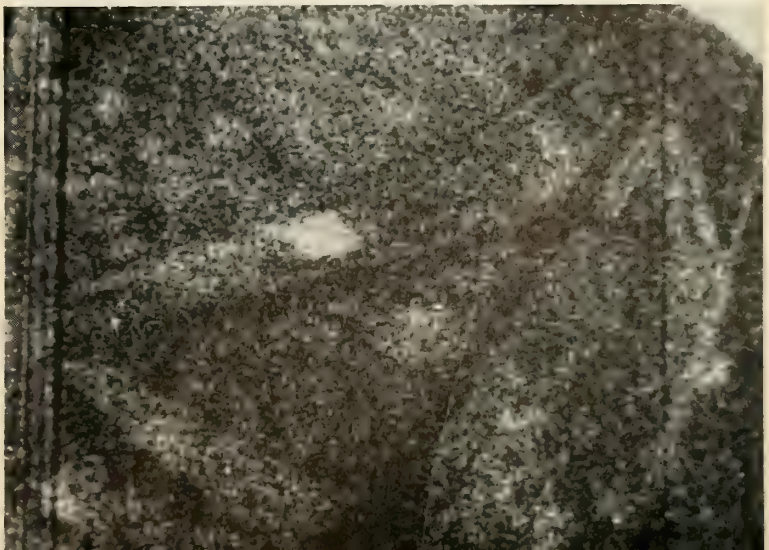


RUNWAYS CLEARLY spotted by TV shooting a scene lit by $8x10^{-3}$ foot-candles.



SAME SCENE, simulated by a giant map, as light falls to $8x10^{-4}$ foot-candles.

GROSS FEATURES still seen as light sinks to level of cloudy moonless night.



of television as a passive reconnaissance system was recognized, the state-of-the-art still lagged the desires of the engineers.

In rapid succession came improved sensitivity and ruggedness of image orthicon tubes coupled with compact transistorized circuitry having low power consumption. Special circuitry, image enhancement, image motion compensation, and similar techniques helped further the progress already obtained from the orthicon tubes themselves.

As television capabilities improved technically, the continued need for a useful night sensor persisted. Engineering development is now bringing about low light-level television as a practical, not just a laboratory, system.

The television used by Du Mont operates at 625 lines, 50 fields and 2:1 interlace. The camera is transistorized and uses a highly sensitive G.E. Z5358 image orthicon tube and an appropriate objective lens.

Low light-level electro-visual systems offer advantages of being passive and operating on a real-time basis. Sensor systems of this type will undoubtedly play important roles in spacecraft as well as aircraft surveillance missions. This is particularly true as the television systems now in the laboratory and under evaluation move into production and operational use.

Instant Motion

Scorsby Machine Used To Test SINS Gear

DOWNEY, CALIF.—Pre-delivery testing of *Polaris* submarine autonavigators at the Autonetics Division of North American Aviation, Inc., includes use of a machine to simulate shipboard motion.

Known as the Scorsby Machine, the equipment employs electric motors geared to shafts that are mechanized to accomplish motion about three axes—pitch, roll and heading (or azimuth). The Scorsby test objective is to demonstrate that the autonavigator—known as "Ship's Inertial Navigation System (SINS)—will provide position information within the precisely specified limits.

"Autonetics Scorsby equipment simultaneously introduces shipboard motions in such degrees as are required for the acceptance test of the *Polaris* submarine autonavigator," according to Senior Test Engineer Jack A. Crain. However, he notes that the Scorsby "runs" are only the last in an extensive series of pre-delivery tests of the system employed to fix a fleet ballistic missile submarine's underwater launching position for accurate delivery of the *Polaris* missile.

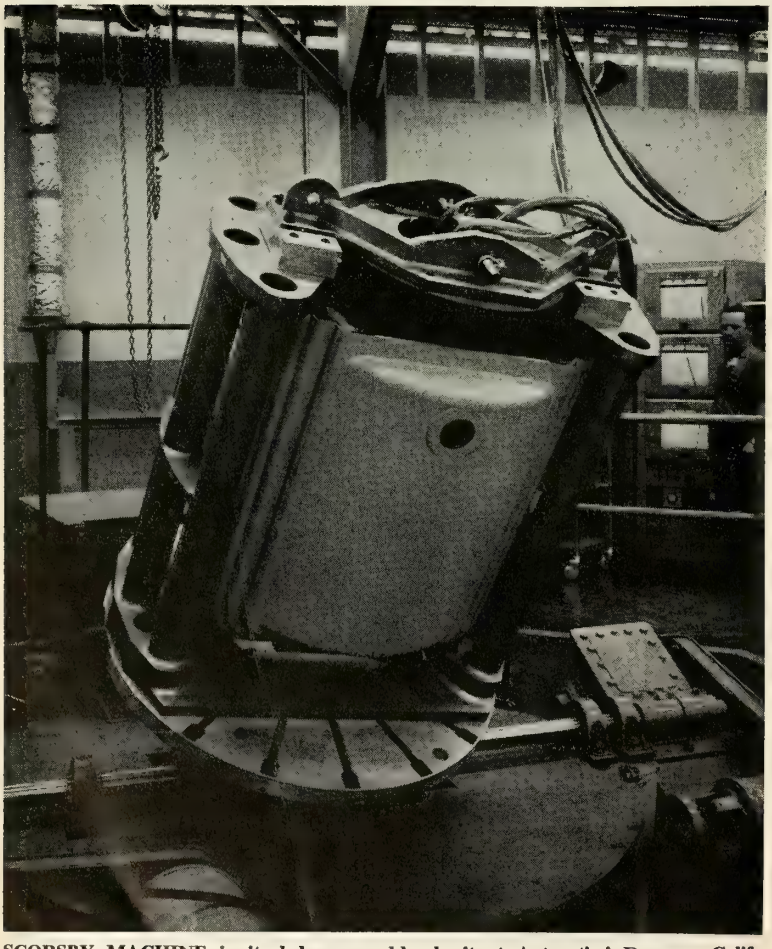
Preceding the Scorsby tests are stationary checkouts of individual SINS components, functional tests of power supplies, circuits, servo loops and compatibility tests of assembled components.

Next comes a series of runs of the entire SINS. One stationary run determines if the inertial components,—gyros and velocity meters—operate within specifications. Another simulates ship's heading, wherein outside heading is successively changed to the four cardinal directional points.

Finally comes running of SINS on the shipboard-motion-simulating Scorsby machine along various headings with motion introduced about the roll, pitch and heading axes. The gyro-stabilized platform is tilted in various ways during these runs to determine if it retains its initially-fixed orientation.

Basically, the Scorsby machine is a controlled-motion platform, believed to have been originally based on a familiar 6-in. naval gun turret installation. In its configuration at Autonetics' Downey facility, the equipment is firmly secured in a concrete, below-ground-level pit.

The SINS' binnacle—stabilized platform and frame—is attached to the Scorsby's platform in an Autonetics-designed holding and mounting frame, familiarly called the "bird cage".



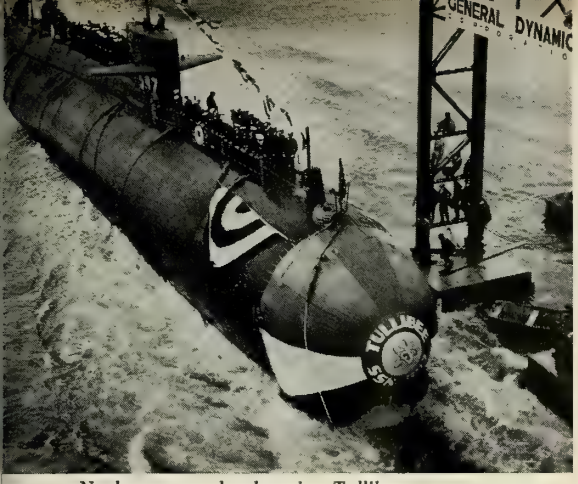
SCORSBY MACHINE in its below-ground-level pit at Autonetics' Downey, Calif., plant, where it is employed to simulate sea motion for testing *Polaris* SINS.

Houston Firm Enters High-altitude Rocket Field

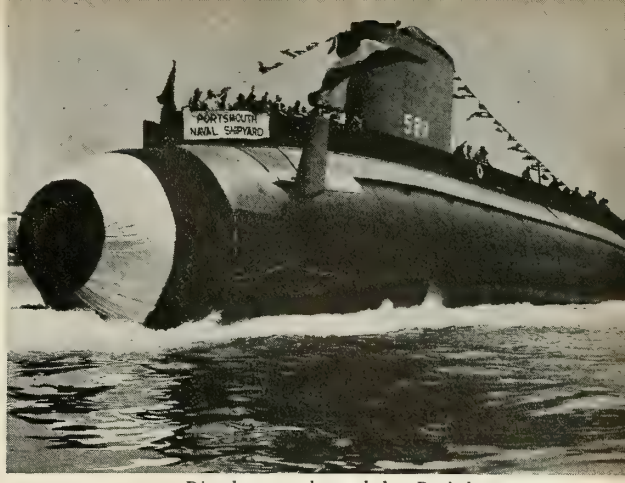
Anderson, Greenwood & Co. of Houston, which made its start after World War II building two-place pusher-type aircraft, has entered the high-altitude rocket research field.

The company is building 24 sounding rockets under fixed price for the U.S. Army's signal missile agency at White Sands. The two-stage solid fuel-ramjet motors are capable of sending payloads of 1 to 1.5 lbs. to 250,000-300,000 ft. Ten have been test-fired.

Anderson believes the 2.76-in.-diameter folding fin rockets can be furnished for $200 or less per copy.



Nuclear-powered submarine Tullibee.



Diesel-powered snorkeler Barbel.

ASW engineering

'Killer Sub' Fleet Strongly Backed

Advocates claim concept is today's best and least expensive solution to the threat—and may be final answer

A number of industrial officials are pushing an ASW "dark horse."

It is a proposal for a massive fleet of "killer" submarines.

These experts contend that the killer sub is the interim answer—possibly the final answer—to the Soviet submarine menace.

• **What's the plan?**—Killer boat proponents want no less than 100 submarines within five years, the dual objective: to counter-attack Russia's submarines—a force of at least 500—and to replace our World War II submarines, all of which will soon be obsolescent.

• **Cost:** Depending on how it's done, the bill should be less than $5 billion for a mixed killer force—both conventional and nuclear-powered. More for an all nuclear-force made up of ships such as the $43-million-a-copy Tullibee class.

The proposal for a large killer boat force came to public view only last month. The subcommittee on Produceability of the National Security Industrial Association said there should be 60 conventional diesel-powered pursuit-type subs and 40 atomic-powered versions, plus 36 missile-launching subs.

The subcommittee says it should be possible to cut these boats' costs 40% below those of the prototype.

Admiral Arleigh Burke, Chief of Naval Operations, repeatedly has voiced concern over the problem of individual excellence of a few ships at a high unit-cost vs. many ships at a low unit-cost.

He believes this relationship should always be carefully considered, lest we spend too much money on too few units to do the job. He recently cited before NSIA the case of a destroyer 10 times as effective as previous types, but costing three times as much. At first, this appeared to be a very good buy. However, it became obvious that should there be three tasks, the superior unit could cover but one—and two would remain unguarded. Burke emphasized that three lesser units could cover all spots.

• **The only answer?**—This has been ammunition for some shipbuilders who want a mix: diesel- and nuclear-powered killer submarines.

These builders concede the nuclear sub's greater speed, its independence of the surface and inexhaustible endurance. But for the foreseeable future, they say the absolute quiet of the hovering diesel-power submarine will give it great advantage where sonar search against submarines is paramount.

The ability of submarine sonar to detect and classify enemy submarines under a greater variety of conditions has been emphasized repeatedly by scientists of sound in the sea. The Woods Hole Oceanographic Institution has advocated the need for a substantial force of killer submarines. Service evaluations at New London have demonstrated operationally that the killer boat is perhaps the only means of detecting the deep-diving submarine which is evading air and surface ASW detection.

This has created a new school of thought in the Navy and in industry. Some insist that the problem of establishing surveillance of the ocean depths can *never* be solved from the air, from the surface or the sea or from shore stations.

They contend that this will be true even if there is a revolutionary breakthrough in detection and attack. They say that history shows that every mobile anti-submarine weapon is soon adapted to the submarine, where it becomes a more effective weapon against surface ships than it was against the submarine.

The group almost universally

agrees that in the immediate and foreseeable future, the only sure method of finding, identifing and destroying enemy missile-firing submarines in the ocean depths is by sending fighting men to the scene of action on killer boats.

They say there is not a single case on record where a surface ship sonar screen ever found a submarine that didn't want to be found.

Some believe that ASW surveillance under the Arctic ice is entirely a problem for the SSK. They agree that some form of passive surveillance of the Arctic Ocean could be achieved from ice stations—vulnerable to air or missile attack—but that no means of attack can be provided with air and surface ASW completely thwarted by submarine under-ice navigation (which is as well-known to the Russians as to ourselves).

Nuclear power is preferred for under-ice SSK's, although the possibility of using diesel submarines which can break through ice long enough to charge batteries, is not being discounted.

• **Nuclears vs. diesels**—What's the case for conventional subs? On patrol modern diesel submarines need to snorkel no more than two hours per day. When they operate in pairs for mutual protection, they are virtually undetectable because one is always on the alert.

In no case are they noisy more than four hours out of each 24 as they recharge batteries at snorkel. Noise on nuclear subs is still a problem, but it's minimal. Many say nuclears are only interim submarines until the fuel-cell submarine comes into being. Operating costs of conventional boats are about 1/7 those of nuclear.

Advocates of diesel killer boats say the 18-19 knot Barbel snorkeling class, which utilizes the streamlined Skipjack hull design and carries a crew of 55-60, would be ideal. Why?

Because the basic need is just for a substantial number of ultra-quiet boats with the ability to hover silently for at least 20 minutes, giving a sonar listening capability—with present fleet sonar—up to 120 miles range.

They contend that if this design were settled upon, one private shipbuilding yard could turn out one a month at a cost of approximately $12 million per boat, maybe even less. The stipulation would be that already proven sonar, batteries and other components and subsystems be used. The emphasis would have to be on *no* new research and development gear being mandatory under government-furnished equipment. As one builder puts it:

"We get into the craziest situations when we sign a contract which guarantees that we will operate and make successful anything that the government chooses to buy and furnish for installation."

• **The coming bind**—The next five years are the crucial ones, the shipbuilding industry feels. In 1965 all of the World War II submarines will be in block obsolescence, with general loss of hull thickness and drastic depth restrictions. "Then can we say our 20- or 30-knot-faster nuclear submarines will be equal even to the present Russian strength of about 500?" many observers ask.

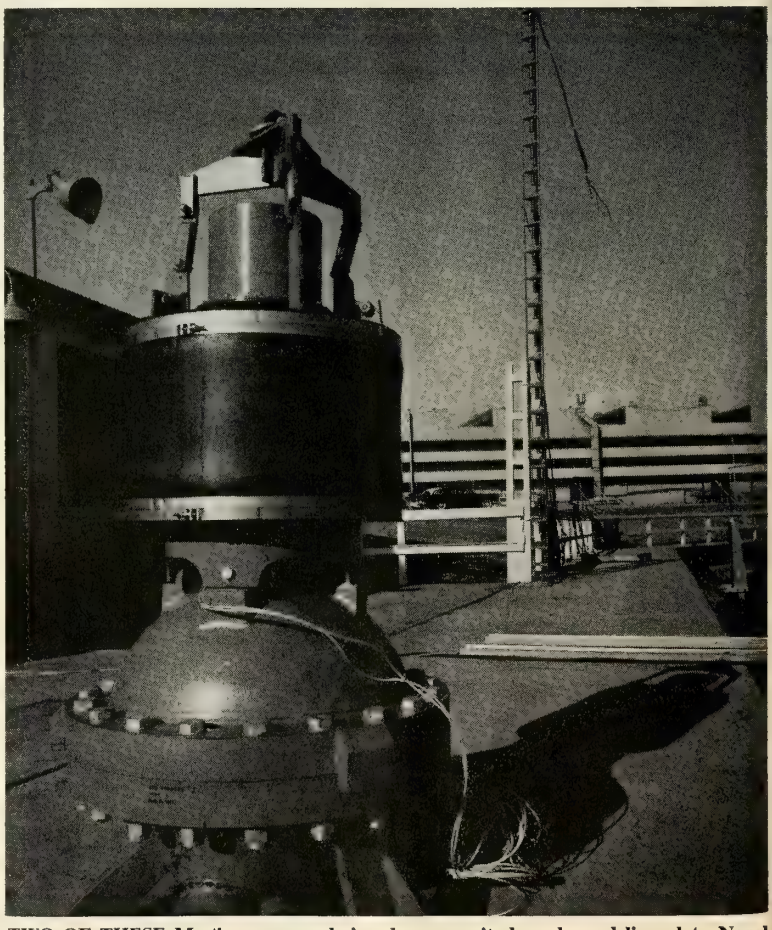
The solution, shipbuilders say, is mass production in commercial shipyards, with boats being delivered on time and at a stated price—not cost-plus. But they also realize that the Navy has the problem of ships versus progress; volume is sacrificed because the latest, most modern ship is desired.

The Navy now has 110 submarines in commission. Only 30 have been built since World War II, although another 24 started during the war have been completed.

But, on the other side of the coin, builders point out that we would not have much time in another war to design and build ships.

Progress in ship design has been limited. The shipbuilding industry likes to cite the Nautilus and Seawolf. Even after three years of operation of these radically differing designs, one top

To Eavesdrop Underseas



TWO OF THESE Martin company-designed sonar units have been delivered to Naval Research Laboratory for evaluation under a no cost contract. Unit consists of a pressure sphere with electronics control equipment at the base and sonar transducer above the sphere. In background is a hydrophone receiving array which is suspended beneath the sonar unit. Array contains 20 hydrophone listening devices for detecting and measuring underwater sounds at depths to 18,000 feet. Basic aim is to get an acoustic path that is reliable under a good many oceanic conditions. A transistorized preamplifier circuit board in the hydrophone is imbedded in a one-inch cylinder. Rubber shells are put on to prevent short-circuiting when transducer is immersed in water.

Navy admiral remarked he couldn't see the particular benefit of one versus the other, excluding the power plant.

In fact, some builders contend that many of the changes in various classes of submarines are not actually improvements at all. They say the cost goes up because more funds are spent in production of one-or-two-of-a-class—just for design and making it operable. They say money can be saved by repetition of classes and cutting down on government-furnished equipment.

• **Where the trouble lies**—Proponents of SSK's acknowledge that the Navy has partially recognized the value of the killer sub. Some 27 nuclear attack submarines have been authorized; 12, including the Tullibee have been launched, and seven are in commission. However, the Tullibee is the only one which can be said is strictly in the hunter-killer class with the best available sonar. Even it has the SS(N), rather than SSK designation which the Navy has abolished.

The big trouble, according to some killer boat proponents, is that the Navy tends to limit the number of such ships, and to insist that they be "along with other—sea, air—approaches" in the ASW contest.

However, more than one expert voices the same conclusion: "If forces in power in the Navy today can keep the cost of submarines up, fewer submarines will be built. Control of the Navy comes with numbers."

The killer boat proponents consider ASW warfare to be the sea-going epitome of General Sherman's epigram—"War is hell." They say there can be no such thing as a "clean" ASW war—one in which the attacker stays beyond the range of submarine counter-attack. Many are violently opposed to spending billions of dollars on research and developmnet and purchase of weapons to give surface ships and aircraft this capability. As one ex-Naval officer comments:

"While we are researching for a final solution, we'll find the barbarian with knife in hand at our ivory tower's door."

They feel that the stand-off concept in recent years has actually lost ground in terms of its effectiveness against the enemy submarine. When nuclear power is further applied, they say, the disparity will favor the enemy even more. They insist that it remains to be proven that the Navy's air or surface arms can do the job, particularly if the enemy fights back.

The enemy, they argue, is taking a lesson from the Nazi Navy's Doenitz, who—until the last days of the war—didn't have his submarines fighting back. American submarines have always fought back (recall the many torpedoed Japanese destroyers) and the Russians may be expected to do likewise.

While knowledge of the Russian submarine fleet is scanty, many point to the evidence that the Soviets have weapons that out-range our surface stand-off weapons to a constantly widening degree. Their tactic will be that of the wolf who reasons that if he kills the dog he can get all the sheep he wants.

With naval history showing that battles are most often won by sheer force of numbers, the massive SSK proposal is gaining attention—particularly when a cost ratio of 6 for 1 could enable the Navy to build, operate and maintain three pairs of conventional ASW submarines for each nuclear sub at sea.

Ships are built for a life expectancy of 15-20 years; not many in the Navy see a future for a diesel-powered submarine 20 years from now. Nonetheless, if it's decided we need more forces in being, the tide could turn to the conventional sub.

Singer 'Sniffers' Help Navy Planes Locate Submarines

The Navy has added a new nose for its hunter-killer aircraft to "sniff out" enemy submarines. The system, which involves an unusual technique, shows a lot of promise.

Singer Manufacturing Co. has a contract to produce 800 ASR-2 "sniffer" units for installation in the Grumman S2F-2, the Lockheed P2V and the new S2F-3.

Origin of the system undoubtedly is traceable to smog-ridden Southern California, which years ago had to come up with an atmosphere sampler to determine chemical content. General Electric's Light Military Electronics Department conceived the idea that such a device could be used for detecting the snorkeling submarine.

Now, six years later, the fleet is getting the ASR-2. Some six aircraft of Carrier Group Four have it installed; pilots say it's working fine. While security prevents mention of specific capabilities, this much can be said:

Exhaust through the vent line of the snorkel contains small particles of carbon monoxide generated by the diesels.

S2F-2's take about five samples per second at an altitude of about 1500 ft., where surface winds usually level off. Particles are scooped in and moisturized, and hydrocarbons are detected by a cloud-chamber photoelectric cell. The system, however, depends on strength of wind and amount of exhaust emitted. The British have a similar system called Autolocus.



Ceramic Provides Its Own Heat Shield

Oxidation-resistant coating forms at 2200°F; compound ideal for changing temperatures of re-entry

An experimental self-sealing ceramic compound which develops its own protective coating in the face of two of the primary environmental enemies of hypersonic flight—heat and oxidation—has been developed at the Aerospace division of Boeing Airplane Co.

Ceramic engineer John DiLazzaro, who developed the new graphite-based material, says the ceramic is capable of instantaneously mending cracks in its protective layer from its own base material.

Boeing Magazine says that tests made thus far, while not considered sufficient for design data, have shown interesting results.

The material is composed of graphite and ceramic powders encompassing a range of compositions. The magazine points out that investigation of the mechanism involved in forming the protective layer can be important to a number of high-temperature materials now in the process of development.

• **Plumbago**—"Graphite materials have a good strength-to-weight ratio at very high temperatures," the publication says. "Graphite doesn't melt; at around 6500°F, it sublimes, changing from solid to gas."

One of the main limitations to use of graphite in hot-structure materials and coatings has been its tendency to oxidize. To overcome this, coating must be used. A self-sealing graphite ceramic would provide its own coating, the Boeing report notes.

Typical of the composite graphite bodies developed by DiLazzaro is one consisting by weight of 50% graphite, 24% molybdenum disilicide and 25% titanium boride, plus a small percentage of minor ingredients to promote bonding.

This composition contains over 70% of graphite by volume and retains many of graphite's desirable properties, the ceramics engineer reports. A powder is produced by milling the components together that will pass through screen mesh openings of about .003 inch.



HEAT-and oxidation-resistant coating is visible on the lower test disc. Upper disc has not been exposed to high temperatures.

After cold-pressing to shape, the ceramic is fired to nearly 3300°F for about one hour in an inert atmosphere. DiLazzaro reports that the material shrinks very little during firing and resembles graphite in appearance when it comes from the furnace.

The protective layer develops after heating in air for three hours at 2200°F.

"In one composition, the layer appears as a smooth, adherent, nonporous, yellowish-brown film about a thousandth of an inch thick," the Boeing publication says. "After several hours at 2600°F, the color changes to brown. After 23 hrs. at this temperature, the layer has thickened to between 0.01 and 0.015 in."

• **Lasting protection**—Ultimate thickness of the layer is said to depend upon the combination of time, temperature and oxidation. Even when suddenly plunged into a heat furnace, the layer forms spontaneously, although it is thinner than when heated slowly from a cold-furnace state.

"This could make the ceramic useful in space-flight applications where re-entry and other conditions often involve rapid and extreme changes in temperature," Boeing points out.

In a typical test, a small rectangular bar was clamped between water-cooled graphite electrodes and resistively heated to 3000° in less than one minute. After three minutes the temperature was 3300° and remained approximately constant for 15 min.

"The protective surface appeared as a viscous, glass layer agitated by a slow, continual 'boil off' of gaseous material," the Boeing publication says. "The glassy material remained on the surface and continued to provide a measure of protection to the material beneath, even after becoming liquid."

How the material will behave in temperature ranges above present test limits is not yet known; current Boeing research is devoted to making the composite graphite bodies usable for long periods of time at temperatures of more than 3000°.

Dry Lubricant Efficiency Upped 30% by Radiation

Solid film lubricants capable of operation while exposed to nuclear radiation have been developed by Electrofilm Inc., North Hollywood, Calif.

Exposures on the order of 1×10^7 Roentgens up to 1×10^9 Roentgens at temperatures up to 550°F. did not deteriorate the films. Wear life was actually increased by 30%.

The dry lubricants operate effectively from –65° to 1800°F. and the friction and wear characteristics meet Mil Spec 25504.

Wyman-Gordon Moves Precision Forging Plant

Wyman-Gordon Co. is transfering its Prex facilities at Franklin Park, Ill., to its eastern locations.

Prex Corp., which became part of the Wyman-Gordon corporate struc-

ture in 1956, specializes in close-tolerance, small, precision forgings. Most of its machinery will now be located at North Grafton, Mass. and the rest at Worcester, Mass. The move will take several months.

No interruption in Prex's regular production schedule is anticipated.

In addition, Wyman-Gordon is carrying out a threefold expansion of its beryllium machining processing and inspection facilities at North Grafton. Special rooms installed earlier this year to handle beryllium powder will be increased in size to facilitate the larger quantities of the element required in production.

With the expansion of the physical plant, Government security restrictions are also increasing—but at a much faster pace. The North Grafton plant is owned by the Air Force and operated by Wyman-Gordon.

Shock Tunnel Will Use Pressures To 100,000 psi

A Mach 20 shock tunnel will be in operation in September at Republic Aviation Corp., Farmingdale, N.Y.

The tunnel, utilizing pressures to 100,000 psi, consists essentially of a driver tube, driven tube and vacuum tank. The high pressures are a product of the combustion of a mixture of hydrogen, oxygen and helium gasses in the driver tube.

The driver tube will be charged with the mixture at 15,000 psi. Ignition and combustion will raise the pressure to the maximum which bursts a metal diaphragm, driving the gas into a small zone ahead of the nozzle.

The compressed and heated gas ruptures a secondary diaphragm, causing the flow through the nozzle into the vacuum tank at about Mach 20.

The specimen is mounted in the vacuum tank at a working pressure of one micron of mercury. Observation windows in the tank permit high-speed photography of the tests.

Republic intends to use the tunnel in studies relating to aerodynamic and heat transfer problems associated with high-speed flight and re-entry.

The facility is being installed by the designer, FluiDyne Engineering Corp.

Shadowgraph Photographs Hypervelocity Projectiles

A hypervelocity shadowgraph system capable of "freezing" projectiles with velocities of more than 14,000 feet per second has been installed at the Eglin Air Force Base Air Proving Ground Center, Fla.

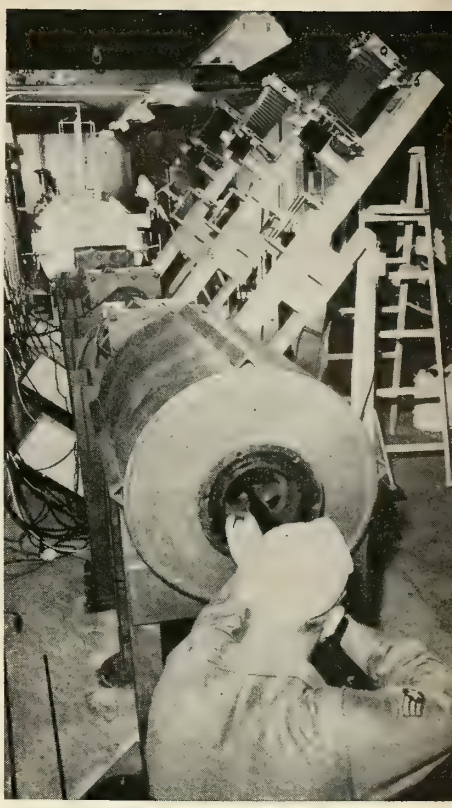
Designed and built by Avco Corp., the multiple-path photoelectric projectile detector and shadowgraph system will be used in a terminal ballistics study under simulated high-altitude conditions.

Each station in the commercial system consists of a 0.25 microsecond spark-gap light source, collimating lens, light screen, objective lens, 0.050 microsecond Kerr Cell shutter, camera, pulse generator and optical bench.

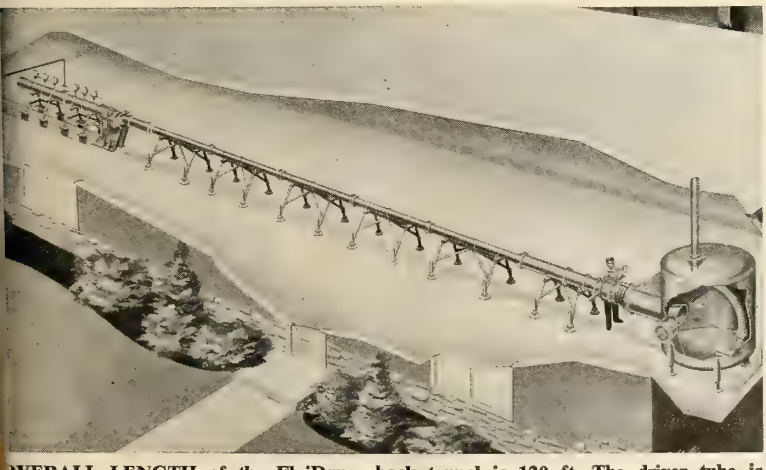
A special light screen and optical port assembly was developed to meet the requirement of a simulated 100,000 ft. altitude. The light screen is based on catadioptric techniques of reflection and refraction of light that produce a field of uniform sensitivity.

When a hypervelocity projectile interrupts the screen, it causes a current change that as a result triggers the synchronized shutter-light source.

A similar screen has been tested at Avco for projectile sizes as small as a 0.22 caliber bullet. The bullet crosses the 2.5 in. camera field in 15 microseconds. The system freezes the projectile within a half-inch of the center of the field.



SHADOWGRAPH system undergoes pre-operational checks at Ballistics Range 22, Eglin AFB, Fla.



OVERALL LENGTH of the FluiDyne shock tunnel is 120 ft. The driver tube is mounted on a steel track to facilitate primary diaphragm replacement. The model support in the vacuum tank allows 12 inches of streamwise adjustment.

Simple Separation Slated For Re-entry Balloon Test

In-flight stage and cannister separations in the Goodyear re-entry balloon deceleration tests this summer will be effected by a system from Hunter-Bristol Division of Thiokol Chemical Corp.

The system consists of a circular arrangement of shaped-charge explosives which cut outward through the *Cree* test missile's skin. The method eliminates the usual flanges, brackets, accurate joints and bolt patterns associated with conventional separation systems.

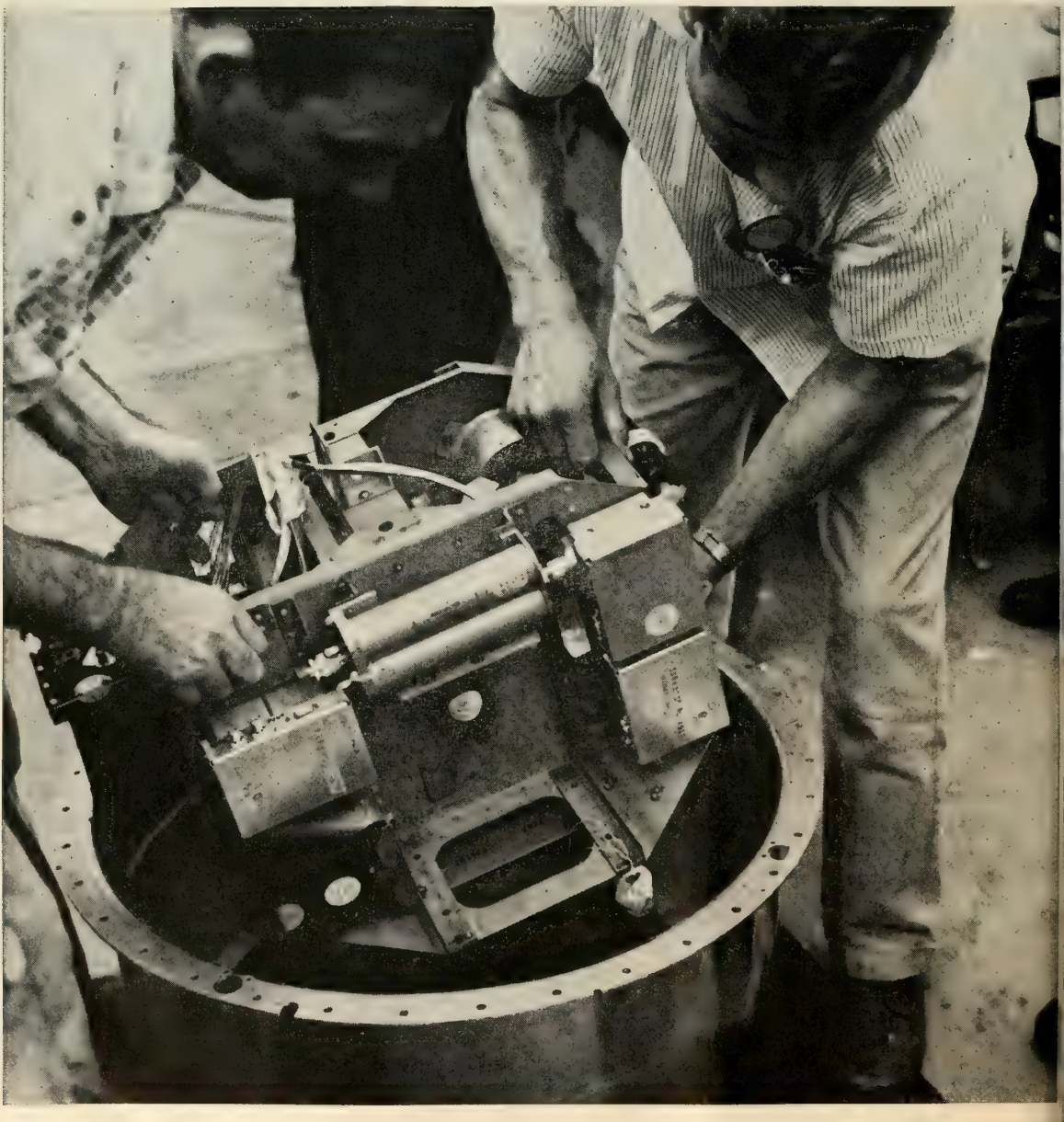
The Goodyear balloon deceleration system (M/R, July 4, p. 26) will be tested in a series of Cook Electric *Cree* test missiles this summer.

Lost Discoverer Heavily Instrumented

The recovery capsule of the ill-fated *Discoverer XII*—launched June 29—was loaded with nearly four times the instrumentation for capsule investigation carried in previous launches. The "diagnostic" attempt was futile, however, since the 300-lb. vehicle failed to go into orbit.

The capsule was equipped with four telemetering channels and instrumentation to monitor all phases of satellite re-entry and recovery procedure.

In previous *Discoverer* launches, six stabilized in orbit as programed. At least two re-entered, but none were recovered. Lockheed and the Air Force had hoped the latest attempt would tell what went wrong in other shots.



IAS meeting is told . . .

Venus' Radiation Worse Than Mars'

Other speakers discuss need for lifting vehicles in manned re-entry, a proposed space glide vehicle, pilot's role in moon landing

LOS ANGELES—Radiation may not be a significant hazard in a landing on Mars, but it could be during entry to Venus.

Observations of the two planets indicate that Mars probably has a magnetic field so weak that nothing akin to the Van Allen belts surrounds it. Venus, on the other hand, has a more intense magnetic field—indicating that radiation belts may exist.

Zdenek Kopal, a University of Manchester astronomer who presented these observations to the Institute of Aeronautical Sciences last month, also suggests that the moderately dense Martian atmosphere might offer a safe-entry corridor for purely ballistic vehicles.

Lifting vehicles, he believes, probably will be needed for manned entry to Venus or the Jovian planets to avoid excessive deceleration and heating.

Manned re-entry to earth's atmosphere at super-satellite speeds also calls for lifting vehicles, Robert B. Hildebrand, Chief of Advanced Systems Research for Boeing Airplane Co.'s Aerospace Division, told the meeting.

"Rocket decelerated entry and multiple pass entry each have problems peculiar to their operation which may make them less desirable than the single pass re-entry," Hildebrand said. He noted that one important new consideration is that in a multiple pass entry the vehicle might pass in and out of the Van Allen radiation belts.

"A lifting vehicle with moderate lift-to-drag ratio could be utilized for re-entry with super-satellite velocities and could be protected with ablation materials to overcome the high heating rates associated with the initial entry."

The Boeing researcher said that the speed decreases to below satellite speed, where radiation cooling appears attractive, the vehicle could use its lateral maneuverability to provide an extremely flexible system.

• **Glider transport**—L. W. Warzecha of General Electric's Missile and Space Vehicle Dept. also proposed a maneuverable semi-ballistic glide vehicle—for transporting men or material between earth and a satellite.

He said such a piloted space craft can be built light enough so that it can be launched by an advanced *Atlas* or *Titan* missile.

Warzecha described such a vehicle as having a recoverable glide vehicle section controlled by the pilot; a parachute landing system; and a detachable rocket propulsion and guidance section for space maneuvers. He said launch weight would be about 5700 lbs.

The vehicle would have a 550 mi. cross-range maneuverability so that it could come down out of a north-south orbit and head east or west 550 mi. to a safe landing area.

Without a cross-range capability, he pointed out, a space pilot might have to wait for days until the earth's rotation placed his orbit over a favorable area. The 550-mi. range would make possible a daytime landing at any pre-selected point on any day of the month from an orbit of 500 mi. altitude, he said.

• **No job for pilot**—Discussing a lunar landing at a pre-selected site, research engineers Arnold Peske and George Swanlund of Minneapolis-Honeywell Regulator Co. said their studies indicated little justification for having a man in the control loop since he would be serving as little more than an amplifier in an error-tracking task.

"The major conclusion here is that the operator is not making the best use of his capabilities; his function in the control of the vehicle should be to monitor the automatic system and then to take over in event of a failure," they said.

It was suggested that a better task for the pilot might be in recognizing and tracking the landing site since automatic techniques such as map-matching require heavy and complex equipment.

In some of the other papers:

• Cornell Aeronautical Laboratory's Roger C. Weatherston and William E. Smith proposed a new type of thermal radiator for space vehicles with a long, thin, continuously rotating belt to replace heavy conventional radiators.

• Solar Aircraft Co.'s C. W. Haynes and P. J. Valdez reported on an extensive pressure vessel test program to evaluate rocket motor case material, carried out under contract for Thiokol Chemical Corp. They said the program has led to improvements in manufacturing techniques.

• North American Aviation's Tajashi Mitsutomi of the Autonetics Division asserted that electronic microminiaturization will have a tremendous effect on electromechanical control systems in regard to increased reliability and reduction of size, weight and power. He said one of the most difficult problems of electronic microminiaturization is electrical interconnection. Welding offers high reliability for this but has yet to be fully evaluated, he said.

• Thiokol Chemical Corp.'s R. W. Seaman and D. S. Smith reported on successful completion of preliminary flight rating tests of the Reaction Motors Div. XLR99-RM-1 rocket engine being installed in the North American *X-15*.

• North American Aviation's V. L. Beals and S. R. Hurley of the Columbus Division said miniature rocket motors not much bigger than shotgun shells but with nearly 10 times the recoil have been used for impulsive excitation in flight vibration testing of the A3J Vigilante, Navy's Mach 2 attack bomber.

• Chance Vought Aircraft's Russel O. Bowman and Fred W. Thomae reported on an algae life support system in which a mouse survived for 28 days supported by four liters of algae. Highest CO_2 content found was 0.5%.

• Lockheed Aircraft Corp.'s R. O. Lowrey discussed space flight simulators under development at the Georgia Division and ARO, Inc.'s B. H. Goethert presented an extensive analysis of base flow characteristics of missiles with cluster-rocket exhausts.

Britain to Buy 500 Malkaras But Aussies Reject Missile

A few days after it was announced that Britain would buy 500 *Malkara* anti-tank missiles from Australia, an Army spokesman in Melbourne said Australia had turned down the weapon because in its present form it did not meet their requirements for use in a tropical country.

Development of *Malkara* began in 1951 at the Australian Government Aircraft Factory near Melbourne, and trials started at Woomera over four years ago. Development costs amount to $14 million and production figures for the 500 missiles, to be bought by Britain for use by the Royal Armoured Corps, will be over $4 million.

Immediately after the Army's rejection of the weapon, production officials of the Australian Defence Ministry expressed surprise at the announcement. One said "The British seem to be very enthusiastic about the *Malkara*. We think it could play a very useful part in an emergency in Asia."

It appears now that Britain is the only country interested in the weapon. NATO countries and America have chosen the French anti-tank missiles *SS10* and *SS11*, produced by Nord Aviation. These are believed to cost only one-tenth as much as *Malkara*.

The British Labour Party has seized on this as another "Government missile muddle" and "rocket flop." They claim that British Army experts advised that the weapon was too cumbersome and already out of date, and that the decision to buy *Malkara* was political—to keep the Australian factories going and as a gesture for the cooperation received at Woomera. The Australian designers have been asked to develop a smaller version of the weapon.

Indian Research Rocket Nears Testing Stage

The Indian Astronautical Society is spearheading a successful rocket development program in India which far surpasses any other program in the East. The IAS expects to supervise the launching this month of a solid-fuel rocket capable of reaching over 120 miles.

Twelve receiving stations are deployed throughout southern India to receive the signals transmitted by the instrumented second stage. The instrumented payload weighs nine lbs. Solar cells will provide the power for transmission.

The two-stage high-altitude rocket will follow several one-stage test shots expected to reach over 100 miles each. The two-stage rocket will measure the accuracy of programed ballistic flights through the shaped-charge technique developed with a solid, slow-burning (1.8cms./sec.) plastic propellant.

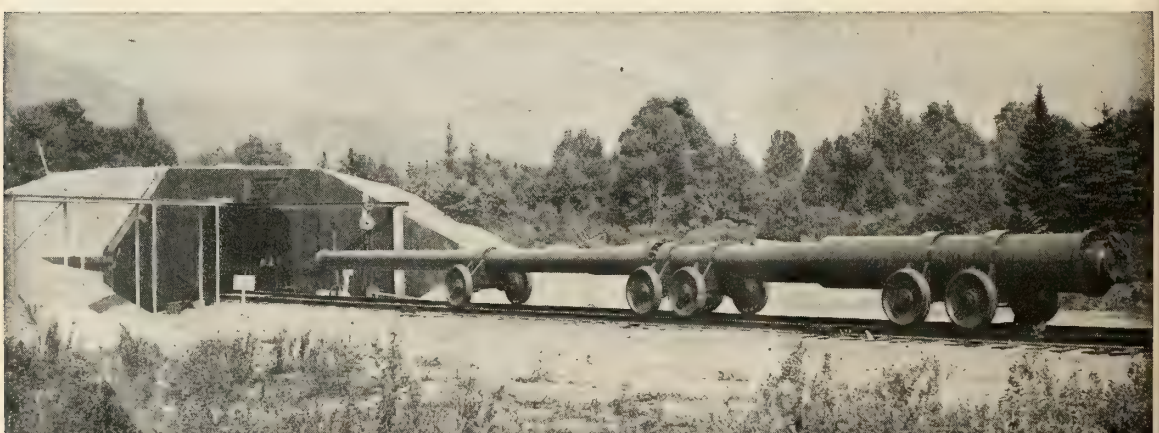
Indian officials claim that the new alloy used in the rocket's construction is "one of the lightest known" but have declined to identify it. It is understood, however, that the same metal is being used in a rocket engine being developed by the Indian Defense Department.

Sweden Adds Helicopters To Bolster ASW Strength

The Royal Swedish Naval Administration last week moved to strengthen its Antisubmarine warfare and minesweeping capability. It signed an option agreement for 20 Vertol 107 Model II transport helicopters.

Under terms of the option, deliveries of the new twin turbine powered helicopters can begin in the fall of 1961. The aircraft would be operated by both the Royal Swedish Navy and the Royal Swedish Army. Tandem-rotored Vertol 44 helicopters, powered by a single piston engine, have been in service with the Royal Swedish Navy since 1958. They have been used extensively in minesweeping and ASW-type missions.

Cannon for Nose Cone Firings



CANADIAN-BUILT gas gun at Valcartier, P.Q., Research Station has been developed for testing nose cone configurations. The rail-mounted 14-in. gun can propel a 100-lb. nose cone at 12,000 ft./sec. into the evacuated tube. The tube has gas composition and pressure controls to simulate upper atmospheric conditions. Launcher recoils up inclined railway on firing.

soviet affairs

by Dr. Albert Parry

Many rocket and missile terms

are included in the latest foreign-language military dictionaries being issued by the Military Publishing House of the Ministry of Defense of the USSR. The new *English-Russian Military Dictionary,* to be published by the House in Moscow this summer, will contain nearly 55,000 words, phrases and abbreviations used in the armed forces of the United States, Great Britain, Canada, and other Western countries, also in the united forces of NATO. This will replace a dictionary issued by the Russians more than ten years ago, which is considered now quite obsolete. Rocketry and missilery make up a prominent category in the new work.

A separate missile glossary

is soon to be issued in Moscow under the title *English-Russian Dictionary of Jet-Age Weapons* (in Russian: *Anglo-Russky Slovar' po Reaktivnomu Oruzhiyu*). Many rocket and missile terms are also found in the *German-Russian Artillery Dictionary,* published by the same House in Moscow in early 1960. According to Maj. Gen. P. F. Kopylov, chief of the Ministry's Military Publishing House, it issued five other dictionaries from 1956 to 1960: *English-Russian Dictionary of Radioelectronics, English-Russian Artillery Dictionary, German-Russian Aviation Dictionary, English-Russian Dictionary of Rear Service and Logistics,* and *Japanese-Russian Military Dictionary.* All of these include many Space Age entries.

Practically ready and soon to be printed

by the same Moscow House are *French-Russian Military Dictionary* and *German-Russian Military and Naval Dictionary.* In preparation are military dictionaries in Chinese-Russian, Korean-Russian, Polish-Russian, and other languages. In early March 1960, some 25 different military dictionaries were in the works at the House, in various stages of compilation.

In the current supply

of Russian dictionaries available for sale in the United States, the electronics part of *International Electrotechnical Vocabulary (Group 07, Electronics)* should be cited as quite comprehensive. Its second edition, issued in Moscow in 1959 by the State Publishing House of Physical-Mathematical Literature, effectively uses two methods: terms and their definitions are given in Russian and English; terms alone (with no definitions) are listed in French, German, Spanish, Italian, Dutch, and Swedish. The dictionary, printed in various editions for different "groups," is gotten out under the auspices of the International Electrotechnical Commission, affiliated with the International Organization for Standardization in Geneva, Switzerland. Another solid dictionary in the same series is for *Group 10, Machines and Transformers,* published by the same house in Moscow in 1958, with the same arrangement by languages, except that Polish is substituted for Dutch.

American missile dictionaries

are most outstandingly represented by Alexander Rosenberg's *Russian-English Glossary of Guided Missile, Rocket, and Satellite Terms,* published by the Reference Department of the Library of Congress in 1958. In electronics, still useful is *English-Russian, Russian-English Electronics Dictionary,* issued as a Department of the Army Technical Manual in August, 1956. It is for sale by the Superintendent of Documents in the U.S. Government Printing Office. The *Russian-English Glossary of Aeronautical and Miscellaneous Technical Terms,* published a few years ago by the Air Technical Intelligence Center at the Wright-Patterson Air Force in Ohio, is not listed as a restricted item, but it is available only to U.S. Government personnel and government contractors.

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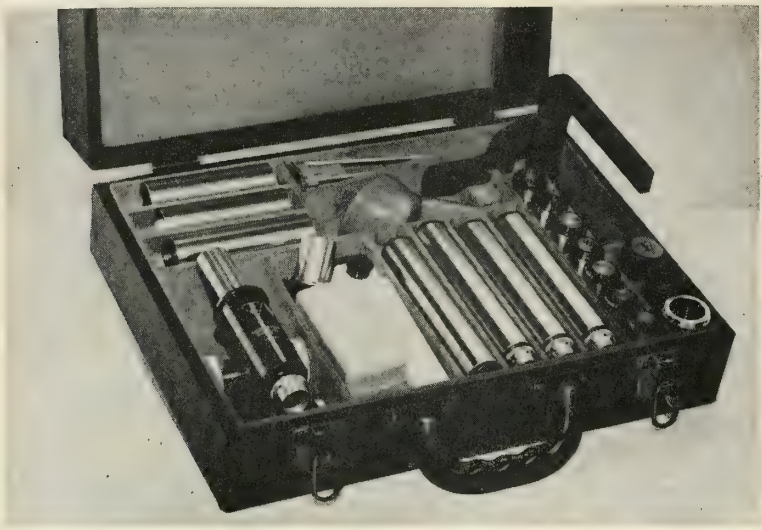
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Complete Optical Inspection Kit

Bausch & Lomb Inc. announces the availability of a complete set of industrial optical tools assembled in a single kit. Originally designed to be used exclusively by B&L personnel, the kit is now being marketed for its wide application to the industrial and engineering fields. It brings together componets of fundamental measuring and examination tools and offers them in a single package.

The kit has value for quality control and inspection work, since the flexibility provided by its many component parts is a convenient way to meet changing job requirements. Within the kit are more than 20 optical units which can be assembled into a variety of optical viewers, surface comparators and microscopes. The case, with full compliment of parts, weighs only 16¾ pounds.

Magnifications vary from 7x, with the small optical viewer, to combinations of 10x, 20x, 40x and 80x, with the various microscopes. Also included is a selection of reticles and measuring scales ranging from divisions of 0.001 in. to 0.005 in. The instruments are suitable for mounting on machinery as well as for bench inspection.

Circle No. 225 on Subscriber Service Card.

High Voltage Varactors

A series of diffused junction varactor diodes with high voltage breakdown properties is available from Microwave Associates, Inc.

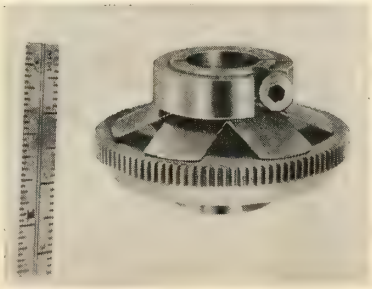
The complete series MA-4280 through MA-4292 (13 new diodes) range in junction capacitance values from 0.4 uuf measured at –6 volts, to 35 uuf maximum for the MA-4292. Junction capacitance at 0 volts is approximately twice the –6 volt value. At –30 volts, the junction capacitance is approximately one-half its value at –6 volts. The inverse breakdown voltage rating is –30 volts. Typical cut-off frequency of the new units is 30 kMc except for the large capacitance types which have about 2 ohms series resistance.

The units are mechanically interchangeable with 1N21, 1N23, 1N415, 1N416, 1N21WE, or 1N23WE point-contact diodes and the MA-450 and MA-460 varactor diodes.

Circle No. 226 on Subscriber Service Card.

Ball Bearing Slip Clutch

A slip clutch which eliminates galling and also maintains more uniform slipping torque is available from Dynamic Gear Co. Overall length of the unit is only 0.800 in.



The slip clutch has application as a safety device in expensive, complex gear trains. Installed in the train as a tensioning device, the unit will slip should output rotation be interrupted due to jamming or overloading. The Dynaco slip clutch can be set to a predetermined torque value and will maintain this value even after extended periods of slipping.

Circle No. 227 on Subscriber Service Card.

Low Noise Fan

The Cosmodyle Corp. is producing a Low-Noise Axial-Flow Fan, which operates with a noise level of less than 65 db. The fan, which was designed for ship-board and airborne applications, will deliver 140 CFM at a pressure rise of 2 in. H_2O. The motor is designed in conformance with the requirements of Specification MIL-M-1940. It operates on 400 cycle, 3-phase, 115 volts. The fan housing is 4.25 inches in diameter and is 4.5 in. long, and the unit is finished in accordance to MIL-C-6805.

Circle No. 228 on Subscriber Service Card.

Telemetry Band Unit

A completely solid state telemetry band unit incorporating electronic commutation and a single multi-input amplifier has been announced by Solidtronics Division of Electrosolids Corp. It is designed to handle any number of low level input transducer signals and is available in all of the IRIG bands.

The system consists of an electronic commutator, carrier amplifier, subcarrier oscillator and discriminator network. The electronic commutator is available in plug-in modules of five inputs each which can be added by simply plugging in to obtain as many inputs as desired. The physical unit is made up of the basic module containing a two input commutator, carrier amplifier, subcarrier oscillator and discriminator network and the additive five-input plug-in modules.

Circle No. 229 on Subscriber Service Card.

Reference Tunnel Diodes

The General Electric Co. is now manufacturing two new germanium tunnel diodes designed for use as circuit reference elements.

The devices' peak point current ratings of 2.2 ma and 4.7 ma conform to the preferred value standards set by industry associations for electronic components.

The 1N2969 has a typical peak point current of 2.2 ma and the 1N2941 has a typical peak current of 4.7 ma. This rating is held to a variation of no more than 10% in both tunnel diodes.

Both devices have typical peak to valley current ratios of 8 to 1. The 1N2941 has a total capacity of 30-mmfd while the 1N2969 is rated at a total capacity of 20-mmfd.

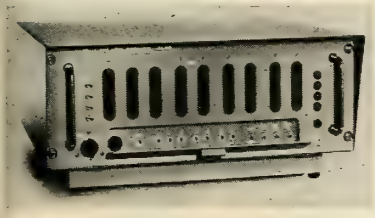
Both tunnel diodes have typical peak point voltages of 55-mv, typical valley point voltages of 350-mv, and typical forward peak point current voltages of 500-mv.

The new G-E current reference tunnel diodes are rated for operation over an ambient temperature range from –55°C to 100°C.

Circle No. 230 on Subscriber Service Card.

Correlation Device

Time correlation of data recorded by various instrumentation devices using the proposed IRIG code is now possible with the EECO Model ZA-810 Time Code Generator from Electronic Engineering Co.



The compact, single chassis solid state unit is suitable for laboratory or field use as the heart of an instrumentation timing system. The ZA-810 has the accuracy and stability (three parts in 10^8) equivalent to a secondary standard.

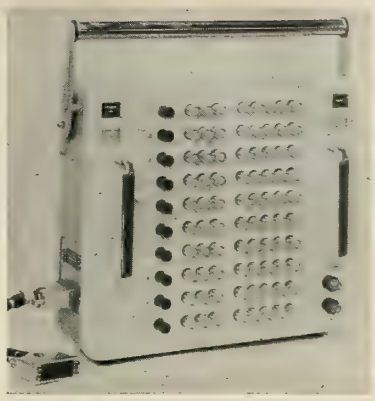
The two outputs of the unit are in DC level shift form and modulated 1000 cps. carrier. The 36-bit code indicates time-of-day and day-of-year and is read out once per second at a 100 pps rate. The unit employs a "leap year switch" to provide for the extra day every four years for long duration timing programs.

Circle No. 231 on Subscriber Service Card.

Tape Frame Simulator

A portable Tape Simulator for manual entry of data into punched tape systems is available from Hallamore Electronics, a division of the Siegler Corp.

The Tape Simulator, Model 0359, has a capacity of 80 bits of information, each entered by a push button on the instrument's panel. The 80 buttons are arranged in 10 lines and 8 channels to coincide with the common 8-channel punched tape code. As each push button is depressed it lights up to



facilitate easy reading of the program that has been punched. Each of the ten lines can be reset by its own reset button, and the entire panel can be cleared for a new entry by a master "clear" switch. A lamp test switch turns on all lamps to facilitate maintenance and checkout.

Circle No. 232 on Subscriber Service Card.

Refractory Thermocouple

A refractory metal thermocouple combination for reliable temperature measurement up to 2800°C (5072°F) is now available from Engelhard Industries, Inc. The new combination consists of tungsten vs. tungsten 26% rhenium and is suitable for use in vacuum, hydrogen or inert gases such as nitrogen, argon and helium.

Recommended for use at 2000 to 2800°C (3632 to 5072°F), its high output also makes it useful at lower ranges. The combination of high melting point with low vapor pressure makes it attractive for use in vacuums at both high and intermediate temperatures.

Circle No. 233 on Subscriber Service Card.

Sub-Subminiature Switch

A sub-subminiature environment-sealed switch—designed for missile, aircraft, and mobile applications—has been introduced by Micro Switch, a division of Minneapolis-Honeywell Regulator Co. The switch operates dependably in temperatures from –65 to 250°F, the company said.

The single-pole double-throw switching unit is housed in a sealed enclosure which has been evacuated and filled with inert gas to insure constant operating characteristics. An O-ring seal on the actuator shaft, glass-to-metal terminal seals and potted lead wire termination keeps dust, moisture or air out of the switching chamber. An ice-scraper ring removes ice or mud from the actuator shaft.

Circle No. 234 on Subscriber Service Card.



Circle No. 10 on Subscriber Service Card.

Weighs Liquid Propellants

A weighing system for liquid propellant storage tank installations is available from Gilmore Industries, Inc. The Model 176-A is designed to 1) weigh fuel stored in the tanks and 2) determine a weight versus "time flow" relationship for accurate calibration of flowmeter transducers.



A printout is provided every second by time correlation, to permit a sufficient number of points to accurately determine a curve of weight flow versus time. Checking this against flowmeter output results in a calibration curve for any particular flowmeter. The data is picked up instantaneously with the servo running, and the only error in this type of system is the lag of the servo behind true weight.

Calibration is provided by a M170 Digital Indicator Load Cell Calibrator.

Circle No. 235 on Subscriber Service Card.

Disk Storage Device

Laboratory For Electronics' Computer Products Division, announces a line of rotating magnetic disk storage devices, the BD-100 (Bernoulli Disk) Series, for commercial application.



The flexible rotating Disk of paper-thin magnetic mylar material maintains a small, controlled separation between the storage disk-medium and the read/write heads of the memory unit through utilization of basic fluid motion principles.

Due to the low mass of the revolving disk, the positive separation constantly maintained between disk and back plate, the air-tight sealing of the entire unit, and the simplification of machining required, the Bernoulli Disk-100 Series offers many advantages over conventional drum-type memory units.

Circle No. 236 on Subscriber Service Card.

Miniature Drill Head

A multiple drill head providing speeds high enough for very small drills on center distances as small as 3/8 in. has been announced by Metron Instrument Co. Especially designed for precision production of miniaturized parts, the Metron drill head features speed ranges of 0-8000 RPM, which makes possible the use of extremely small drills. All spindles are ball-bearing mounted; gears are case-hardened; hole center tolerances are ±.001 in. Maximum distance between centers is 3 in.; maximum drill size, #20. Case size is 2 in., 3 in., or 4 in. dia., depending upon particular requirements of individual user.

Circle No. 237 on Subscriber Service Card.

Swiftest Silicon Switch

The fastest silicon mesa switcher in industry is being supplied by Texas Instruments.

The guaranteed features of the 2N706A include: dc beta ranges of 20 to 60; lower T_s (charge storage time constant) of 25 nanoseconds maximum; guaranteed lower output capacity from 6pf to 5pf; turn-on time (T_{on}) of 40 nanoseconds maximum; turn-off time (T_{off}) of 75 nanoseconds maximum; minimum BV_{ceo} of 15 volts at a sustaining current of 10 mA; and maximum I_{cer} (RBE = 100K) of 10 uA at 20 volts V_{ce} (which gives a practical "Switch off" test).

Circle No. 238 on Subscriber Service Card.

Telemetering Commutators

A size and weight reduction of 67% is the principal feature of a new solid-state multi-coder developed by General Devices, Inc.

The unit, a completely self-contained telemetering commutation package, contains in one housing two high and two low level commutators, two power supplies, inverter, amplifier gate matrix, and probe. The entire package measures 7¾ in. x 3¼ in. x 2½ in. and weighs 5¼ lbs.

Designed to sample and sort high and low level signals in standard PAM/FM telemetry applications for missiles and aircraft, the unit will operate directly from 28 volt power source in peak accelerations up to 75 "g", and in temperatures up to +300°F. The multi-coder is designated as Model S-857-1B, and has been qualified for the *Titan* and *Minuteman* programs.

Circle No. 239 on Subscriber Service Card.

Subcarrier Oscillator

A high-input impedance, millivolt transistorized subcarrier oscillator is available from Hoover Electronics Co., with floating input and essentially infinite common mode rejection.

Model 10081 has an input impedance of 50,000 ohms, provides full frequency deviation output for only 20 millivolts input, maintains linearity within 1% of bandwidth and a frequency stability within 2.5% over the temperature range of 0° to 85°C.

The oscillator is available for channels 5 through 18 and A through E and is manufactured to IRIG standards.

Circle No. 240 on Subscriber Service Card.

Video Band Recorder

The Mincom Division of Minnesota Mining and Manufacturing Company is producing a CM-100 Video Band Recorder/Reproducer. This new system records both analog and pulse signals. At any one of its six speeds, the CM-100 is capable of twice the frequency response of similar equipment previously produced—1 mc at 120 ips, 500 kc at 60 ips, 250 kc at 30 ips, 125 kc at 15 ips. Overall bandwidth is 400 cycles to 1.0 megacycle per track. The 7-track system is packaged in a single, standard size rack and offers selection of six speeds ranging from 7½ ips to 120 ips with instantaneous speed control.

Circle No. 241 on Subscriber Service Card.

Heavy Duty Stopwatch

A new precision 12-hour stopwatch, specifically designed for panel-board and dash-board mounting, is available from Heuer Timer Corp. It incorporates shock-resistant heavy-duty features (Incabloc jewel mountings, solid man-size crown, Plexiglas crystal, and heavy dust-proof housing s p e c i a l l y which qualify it for aircraft, marine plated for brine and sweat resistance) and test-bench service. The large jumping hour-disc, the full-circle center-shaft minute register, the bold luminous

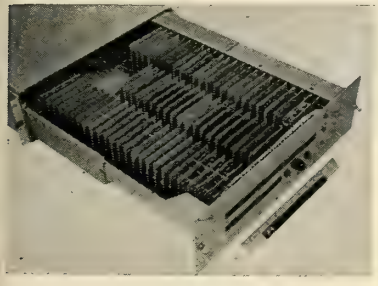
markings on a non-reflective black face, and the knurled turning bezel with its large set mark—all make for easy visibility and fast reading under the half-light of shop or cockpit.

For process and research instrumentation which requires decimal data, an alternate dial face with extra peripheral divisions in hundredths-of-a-minute is provided.

Circle No. 242 on Subscriber Service Card.

Core Memory Tester

A solid-state Magnetic Core Memory Tester from Packard Bell Computer verifies the operational status of a 19-bit, 4, 096 address core memory. Designed to fit a standard relay rack, the Memory Tester measures 5-¼" high x 19" wide x 20" deep. The power requirement is 105 to 125 VAC, 50/60 cps.



The core memory test may be made on selected addresses and bits or in sequence on all addresses with every combination of the 19-bits. During the test it is possible to start, stop, or restart from any address with any word pattern.

Circle No. 243 on Subscriber Service Card.

ECM Cooling Package

A miniaturized vane pump with integral relief valve and electric motor combination has been added to the Vickers line of packaged components and systems for aircraft and space vehicles. The 3.0 pound package is used as a coolant motorpump for electronic countermeasures equipment (ECM).

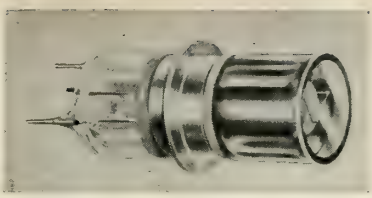
This package occupies approximately 28 cubic inches of space. The main feature is the replaceable vane pump cartridge that simplifies service.

The pump delivers 1.05 gpm at 90 psig pressure. It is nominally rated for 1000 hours continuous duty at operating temperatures ranging from −65°F to +160°F at 11,000 rpm speed.

Circle No. 244 on Subscriber Service Card.

Fast Infrared Detector

An infrared detector of extremely small area (0.1x0.1 mm²) is being produced by Radiation Electronics Company, a division of Comptometer Corp.



Utilizing the photovoltaic effect in indium antimonide at liquid nitrogen, the Model J-02 detector exhibits typical NEP values of 2×10^{-12} watt at 5 microns and 7×10^{-12} watt for 500°K blackbody. The J-02 responds from the visible region to 5.7 microns with a time constant of less than one microsecond.

Circle No. 245 on Subscriber Service Card.

High Temp Cement

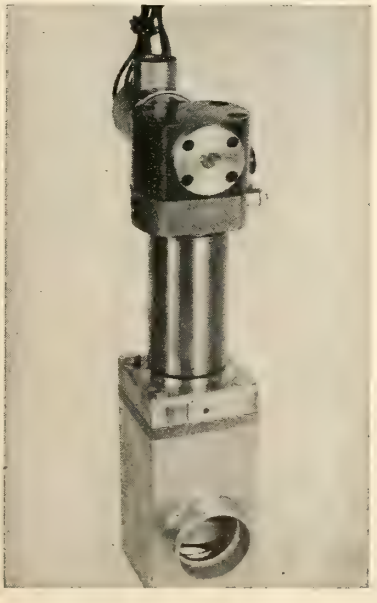
Instrumentation Associates has available a new high temperature cement product known as Astroceram Cement Type A and B. Astroceram A, a high temperature cement (over 4300°F) can be air dried. It exhibits particularly good adhesion to metals, suggesting possible use in coating, seals, and feedthroughs. Application is simple.

Astroceram Cement Type B is a high temperature (over 5000°F) cement which must be fired to develop a bond. This cement gives excellent bond strength with refractories. It has very low thermal expansion and exceptional resistance to heat shock.

Circle No. 246 on Subscriber Service Card.

Pneumatic Vacuum Valves

A complete line of compact pneumatically operated vacuum valves is being sold by Veeco Vacuum Corp.



Designated type "PV", these valves are bellow-sealed construction and are sold in 5/8, 1 and 1.5 in. port size. Each valve is individually tested on a Veeco mass spectrometer leak detector assuring no leak at a sensitivity of 1×10^{-10} std.cc's/sec.

Available for either right angle, or in-line application, the Veeco "PV" valve can be mounted either vertically or horizontally and can be obtained with either pipe thread or solder connections.

Circle No. 247 on Subscriber Service Card.

Tension Liquid Spring

A Tension Liquid Spring using liquid compressibility is available from Taylor Devices, Inc.

This Taylor T823 Tension Spring may be preloaded up to 300 lbs. with an end force of 800 lbs. As a shock absorber, this spring will absorb up to 1000 in. lbs. of energy.

With a ½ in. stroke, this 1 in. diameter by 3 in. long (plus mounting ends) the Spring equals 5 coil springs of the same dimensions. These Taylor Springs are complete with end attachments.

Circle No. 248 on Subscriber Service Card.

Finned Heat Sinks

Relco Products is currently producing six types of heat radiators which dissipate heat rapidly by means of machined integrally finned aluminum surfaces.

The heat radiators are machined from solid aluminum cylinders to permit great design flexibility. Radiating surfaces of 35 to 65 square inches are machined to rigid specifications to give low thermal resistance.

A hard anodized insulating surface provides the maximum in thermal radiation and meets military specifications for long life and durability.

Circle No. 249 on Subscriber Service Card.

Sub-Miniature Ceramics

Sub-miniature ceramics within extreme tolerances are available from American Lava Corp. The webs are held to ±0.001 in. and comparable tolerances are held on concentricity.

The parts are made in a high strength AlSiMag alumina ceramic. However, these parts can be made with comparable precision in any of several AlSiMag compositions.

Circle No. 250 on Subscriber Service Card.

Ganging Air Valves

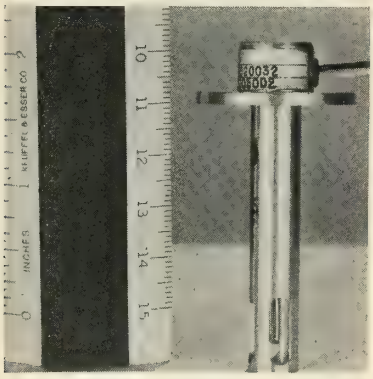
Solenoid operated air valves from Mechanical Air Controls, Inc. can be combined quickly and easily to provide a single, compact and inexpensive manifold to suit the exact requirements of any application. Two to ten (or

more) MAC "add-a-unit" manifold-base 4-way valves may be ganged together to form common inlet, common exhaust and common conduit channels. If more than one pressure is to be used, valves can be isolated and pressure fed from each end of the manifold.

Circle No. 251 on Subscriber Service Card.

Mercury Tube Thermostat

A tiny, reliable mercury tube thermostat, used to accurately control the temperature of the ground support equipment is available from Vap-Air Division of the Vapor Heating Corp.



The Merc is a single built, single setting (45°F) accurate to ±1°F with 1.5°F differential.

Circle No. 252 on Subscriber Service Card.

Tough Spaghetti Tubing

A line of Spaghetti Tubing and Monofilament is available from Pennsylvania Fluorocarbon Co., Inc. Extruded from a new, tough, clear, modified trifluorochloroethylene polymer, Penntube III has the unusual thermal and chemical stability of fluorocarbons and the advantages of lower cost, transparency and heat sealability. Available in monofilament down to .008″ and spaghetti tubing in AMS 3648 sizes.

Circle No. 253 on Subscriber Service Card.

Size Eight Gearheads

Kearfott Division of General Precision Inc., has added Size 8 units to its extensive line of gearheads for servo motors and motor generators. Centered-shaft gearheads are available in 28 ratios, ranging from 7.62:1 to 1254:1, and eccentric-shaft gearheads can be provided in 25 ratios, ranging from 7.62:1 to 903:1. Shafts may be plain, pinion, or of special design. A specific gearhead may be mounted on any Kearfott motor or motor generator of the proper size and having the proper shaft configuration.

Circle No. 254 on Subscriber Service Card.

new literature

FILLER METAL CHART—Aluminum Company of America announced a filler metal selection chart for engineers, designers and shop men, that quickly specifies correct filler alloys for all recommended wrought alloy parent metal combinations. Filler alloy choices are based on parent metal combinations and common service requirements demanded of welded assemblies. In one table, parent metal combinations of wrought alloys currently recommended for welding, are indicated. Acceptable filler metal alloys are listed for each combinations, and given an A, B, C, or D rating for each of the following service requirements: ease of welding; strength of welded joint, corrosion resistance; service suitability at temperatures exceeding 150°F; color match after anodizing; and ductility.

Circle No. 200 on Subscriber Service Card.

DENSITY METERS—A 48-page general catalog (No. 604) has just been issued by Empire Devices Products Corp. It describes and illustrates the company's entire line of noise and field intensity meters, impulse generators, power density meters, modulation meters, coaxial attenuators and terminations, crystal mixers and microwave components. Fully indexed, each catalog section provides information on applications, features, characteristics and specifications, as well as a photograph and descriptive text, for every product in the Empire Devices line. Where necessary, line drawings and tabular data are also included.

Circle No. 201 on Subscriber Service Card.

POROUS METAL—A two-page, two-color, technical bulletin discussing Porostrand, a new type of porous metal made by wire winding techniques, is now available from Bendix Filter Division, Bendix Aviation Corp. This bulletin covers both filteration and non-filteration applications of Porostrand porous metal. Typical applications are listed together with outstanding features, which include an extremely wide size range of the finished Porostrand structures.

Circle No. 202 on Subscriber Service Card.

VIDEO BAND RECORDER—Extended capabilities of Mincom's new CM-100 Video Band Recorder-Reproducer are detailed in 12-page, 4-color brochure by Minnesota Mining and Mfg. Co. The new system records and reproduces both analog and pulse signals. Single, standard size rack contains 7-track system covering an overall bandwidth of 400 cycles to 1.0 megacycle on each track. Illustrated curves show greater bandwidths at lower speeds; for example, frequency response up to 1.0 megacycle at 120 ips, 500 kc at 60 ips. Instantaneous selection of six speeds ranging from 7½ ips to 120 ips on single ½-inch tape.

Circle No. 203 on Subscriber Service Card.

SUB-SUBMINIATURE SWITCH—Data Sheet 169 describes the new environment - free sub - subminiature switch, catalog listing 1XE1, developed by Micro Switch, a Division of Minneapolis-Honeywell Regulator Company. Data Sheet 169 includes full description, dimensions, electrical ratings, mechanical characteristics and other important information.

Circle No. 204 on Subscriber Service Card.

OSCILLOGRAPHS—The Heiland Division of Minneapolis-Honeywell Regulator Company has published a new 36-page manual that illustrates the applications of its direct-recording Visicorder oscillograph. Designed as a reference guide for engineers and scientists, the booklet contains 18 case history descriptions of how Visicorders have been used in widely different ways.

Circle No. 205 on Subscriber Service Card.

HIGH TEMPERATURE RESISTORS—A high temperature, non-inductive resistor is described in a new bulletin, CE-2.07, available from Corning Electronic Components. The bulletin states that Corning ST-type resistors were designed for power circuits requiring minimum component volume and maximum power dissipation. They are made by fusing a tin-oxide film to the surface of glass rod, then coating the assembly with ceramic cement.

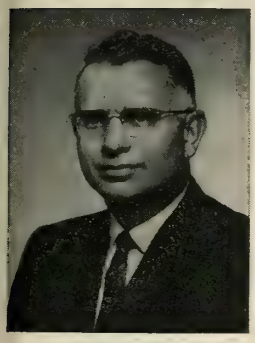
Circle No. 206 on Subscriber Service Card.

TOROIDAL INDUCTORS—A comprehensive ready-reference wall chart on toroidal and variable inductors has been published for design engineers by Burnell & Co., Inc. The three-color chart measures 24″ x 36″ and has metal edging top and bottom to insure its hanging flat against a wall. Twenty graphs provide Q versus frequency curves for several ranges of voltage or inductance.

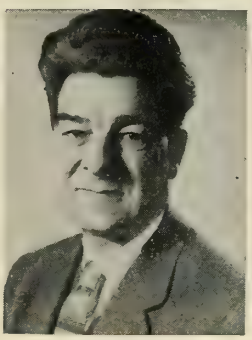
Circle No. 207 on Subscriber Service Card.

BORON—A 24-page booklet entitled "Borax and Other Boron Compounds" has just been published by Stauffer Chemical Company. Contents include data on the production, uses and chemistry of borax, borax glass and boric acid. Also outlined are properties, reactions and uses of boron oxide, boron trichloride and thirty other boron compounds now available in research quantities.

Circle No. 208 on Subscriber Service Card.



WHITSON



PRITCHARD



JOHNSON



COHN

Dr. William L. Whitson: Elected vice president of The Martin Co. Prior to joining the firm he was Daystrom, Inc's vice president, engineering and previously acting chief scientist for the Advanced Research Projects Agency.

Dr. Edward M. Pritchard: Named director of engineering for the Military Systems-Stavid Division of Lockheed Electronics Co., directing Airborne Electronics, Electromagnetic Systems, Shipboard Electronics, Special Projects, Advanced Techniques and Advanced Systems.

Dr. Ralph P. Johnson: Appointed vice president, Electronics Divisions, Thompson Ramo Wooldridge Inc. responsible for TRW's Commercial Electronics Group, Electronic Components Group, Pacific Semiconductors, Inc., Ramo-Wooldridge Division and The Thompson Ramo Wooldridge Products Co.

Dr. Seymour Cohn: Former head of Stanford Research Institute's Electromagnetic Laboratory, joins the Rantec Corporation as vice president and technical director. He succeeds **Dr. Robert S. Elliott,** now a professor at UCLA, who will remain with the firm on a consultant basis.

Richard P. Thornton: Appointed general manager of the Packaged Electronics Division of Amphensol-Borg Electronics Corp.

Howard H. Hubbard: Former Space Technology Laboratories' South Point, Hawaii, manager, named director of a newly formed Commercial Microwave Systems Division of D. S. Kennedy & Co.

Guy J. Sanders: Director of engineering for the Industrial Acoustics Co., appointed chief engineer of the Sound Control Department, Metal Products Division, Koppers Co., Inc.

George Friedl, Jr.: Former Litton Industries vice president, joins Houston Fearless Corp. as director of operations in its Houston Fearless Division.

Laurence H. Cherry: Former chief of planning, research and development at Solar Aircraft Co., joins Grand Central Rocket Co., as associate director of marketing.

Peter P. Pruce: Former consulting engineer for research and development in the Airborne Systems Laboratory of Hughes Aircraft Co., joins Lynn-Western, Inc., as executive vice president and director of client services.

Harold A. Goldsmith: Appointed president of The Siegler Corp.'s Bogen-Presto Division. Was co-founder of Magnetic Amplifiers, Inc., recently merged with The Siegler Corp.

H. French Harris: Named manager of the *Discoverer* and *Samos* satellite projects at Philco Corp.'s Western Development Laboratories. Was formerly systems design and integration section manager.

W. C. King: Former sales manager for Commercial and Government products for The Hammerlund Manufacturing Co., elected district manager of Wilcox Electric Co., Inc.'s new marketing office in the New York City area.

B. F. Coffman, Jr.: Appointed manager of Aerojet-General Corp.'s Hybrid Rocket Engine Projects. Was formerly head of the Navy's rocket branch, Bureau of Aeronautics.

James R. "Bob" Bruce: Former technical program coordinator of the research projects lab at the Army Ballistic Missile Agency, named assistant manager of Northrop Corp.'s Huntsville, Ala., district office.

Dr. Donald A. M. Mackay: Appointed director of research at Evans Research and Development Corp.

John M. Britton: Elected manager of research and development contract sales for Hughes Aircraft Co.

William J. Tull: Vice president, GPL Division of General Precision, Inc., received The Thurlow Navigation Award, the highest honor conferred for advancing the science of navigation. He received the citation for his work as the pioneer of Doppler navigation.

Francis X. Buschman: Former vice president in charge of operations for Tensolite Insulated Wire Co. named director of research, development and engineering at Hitemp Wires, Inc.

Royce Johnston: Former senior research engineer with North American Aircraft's Rocketdyne Division, named western regional sales manager for Sealol, Inc.

Raul H. Frye: General manager of the Sparton Electronics Division, elected vice president of the Sparton Corporation. Prior to joining the firm he was assistant general manager and marketing manager of the Defense Products Division of Fairchild Camera and Instrument Corp.

Lawrence H. Stanley: Former executive vice president of Case-Stanley Marketing Consultants, Inc., elected to the newly created position of manager of marketing services for ACF Industries.

Dr. Tai Nien Feng: Former consulting engineer in the Avionics Division of John Oster Manufacturing Co., elected associate director of research for Control Data Corporation.

Dr. Arch C. Scurlock: Elected to the board of directors of C-E-I-R, Inc. Cofounder and president of Atlantic Research Corp., he is also a director and president of the Greater Washington Industrial Investments, Inc.

David F. Frost: Former specialist in the design and development of lumped constant delay lines at R. D. Brew Co., named project engineer in the wire wound delay line division of Andersen Laboratories, Inc.

Frank J. Delves: Appointed vice president-Foreign Marketing for General Precision, Inc., a subsidiary of General Precision Equipment Corp.

contracts

NAVY

$500,000—**Summers Gyroscope Co.**, Santa Monica, Calif., for a quantity of free gyros for use with the *Terrier* and *Tartar* missiles. Subcontract from **Convair.**

$57,911—**Chrysler Corp., Engineering Division,** Detroit, for conducting a research program on semiconducting compounds for thermoelectric power generation at high temperatures.

AIR FORCE

The Hunter-Bristol Division, Thiokol Chemical Corp., for furnishing a shaped-charge system to effect in-flight stage and canister separation on the *Cree* missile. Amount not disclosed. Subcontract from **Goodyear Aircraft Corp.**

$26,000,000—**Remington Rand Univac**, for production and testing of electronic ground guidance computers for the *Titan* missile.

$12,894,376—**Burroughs Corp.**, Detroit, for 36 coordinate data transmitting sets and 40 aircraft detector kits for use with *Sage*.

$7,577,988—**Gilfillan Brothers, Inc.**, Los Angeles, for 165 modification kits for ground control approach equipment and 25 modification kits for mobile radar approach control equipment.

$7,000,000—**Vitro Laboratories Division of Vitro Corp.**, for operation and maintenance of all test instrumentation at Eglin and four other locations which make up the Eglin Gulf Test Range.

$2,963,046—**Motorola Inc.**, for 22 microwave systems for use in radar approach control centers.

$1,392,200—**Bendix Corp., Radio Division,** for phase-in of radio repairs and maintenance on U.S. and Pacific area facilities.

$1,993,000—**International Business Machines Corp., New York City,** for 72 situation display consoles for Sage semi-automatic ground environment computers.

MISCELLANEOUS

$87,651—**Ortholog Division, Gulton Industries, Inc.**, Princeton, N.J., for a tape editor system to be used in studying the performance of missile re-entry vehicles or nose cones. Subcontract from **General Electric Co.**

ARMY

$13,387,382—**Hughes Aircraft's Ground Systems Group**, Fullerton, Calif., for 13 fire distribution systems for air defense batteries.

$8,825,623—**The Martin Co.**, Orlando, for 15 sets of major components for the Missile Master System.

$8,176,000—**General Dynamics Corp's Convair Division**, Pomona, Calif., for continued development of the *Mauler* missile system.

$7,199,262—**Convair**, Pomona, Calif., for development of the *Mauler* system.

$7,000,000—**Sperry Rand Corp.**, Salt Lake City, for the *Sergeant* missile system.

$6,800,000—**The Martin Co.**, for test equipment and engineering services on the *Lacrosse* missile.

$6,757,290—**Douglas Aircraft Co.**, Santa Monica, for *Nike-Hercules* ground support equipment.

$5,000,000—**Belock Instrument Corp.**, College Point, N.Y., for electronic radar simulator systems.

$4,177,049—**The Emerson Electric Manufacturing Co.'s Electronics and Avionics Division**, for rocket motor metal parts for the XM-50 *Honest John*.

$4,097,513—**Western Electric Co.**, New York City, for repair parts to support improved *Nike-Hercules* Hipar equipment.

$4,047,476—**Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for *Honest John* rocket warheads.

$3,623,367—**Clark Equipment Co., Industrial Truck Division**, for 195 special rough-terrain fork trucks with swing-type crane for handling missiles.

$3,600,000—**Aerojet-General Corp.'s Aeronautical Division**, Downey, Calif., for continued development of the SD-2 surveillance drone system.

$3,517,675—**Raytheon Co.**, Waltham, Mass., for the *Hawk* missile system.

$3,394,051—**General Electric Co.**, Burlington, Vt., for work on *Little John* and *Lacrosse* weapon systems. Two contracts.

$3,171,320—**Raytheon Co.**, Waltham, Mass., for nine battery sets for the *Hawk* missile system.

$3,159,303—**Sylvania Electric Products**, Needham, Mass., for a large-scale mobile digital computor.

$3,150,974—**Northrop Corp.**, Van Nuys, Calif., for RP 76-3 target missile.

$3,085,103—**Belock Instrument Corp.**, for 25 *Hawk* missile system training devices.

$2,900,042—**The Martin Co.**, for the *Lacrosse* weapon system.

$1,363,676—**Douglas Aircraft Co.**, Santa Monica, for *Nike-Hercules* transporters.

$1,213,489—**Douglas Aircraft Co.**, for *Honest John* components.

$1,200,000—**Summers Gyroscope Co.**, Santa Monica, Calif., for a quantity of free gyroscopes for use with the *Lacrosse* missile. Subcontract from **Martin-Orlando.**

$1,131,299—**Stromberg-Carlson Division, General Dynamics Corp.**, for two engineering test models of single sideband tactical transistorized radio sets.

$1,084,983—**Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for *Sergeant* missile warhead fuses.

$1,077,096—**The Martin Co.**, Orlando, for the *Pershing* weapon system.

$993,447—**Belock Instrument Corp.**, Long Island, N.Y., for industrial engineering services in connection with the *Hawk* missile training device 3-G-36.

$588,000—**Whittaker Gyro Division, Telecomputing Corp.**, for gyroscopes used as part of the guidance system for the *Nike-Hercules*. Subcontract from **Western Electric Co., Inc.**

$333,813—**Arde-Portland, Inc.**, Newark, N.J., for research and engineering study in connection with the development of high-strength rocket motor cases by cryogenic stretch-forming for the investigation of cool solid propellant rocket nozzles.

$310,274—**The Wurlitzer Co.**, North Tonawanda, N.Y., for manufacture of two classified electronic devices.

$250,000—**Piasecki Aircraft Corp., Mayfield Electronics Division**, Mayfield, Pa., for electronic work.

$208,346—**Braddock, Dunn and McDonald, Inc.**, Yonkers, N.Y., for program of scientific assistance to White Sands Missile Range covering missile systems assigned to Ordnance Mission for testing and evaluation.

$73,000—**IBM, Federal Systems Div.**, Owego, N.Y., for fabrication, packaging and delivery to ABMA of one prototype digital computer.

$49,121—**Curtiss-Wright, Wright Aeronautical Division**, Wood-Ridge, N.J., for research and engineering study in connection with the development of high-strength rocket motor cases utilizing interlocked titanium wire.

$46,757—**Bulova Research & Development Laboratories**, Woodside, N.Y., for feasibility study directed toward "Optimization of Polecat Weapon System."

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DSD **DEFENSE SYSTEMS DEPARTMENT**
A Department of the Defense Electronics Division

GENERAL ELECTRIC

Northern Lights Office Building, Syracuse, New York

editorial . . .

Slippage and What's to Blame

Lost in the thunderous build-up to the presidential nominating conventions is a rather distressing piece of news. The Air Force has revealed that construction of the first combat *Atlas* ICBM pads at Warren AFB outside Cheyenne, Wyo., has slipped six months or more.

Remarkably, not very many people in Washington appear to be particularly concerned. The candidates have not yet picked it up as an issue—or even mentioned it. Yet here is a clear-cut instance where there will be further delay in closing the Missile Gap with Russia.

The pads at Cheyenne—six in the first squadron—were scheduled to be operational by April. In the middle of last month, Gen. Curtis LeMay looked over the installation and said it appeared the pads would not be ready until September.

The Air Force, when queried by M/R about the LeMay statement, said the slippage was confined solely to the first squadron at Cheyenne.

However, since then, reports have circulated that some slippage is to be anticipated in the finishing of some *Atlas* launchers at Offutt AFB near Omaha, Neb., this summer.

What is the reason for the delays?

The answer is at best rather nebulous. The newspaper at Cheyenne, the *Wyoming State Tribune,* notes that since construction started in 1958, about 24 months ago, there have been 21 labor disputes. Work stoppages, says the paper, have resulted more from inter-union jurisdictional disputes than from management-union issues.

But the unions say: "Not so."

They claim the stoppages have been short and scattered. They hold the Air Force responsible for any delays.

The Air Force, which for some not very clear reason (since *Atlas* is a crash program), says it has a "hands off" policy regarding labor disputes, and in a way, it indicates that it does not hold labor difficulties primarily responsible. For the Air Force has not requested any Executive Department intercession, nor does it intend—at the moment—to ask for any.

At the same time, the Air Force does not hold the contractor—Convair—responsible. It says simply that the task of readying the pads is an enormously complex job—a job being undertaken for the first time—that some delays are to be anticipated.

This seems a logical enough explanation. But it is rather interesting that the Air Force did succeed in putting a coffin-type pad—like the ones in the first Cheyenne squadron—in shape for a training shot last month from Vandenberg AFB.

True, the Vandenberg pad did not require all of the equipment going in at Cheyenne. But it is a reasonable facsimile. It shows most of the design and circuitry problems have been licked.

Then why the delay?

It is a curious characteristic of big government and big military programs that when something goes wrong it is very difficult to point the finger at who, or what, is to blame.

Indeed, the bigger a program gets the more difficult it is to single out a weakness and correct it—in time.

Bigness today is a challenge in itself. Just because something grows large does not mean it will move forward.

But bigness is not the only problem. The military and its contractors will set their own pace in the absence of strong direction and a persistent whip at their backs.

That whip really can be flicked only by the White House.

William E. Howard

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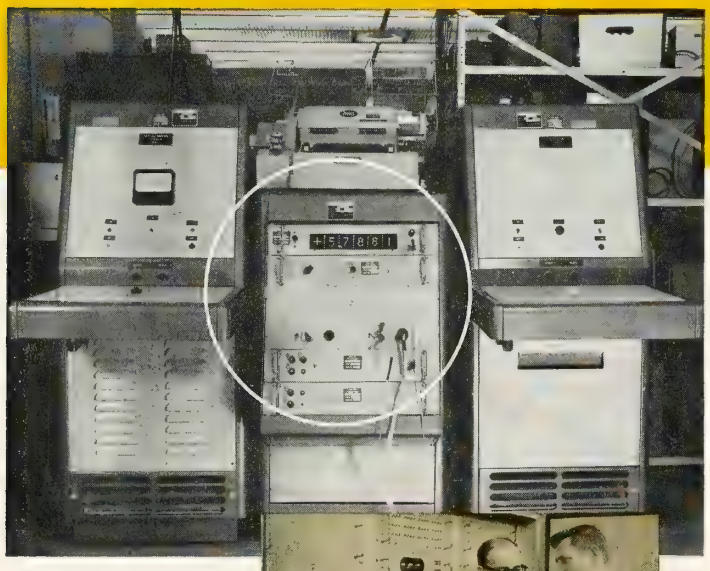
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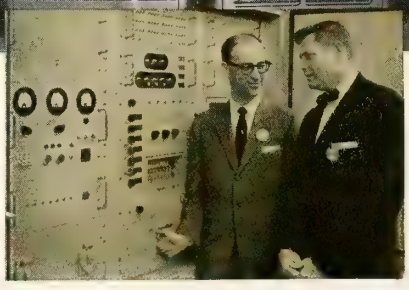
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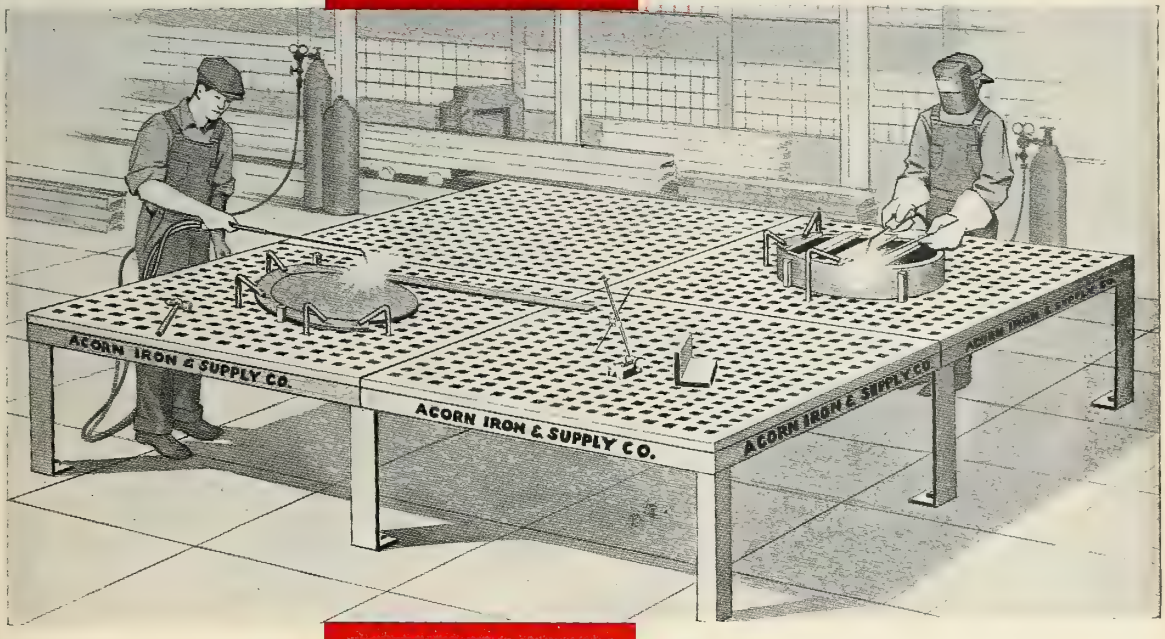
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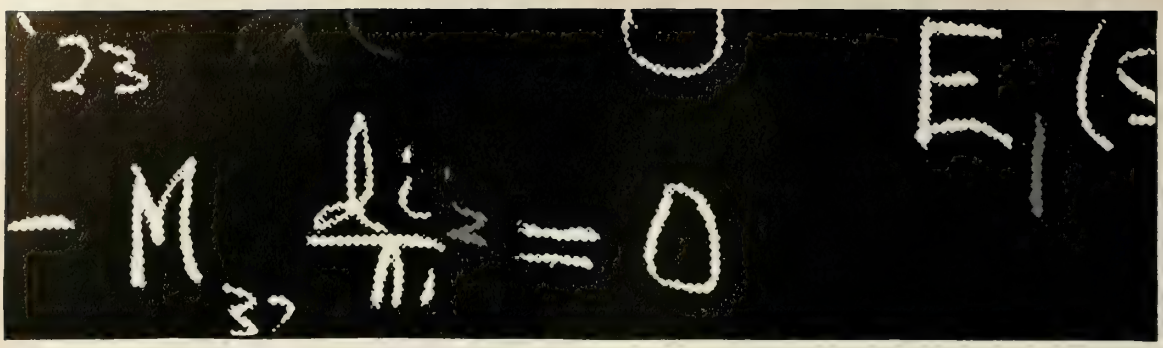
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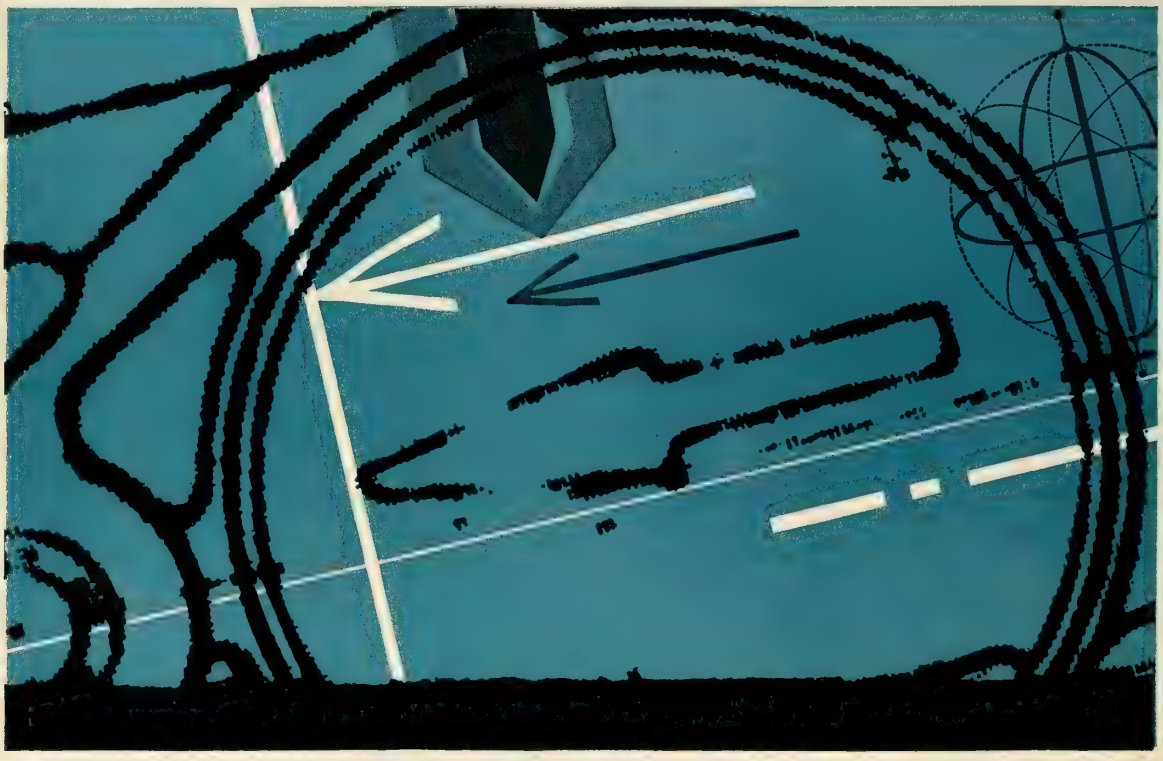
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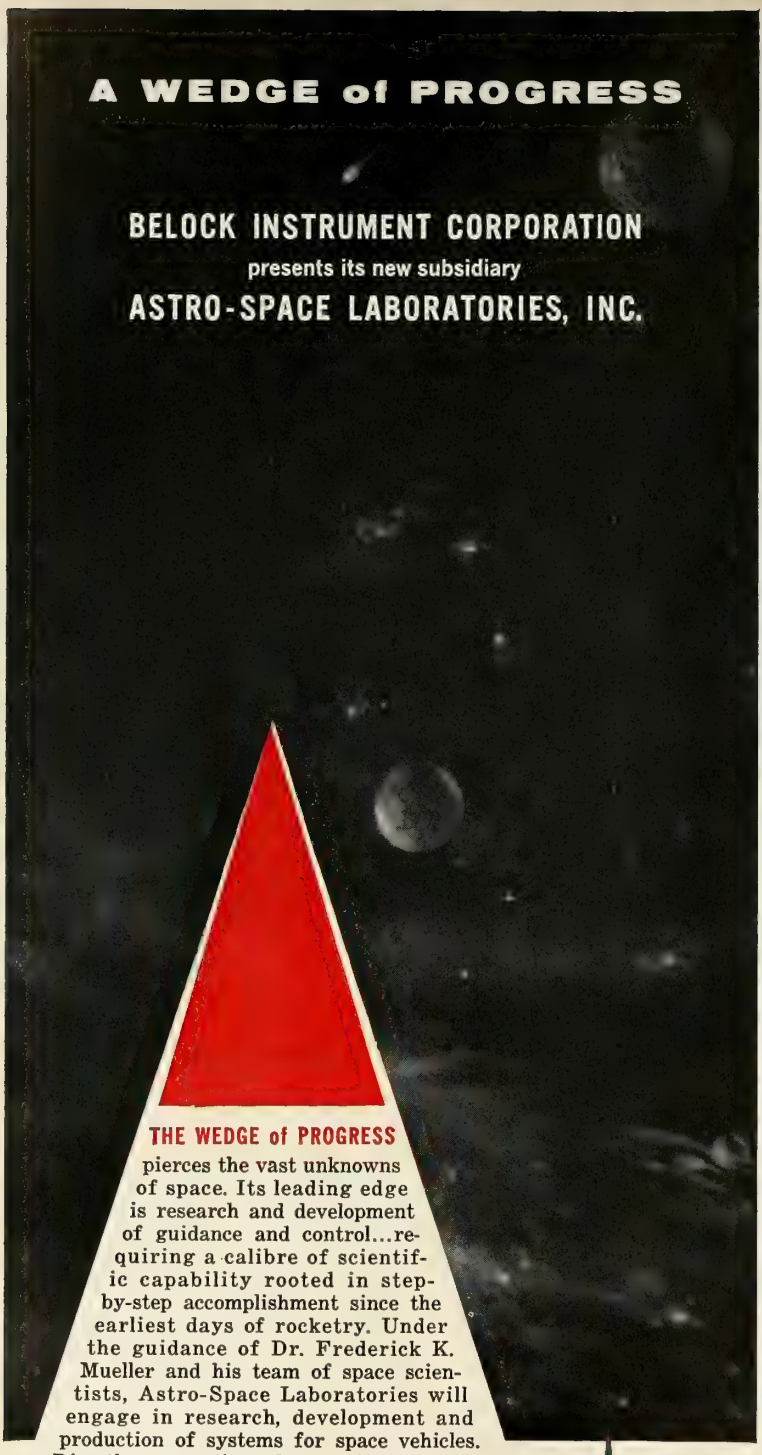
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American Rocket Society, Propellants Combustion and Liquid Rockets Conference, Ohio State University, Columbus, July 18-19.

Third International Conference on Medical Electronics, sponsored by Institution of Electrical Engineers, Olympia, London, July 21-27.

Pennsylvania State University R&D Management, Development Seminar, University Park, July 24-29.

Thermochemistry of Rocket Propulsion, a short course, University of Calif., Los Angeles, July 25-Aug. 5.

Denver Research Institute, Seventh Annual Symposium on Computers and Data Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

4th Global Communications Symposium, co-sponsored by IRE, Prof., Group on Communications Systems, and U.S. Signal Corps (100th Anniversary), Statler-Hilton Hotel, Washington, D.C., Aug. 1-3.

Massachusetts Institute of Technology, Special Summer Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.

International Symposium on Rarefied Gas Dynamics, University of Calif., Berkeley, Aug. 3-6.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Calif., Aug. 8-12.

ASME-AIChE Heat Transfer Conference and Exhibit, Statler Hilton, Buffalo, N.Y., Aug. 15-17.

XIth International Astronautical Congress, International Astronautical Federation, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, Colo., Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Germany, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Storrs, Institute, Aug. 28-Sept. 9.

The Combustion Institute, 8th Interna-

(Continued on page 14)

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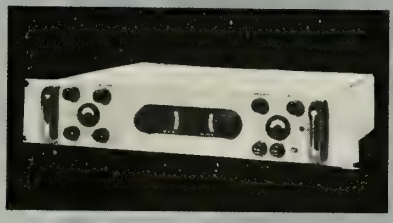
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10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

SEPTEMBER

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

SOCIETY of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Sept. 7-8.

Joint Automatic Control Conference, Mass. Institute of Technology, Cambridge, Sept. 7-9.

American Chemical Society, 138 National Meeting, New York, N.Y., Sept. 11-16.

Second International Congress in the Aeronautical Sciences, sponsored by the International Council of the Aeronautical Sciences, Zurich, Switzerland, Sept. 12-16.

IIIrd International Congress on Surface Activity, Cologne, Germany, Sept. 12-17.

Electronic Industries Association, Fall Conference, Sheraton-French Lick Hotel, French Lick, Ind., Sept. 13-16.

Engineering Management Conference, sponsored by American Institute of Electrical Engineers, and American Society of Mechanical Engineers, Morrison Hotel, Chicago, Sept. 14-16.

Armed Forces Chemical Association, 15th Annual Meeting, Sheraton Park Hotel, Washington, D.C., Sept. 15-16.

Institute of Radio Engineers, National Symposium on Space Electronics & Telemetry, Shoreham Hotel, Washington, D.C., Sept. 19-22.

ASME-AIEE Power Conference, Bellevue-Stratford Hotel, Philadelphia, Sept. 21-23.

Industrial Electronics Symposium, sponsored by Institute of Radio Engineers and American Institute of Electrical Engineers, Manger Hotel, Cleveland, Sept. 21-22.

Air Force Association, National Convention and Aerospace Panorama, San Francisco, Sept. 21-25.

American Ceramic Society, Electronics Division, Hotel Schroeder, Milwaukee, Sept. 22-23.

American Institute of Chemical Engineers, Mayo Hotel, Tulsa, Okla, Sept. 25-28.

A possible Earth to Venus Trajectory (dotted line) for 107-day flight programmed for burnout conditions over Cape Canaveral on 16 January 1961 at 15.65 hours (ephemeris time). Illustration shows positions of Earth, Venus, vehicle at eighteen-day intervals.



MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in defining space trajectories

Astrodynamicists at General Electric's Missile and Space Vehicle Department are currently mapping space . . . determining trajectories for flights from the Earth to other bodies of our solar system.

Under these funded studies, MSVD has recently completed a program of error analysis of trajectories to the Moon involving the four-body gravitational system, as well as a study of flight paths to Venus.

From consideration of the total gravitational field, specific space missions are computed when date of departure, trip time and launch site are specified. The exact launch burnout conditions are determined for the time of day which maximizes the additional boost caused by the Earth's rotation. Employing new techniques, MSVD scientists have made these determinations with as few as three corrective computer runs. These methods also can be applied to flights to other planets of our solar system.

In addition, the Department is developing methods to determine orbital parameters of earth satellites using only Doppler information. This MSVD experience in tracking techniques and computer programs permitted analysis of the Russian Lunik III trajectory.

For more information about MSVD's progress in all phases of space technology, write for the new Department Bulletin, Section 160-92, General Electric Co., Missile and Space Vehicle Department, Philadelphia 1, Penna.

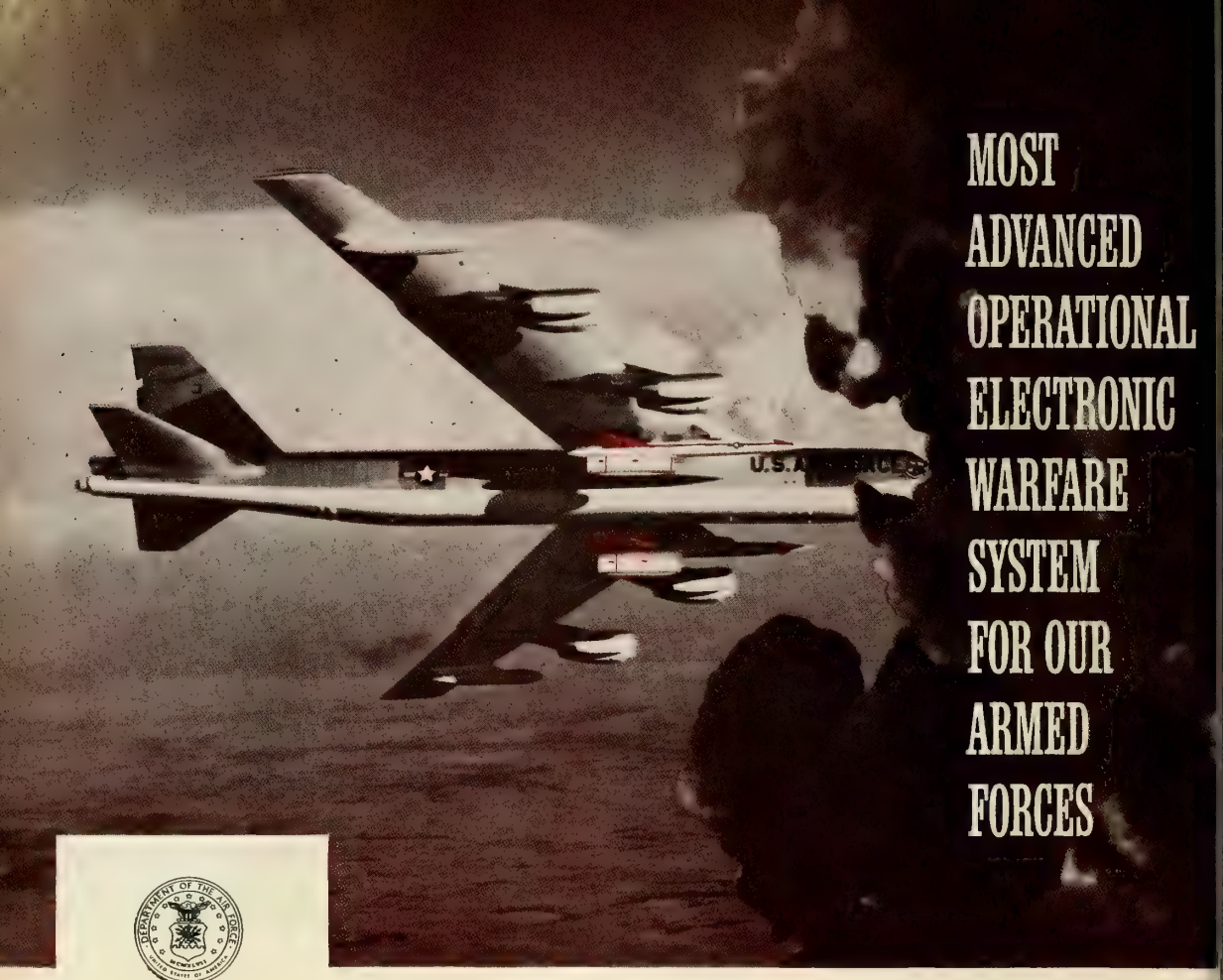
GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD

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MOST ADVANCED OPERATIONAL ELECTRONIC WARFARE SYSTEM FOR OUR ARMED FORCES

"Big Stick" of the Strategic Air Command, Boeing B-52 Missile Bomber fleet is being equipped with Hallicrafters Electronic Countermeasures, most potent means yet devised to confuse and disrupt hostile radar and missile guidance.

For more than a quarter-century, Hallicrafters has worked in close partnership with our armed forces on fast solutions to critical military electronics problems. Example: new airborne Electronic Countermeasures equipments of very advanced design, now being produced to protect our military aircraft. This kind of teamwork continues to pay off for America—in more effective, more reliable, more economical electronic warfare systems.

hallicrafters company

Facilities, and Quick Reaction Capability in Airborne, Ground, Naval and Missile electronic systems for countermeasures . . . reconnaissance . . . maintenance and technical support . . . communications.

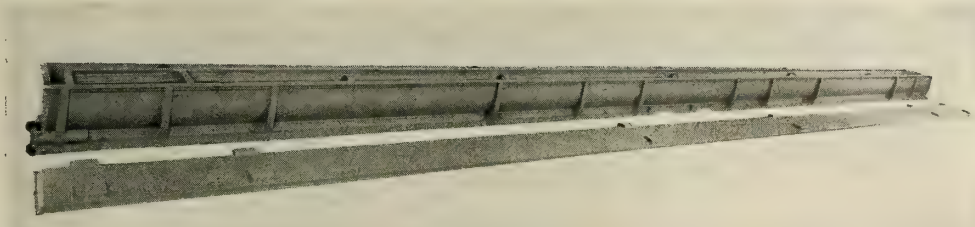
U R G E N T P R O B L E M S R E L I A B L Y S O L V E D

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The Baltimore Steel Company

PIONEERS & LEADERS

in the design and production of containers for rockets and missiles



Forty-three-foot-long aluminum containers created by The Baltimore Steel Company for the periscopes for the Polaris missile submarine, the Skate, the Nautilus and other atomic submarines. The Baltimore Steel Company is the only company producing this type of container. Designed, built and tested under contract with the U.S. Navy Bureau of Ships.

In the important race through space, where national survival is increasingly dependent on the precision and accuracy of this nation's missiles and rockets, it is vitally necessary that these missiles be packed, stored and delivered in the proper containers. These containers must be able to withstand vigorous transportation stresses under all sorts of atmospheric conditions, without in the slightest degree affecting the missile and disturbing its highly sensitive instrumentation and electronic equipment.

The Baltimore Steel Company is very proud of its role as a pioneer and leader in designing, creating and producing containers for the Military Services and industrial concerns, exactly tailored to the individual requirements of each program. The Baltimore Steel Company has been a major factor in the successful development of containers for all types of aircraft engines, missiles, torpedos, and various ordnance items.

From assisting in the creation of the original design, and through every step to the delivery of the finished product, The Baltimore Steel Company is well equipped, through experience and know-how, and with the capacity and capability to handle all container requirements promptly, efficiently, economically.

Containers for components of these other missiles have been designed and produced by The Baltimore Steel Co.

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- ●TERRIER
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- ●MACE
- ●CORPORAL
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There is no substitute for experience and know-how. The Baltimore Steel Company has built tens of thousands of containers for reciprocating engines, turbo-props, jets, torpedos, transmissions for tanks, and other ordnance material . . . where absolute accuracy, precision and dependability are required. The Baltimore Steel Company is successfully meeting new challenges and problems brought to it regularly by American industry and the Military Services.



Container for Inertial Guidance Platform for the Redstone Missile. This complex container, custom built by The Baltimore Steel Company, is insulated and thermostatically controlled, to prevent exposure to low temperature.

For immediate assistance write or call:

Container Division

The Baltimore Steel Company

1400 Eastern Avenue, Baltimore 31, Md. • 501 North Point Road, Baltimore 6, Md.



missile tracker for china lake

Kollmorgen Missile Tracking Binoculars are an integral part of an acquisition and photography system which records tactical air-to-air missile performance at China Lake Naval Ordnance Testing Station. These binoculars, adapted from a basic Kollmorgen design, are high magnification, wide-field instruments with unusual light-gathering power. An operator is able to spot a missile-launching aircraft and track the missile from the time it is fired until it finds its target—all at extreme ranges. Among other Kollmorgen contributions to the missiles field are the bunker periscopes at Cape Canaveral.

By combining optics, mechanics and frequently electronics, Kollmorgen designs many different types of instruments and systems for industrial and defense viewing and inspection applications. A new illustrated brochure describes our design and manufacturing facilities and primary fields of interest. For your copy, write Dept. 107.

KOLLMORGEN
optical corporation
NORTHAMPTON, MASSACHUSETTS

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mergers & expansions

BELL INTERCONTINENTAL CORP. which before the sale of its defense subsidiaries to Textron, Inc. was known as Bell Aircraft Corp., has elected James F. Connaughton president and chief executive officer. Admiral Robert B. Carney, (USN Ret.), former Chief of Naval Operations, has been named a director and chairman of the board. Herbert Brownell, former U.S. Attorney General now with Lord, Day and Lord, has been retained as special counsel.

COLLINS RADIO CO. recently broke ground for a 30,000-sq.-foot communications and data processing center in northeast Cedar Rapids, Iowa. The center will be used by all of Collins' divisions throughout the United States and Canada.

DORSETT ELECTRONICS LABS of Norman, Okla., has merged with Carter and Galantin, Inc. of Chicago, a firm which provides marketing programs for industry, including the manufacture of training and sales devices and films. Carter and Galantin will become a Dorsett division, but continue to operate its facilities in Chicago, New York and Atlanta under its own name. Dorsett produces airborne telemetering systems and audio-visual devices.

ARNOUX CORP. of Los Angeles has acquired Telemetrics, Inc., producers of simulators and signal converters. Robert L. Burr will be general manager of Telemetrics.

CONSOLIDATED ELECTRODYNAMICS CORP., Bell & Howell subsidiary, has established a Technical Supplies Dept. to market recording paper for oscillography, photographic chemicals for oscillogram processing, and magnetic tape for instrumentation. The department will make headquarters in Pasadena.

EMPIRE STATE LABS has been purchased by Helmuth W. Waldorf, former President and owner of the Waldorf Instrument Co., now a F. C. Huyck Corp. division. Waldorf assumes the position of president of the laboratories, which have been incorporated under the name Empire Flight Components, Inc.

RAMO-WOOLDRIDGE DIV. of TRW has opened a Northeastern District Office in Lexington, Mass. . . . J. M. Loge has been incorporated under the name Loge Electronics, Inc.

BARDEN CORP. has purchased a 50% stock interest in E.M.O. Instrumentation Ltd., British manufacturer of precision ball bearings . . . H. K. Porter Co. has acquired Acieries & Ateliers de Construction de Marpent,

(Continued on page 26)

THE PROBLEM:
Development of a new, highly reliable rocket propulsion system

IN FINDING A SOLUTION:

2 HEADS ARE BETTER THAN 1

BUT ARE . . .

4 BETTER THAN 2?
8 BETTER THAN 4?
16 BETTER THAN 8?
32 BETTER THAN 16?
64 BETTER THAN 32?
128 BETTER THAN 64?

At United Technology Corporation, the old adage—"two heads are better than one"—is viewed with respect.

But it also is recognized that at some point, too many can cause excessive administrative detail, confusion, and red tape which increases the difficulty of finding the solution to the original technical problem.

The emphasis—corporate philosophy—at United Technology Corporation, therefore, is on quality—capacity of mind, talent and experience, rather than on sheer numbers of people. This approach permits the maximum percentage of scientific and engineering man-hours to be devoted to the analyses and experimentation required to obtain the best answers to the technical problems at hand.

UTC

UNITED TECHNOLOGY CORPORATION

A subsidiary of United Aircraft Corporation
P. O. Box 358 • Sunnyvale, Calif.

Circle No. 16 on Subscriber Service Card.



W. M. Willis, Chief Engineer of Marman Division, displays some of the many couplings and joints developed by Marman engineers.

MARMAN

Leads in Joint and Coupling Engineering

Pictured at the left are a few of the many V-Band Couplings and Joints designed and produced by Marman for every aircraft and missile application. Marman V-Band Couplings are ideal for connecting all sizes of tubing, piping and ducting used in fluid transfer and structural applications. The lightweight Marman J13 V-Band Joint provides efficient sealing for pneumatic and hot air or gas lines. The J11 V-Band Joint may be used for fluid systems. Marman high-performance CONOSEAL Joints provide a leakproof seal where zero leakage is required over a wide temperature range.

Call on Marman's 20 years of experience when you have a joint or coupling problem. Highly skilled and experienced engineers are ready to be of assistance to you. Also send for the new Marman Catalog No. 800 showing hundreds of joints available from stock.

CONOSEAL is an Aeroquip Trademark

Aeroquip
MARMAN DIVISION

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Joints, V-Band Couplings and Flanges, Fuel and Hot Air Couplings, Band Clamps, Instrument Clamps, Bellows, Ducting, and Universal Joints.

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Standard V-Band Couplings and flanges for high-strength structural connection of components and tubing, choice of solid or formed flanges.



J13 Joints provide a lightweight connection for standard and thin wall tubing where low leakage rate is permissible.



J11 Joints for fuel connections where zero leakage is not required, as well as lube, air and gas lines for temperatures up to 1000° F., pressures to 4000 psig.

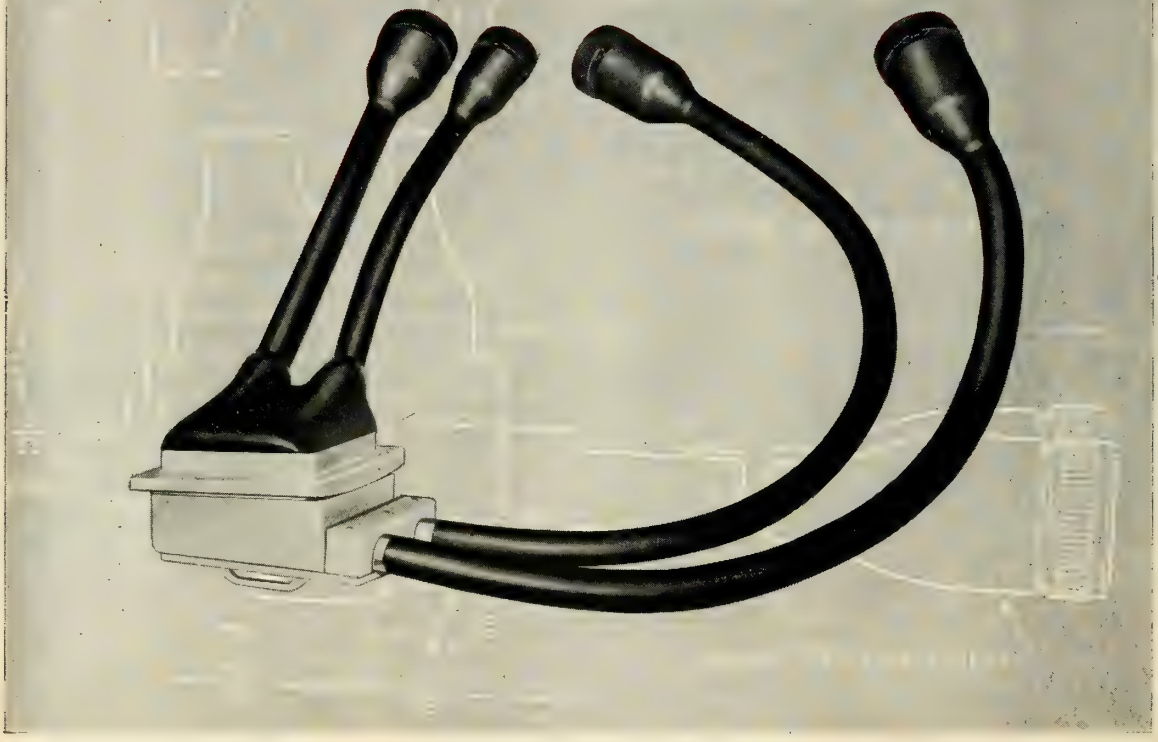


CONOSEAL Joints provide zero-leakage connection of tubing and piping over temperature range of —425° F. to +2000° F., pressures to 20,000 psig.

for an extension in Reliability

engineered...

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▪ **CANNON PLUG/HARNESS SYSTEMS** are designed and manufactured under rigid, quality-controlled conditions in a separate, highly specialized facility completely equipped to handle all phases of design, development and manufacture. As a single source supplier for both plugs and harness assemblies, Cannon can assume complete responsibility for the reliability of the "Cannon Plug/Harness System" as a whole.

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▪ **SPECIAL DESIGN SERVICES:** Because Cannon is a single source supplier of the plugs and completes the termination, it is possible to select and recommend cables and termination techniques designed to custom-match the proper plug for the assembly. The complete assembly can thus be manufactured and tested under conditions prohibited to single-source suppliers.

▪ **FASTER DELIVERY — NO COST PYRAMIDING:** A special, separate facility devoted to umbilical and harnessing production offers the most up-to-date production techniques to provide the industry's fastest delivery—plus no pyramiding of costs. Customers draw on Cannon's capabilities as the world's largest exclusive manufacturer of electrical plugs.

▪ **FIELD TECHNICAL ASSISTANCE:** Experienced specialized sales engineers are available to discuss and assist customers in the technical aspects of plug-harness system requirements prior to manufacture and after installation in the field.

CANNON PLUG/HARNESS SYSTEMS ARE MANUFACTURED IN OUR PHOENIX, ARIZONA FACILITY

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CANNON PLUGS

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Another Philco achievement in global communications

As part of a major study of space communications techniques, Philco is prime contractor for an Air Force project to relay high frequency radio communications around the curvature of the earth, through space. Known as the Passive Satellite Relay Link, it will reflect voice and teletype signals from a 100 ft. aluminum-skinned plastic balloon. Under NASA's Project Echo, the balloon is to be launched into a 1,000 mile earth orbit for use as a passive communications reflector.

The parametric amplifiers, receiving antennas, and tracking and receiving systems are Philco designed, built and installed. The entire program is managed by Philco, under the supervision of the Communications Directorate, Rome Air Development Center.

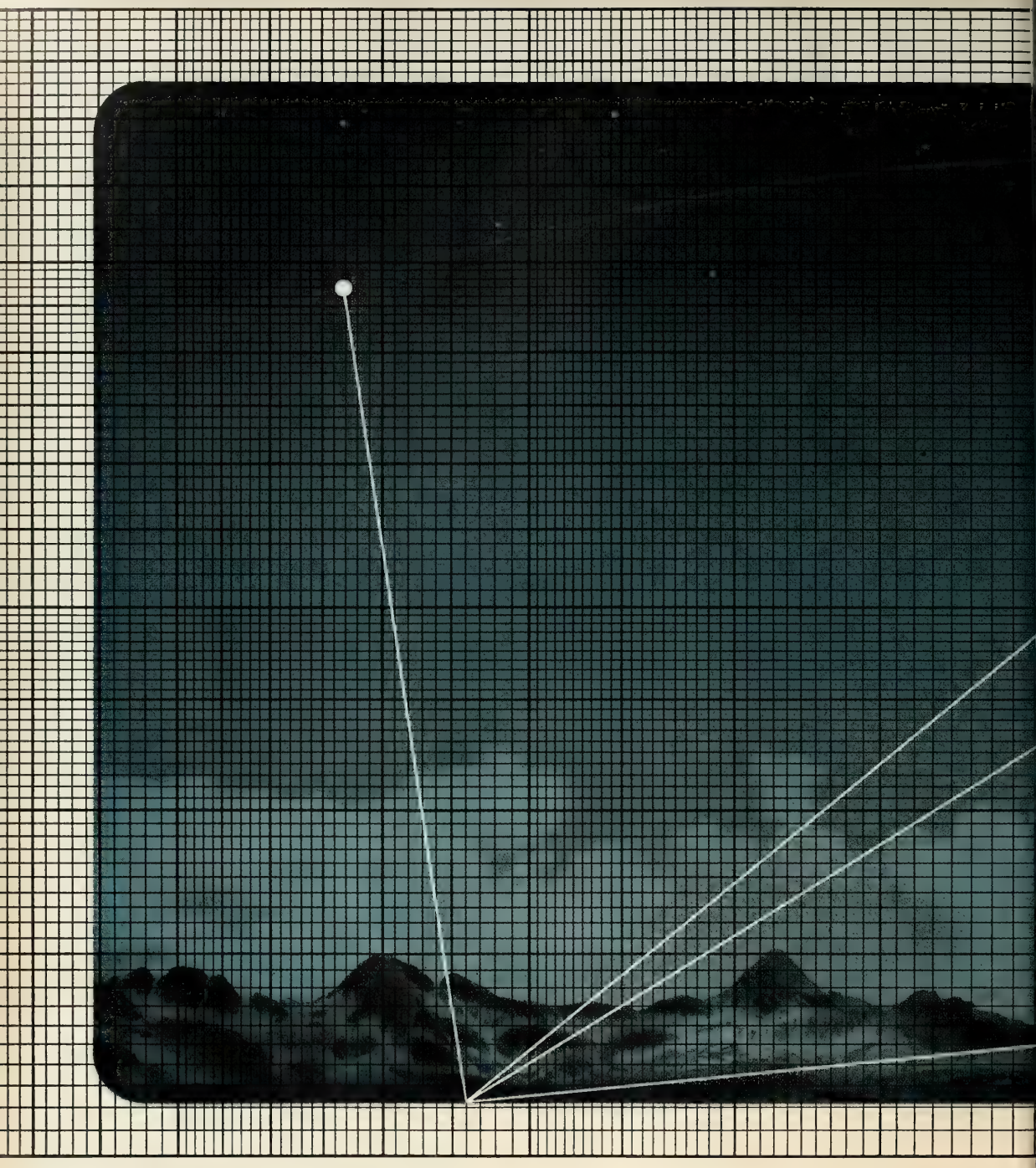
This is one more step in man's utilization of outer space . . . and another important Philco achievement in global communications. For capacity, facilities and experience in advanced electronic systems, look to the leader . . . look to Philco.

Government & Industrial Group, Philadelphia 44, Pennsylvania

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PRECISE MEASUREMENT IN SPACE... with New Westinghouse Radar Technique



An entirely new Westinghouse radar technique now under development at the Electronics Division will sharply increase the accuracy of radar detection, identification and tracking of objects in space.

Utilizing a single radar, the Westinghouse technique opens the door to many important new applications. Among them are accurate measurement of objects in space, satellite reconnaissance, air-to-ground surveillance and mapping and ground-to-air tracking and identification.

We would be pleased to discuss these new developments with qualified persons on a classified, need-to-know basis. Contact: Marketing Manager, Electronics Division, Westinghouse Electric Corporation, Baltimore, Maryland.

YOU CAN BE SURE...IF IT'S **Westinghouse**

Circle No. 20 on Subscriber Service Card.

The Law's Injustice

To the Editor:

Your article on "The Renegotiation Mess" in the July 4 issue of M/R is most interesting and certainly provides a considerable amount of enlightening information.

But there is one facet of Renegotiation which was not mentioned. This is the portion of the law which pertains to manufacturers' representatives.

There are many points about this section of the law which are most unfair to the bona fide manufacturers' representative, the corrections for which are long overdue.

Over the years the minimum reporting amount for manufacturers has been increased, until this amount is four times that contained in the original law. The amount for manufacturers' representatives' reporting has not been changed at all.

Probably the most unfair portion is that (the fees of) manufacturers' representatives alone have been singled out from all of the consultants, professional people, and other independent contractors, and are separately renegotiated, rather than being renegotiated through the manufacturer.

Other provisions of this law make it possible for a manufacturers' representative's fees to be renegotiated even though none of the companies he represents is covered.

When any changes in the Renegotiation Act are considered by Congress, as they supposedly will be by this House committee, the matter of its application to manufacturers' representatives should be given fair and impartial consideration.

Kenneth E. Hughes
Union City, N.J.

First Drone Directory

To the Editor:

I would be very grateful if you would please send me a reprint of the Directory of U.S. Aerial Targets and Combat Surveillance Drones which appeared in the June 27 M/R. To my knowledge this is the first time anyone has compiled such a directory. Congratulations on a remarkable job.

Leonard Matula
Chicago

Misleading Title

To the Editor:

I would like to comment on my article in the April 18 M/R which you entitled "How to Propose a Research Program." As submitted, the title was, "A Philosophy for Propellant Research" . . .

While the article does tie in with research proposals, it was concerned primarily with the establishment of criteria for determining the validity of a research approach. Obviously, it did not provide an adequate treatment of the subject, "How to Propose a Research Program," since this was not its intent.

Charles N. Bernstein
Group Scientist, Propellants and Polymers
Rocketdyne Division, North American Aviation, Inc.
Canoga Park, Calif.

Bad Siting at Tucson?

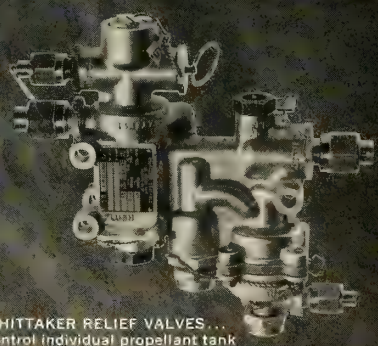
To the Editor:

Enclosed are some further press stories and other items bearing on our local protest against Air Force siting policies (M/R, June 13, page 17). The sites of

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is important in the Discoverer Satellite Program



WHITTAKER RELIEF VALVES... control individual propellant tank pressures, differential tank pressures and provides tank dump feature.



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Advanced design concepts, environmental testing and quality-controlled production . . . assure you of Planned Reliability in every valve and fluid control system that bears the famous Whittaker name!

Advanced concepts now being planned at Whittaker Controls present unusual and challenging opportunities for qualified engineers. Why not inquire now?

the first nine of Tucson's 18 *Titans* were publicly announced on June 8. They insure 100% certainty that lethal fallout from enemy attack will hit Tucson should war come. All escape routes out of the city will be destroyed because the policy is to build these sites right beside good highways and Tucson has only five highways leading through the surrounding mountains. Tucson will become the *worst-sited* of all the *Atlas* and *Titan* bases in the country if something is not done to forestall use of the announced site locations.

We are appealing for Congressional investigation of the entire policy with respect to fixed-base ICBM's . . . We hope that you may take note of this step in our protest by reporting it in M/R. We were very pleased to see the earlier note you ran on this issue.

J. E. McDonald, Chairman
Committee Against Ringing
Tucson With Titans
Tucson, Ariz.

FDR to Blame?

To the Editor:

It certainly would be a pity if this otherwise excellent technical publication should degenerate into a political digest.

Your discussion (M/R, June 6) of the so-called public relations "Fiasco", and especially the thinly veiled attack upon the Vice President of the United States, is unnecessary and ill-advised.

If this editorial is politically inspired it can be deflated easily: Our country is in this predicament thanks to F.D.R. and H.S.T. and their give-away policies in Yalta and Potsdam.

Who, in his right mind, could trust a donkey-riding crusader, waving a defeatist banner and galloping toward ultimate disaster?

A. J. Jankunas
Engineer
Cicero, Ill.

Cheap Fuel Suggestion

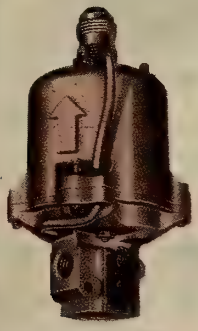
To the Editor:

In a recent Soviet Affairs section, Dr. Parry quotes a Russian scientist as having said that ". . . Pacific Ocean hurricanes roar incessantly, with winds reaching 30 to 35 miles per second."

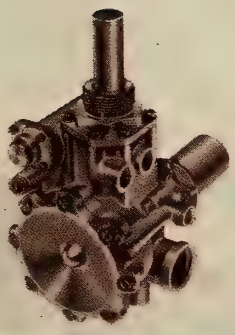
Could it be that we have missed out on something? With a wind velocity of this magnitude, 126,000 miles per hour, we may no longer need to provide a powerplant for our space shots. We can simply place a missile into the wind, guide it correctly, and the Pacific hurricane will carry it off into space. What a weight saving!

Charles O. Heller
Santa Monica, Calif.

It was a typographical error which we are still trying to figure out.—Ed.



WHITTAKER REGULATOR . . . Controls pressure on propellant tanks for expulsion of fuel and oxidizer to engines.



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. . . mergers & expansions

(Continued from page 18)

French producer of steel, railway cars and industrial products . . . Bendix Corp. has purchased a controlling interest in Diseradores y Constructores, S.A., one of Mexico's leading tool-and-die firms.

ATLANTIC RESEARCH CORP. has begun work on a $1.5 million addition to its facilities at Alexandria, Va. The 120,000-sq.-ft. building will be connected to the original plant by an overhead walkway.

GIANNINI SCIENTIFIC has purchased Wiley Electronics Co. of Phoenix, Ariz., formerly a subsidiary of Savage Industries. Giannini, which already numbers Plasmadyne, Plasmakote and Flight Research among its subsidiary corporations, is negotiating for further mergers with as yet unnamed companies.

PYROFUZE CORP. has been organized by the Sigmund Cohn Corp., of Mount Vernon, N. Y. The firm will manufacture specially processed Pyroforic Products, a bi-metallic product that disintegrates with explosive violence at 600°C without support of oxygen.

financial news

Aerojet General Corp.—Consolidated sales reached $200.5 million for the six months ended May 31, an increase of 29% over the same period last year. Earnings were up 16% from $3.8 million to $4.5 million.

Digitronics Corp.—Sales for the fiscal year ended March 31 totaled $822,000, a 50% increase over the $553,000 reported for FY 1959. Net income for 1960 amounted to $35,652, compared to $23,618 for the previous year.

Sanders Associates, Inc.—New business in excess of $30 million raises Sanders' backlog to $50 million. President Royden Sanders said the firm expects total sales for the year ending July 31 to reach $17 million; he forecasts a 50% rise next year.

Infrared Industries—Record sales reached $1.8 million, an increase of 50% over FY 1959, and net earnings increased 28% to $122,207.

Wilson Bros.—Sales for the first five months of this year jumped 72% to $14.9 million, compared to $8.6 million for the same period last year. The firm expects sales of about $38 million for 1960.



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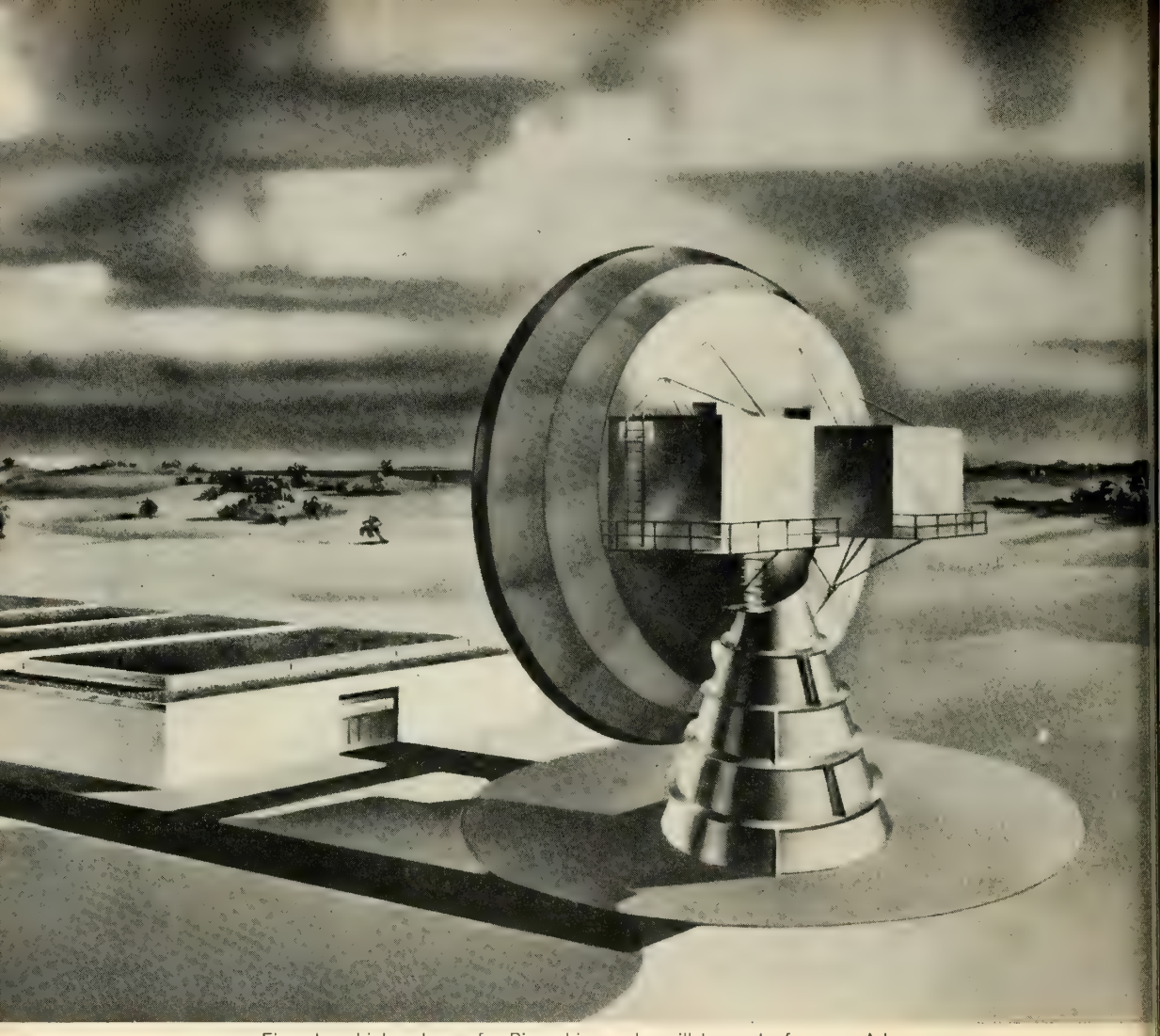
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Five-story high antenna for Pincushion radar will be part of a new Advanced Research Projects Agency installation to be set up in mid-Pacific.

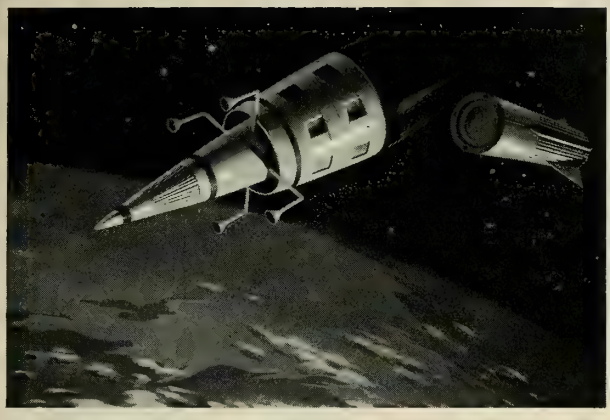
A unique radar designed to track and identify the warhead of ICBMs thousands of miles away is now being developed by Raytheon.

Designated "Pincushion", because of its microwave beam pattern formation, the 80-ton Raytheon radar will be part of Project Defender, ARPA's program to develop advanced anti-ICBM concepts.

RAYTHEON COMPANY, WALTHAM, MASS.

RAYTHEON

EXCELLENCE IN ELECTRONICS



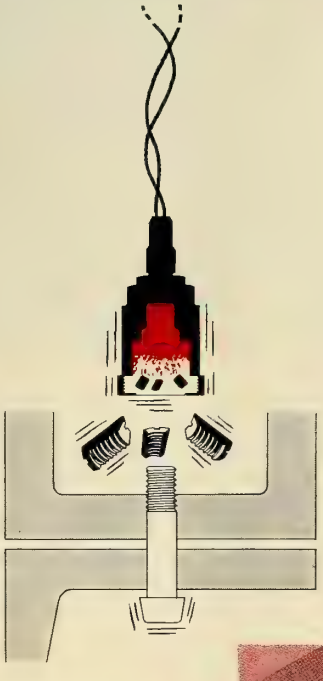
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- RELEASE FROM LAUNCHING PADS.
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THE NEW

SEPARATION NUT



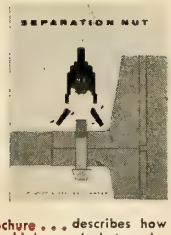
A unique, safer and more efficient method for separation systems is offered by the Separation Nut.

The Separation Nut is unique because its controlled separation is a highly reliable mechanical function activated by a very small explosive charge.

By using the Nut's small explosive charge rather than the "brute force" explosive techniques so commonly used to fail high strength material in explosive bolts, the Separation Nut can substantially reduce a potentially hazardous condition to installation crews and to the vehicle itself.

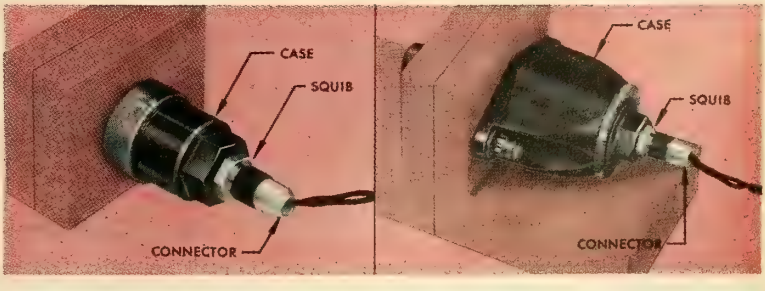
More compact joints can be designed since Separation Nuts are used in combination with standard diameter, high strength bolts used at full allowables.

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Basic configuration . . . accommodates bolt thread sizes including 1/4-28 thru 3/4-16.

CAPTIVE NUT

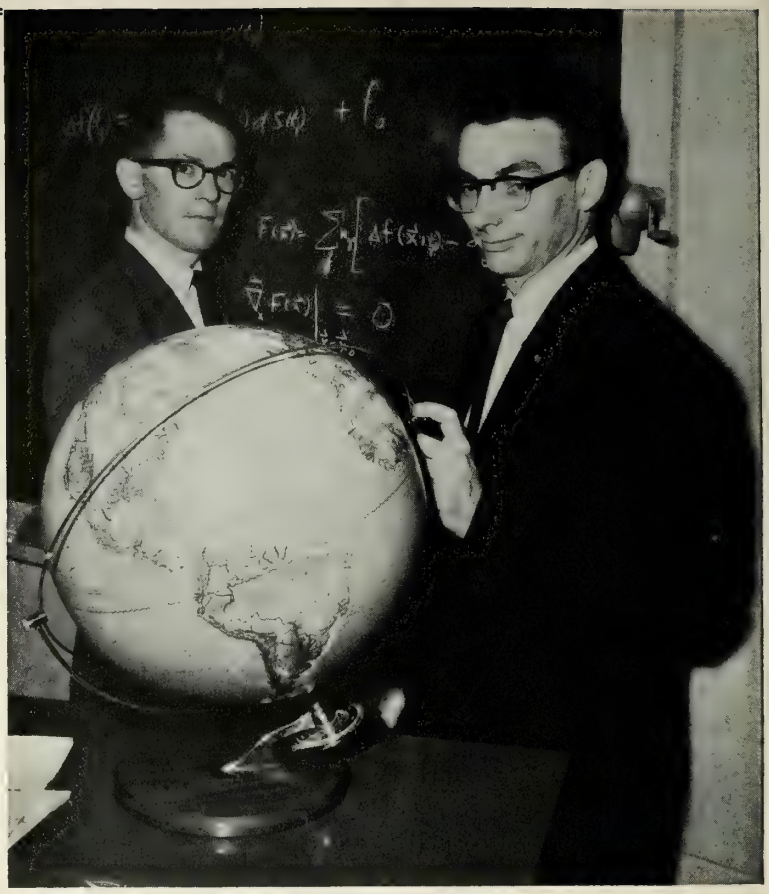
Because only a low explosive charge is used, all fragments can be easily contained by Nut's case. A similar case can arrest a bolt after detonation.

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Project Transit—the first of its satellites already is orbiting the earth—was sparked by the side-interests of physicists at the Applied Physics Laboratory less than three years ago. The Project, an important contribution to the science of navigation, was kindled because of the Laboratory's policy of encouraging its scientists free rein in exploring tangential thoughts.

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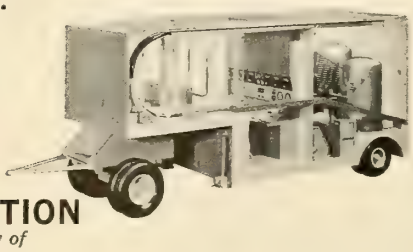
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develops from a program
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Titan, America's two-stage intercontinental ballistic missile, is making giant strides—attaining new goals in U.S. missile technology. It has repeatedly demonstrated its ability to accomplish stage separation and altitude start of the sustainer engine. Equally outstanding successes in guidance and nose cone ejection-recovery are making Titan a significant contribution to our national space potential; a highly sophisticated missile system powerful enough to deliver a warhead accurately at more than 5,500-mile range.

As Titan continues to develop toward a state of operational capability, it provides another demonstration of the remarkable successes of the U.S. Air Force's ballistic missile program. This program, conceived only six years ago, has produced progress beyond expectation in an undertaking never before equalled in complexity.

Space Technology Laboratories is responsible for over-all systems engineering and technical direction for Titan, as it has been for Thor, Atlas, Minuteman and related space programs. Principal associate contractors for Titan include: The Martin Company for airframe and system integration, Avco Manufacturing Corporation for nose cone, Bell Telephone Laboratories and Remington-Rand for guidance, Aerojet-General Corporation for propulsion.

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The Countdown

WASHINGTON

A Ship Becalmed

Strong winds blowing out of the Democratic convention for greater defense spending are leaving the Eisenhower Administration unmoved. COUNTDOWN is told the Administration has all but decided to stand firm on its earlier refusal to use the extra half-billion dollars Congress tacked on the defense budget for missiles and space. There are reports, however, that some extra dollars may be released for the missile-packing B-70 bomber. How much, no one will say.

Undersea Revolution

Navy planners are eyeing the Reynolds Metal Co. Aluminaut—an experimental submarine designed to go down 15,000 ft. Now entering the construction phase, the Aluminaut could revolutionize undersea warfare. Made of high-strength aluminum alloy six inches thick, the sub will be roughly 33 ft. long, have an inside diameter of 7 ft. and be capable of carrying a 3-man crew 100 miles. Endurance of its silver-zinc storage batteries will be two days. Designed for oceanographic exploration, the sub would be able to outdive all known submarines by several thousand feet.

Almost Operational

The most potent air-to-air missile to be developed in years—the nuclear-tipped *GAR-11*—is now scheduled to be in Air Force squadrons by the end of this year. Made by Hughes Aircraft, *GAR-11* is the big brother of the *Falcon* missile family.

On the Pad

October 1 is the latest date to be set for the launching by NASA of an *Atlas-Able* with a $5 million moon-orbit payload. . . . Next shot in the *Mercury* program—possibly by the end of July—will be a test of the McDonnell production capsule atop an *Atlas*.

Courier Shot Slips

Launch of the Army Signal Corps' *Courier* delayed-repeater communications satellite—originally set for July 15—is expected to slip about a month. The reason: congestion at the pad.

INDUSTRY

AF Project 3059 to Aerojet

Aerojet-General has won the hot competition for the Air Force's Project *3059*—the development of a million-pound-thrust solid-propellant booster. Grand Central Rocket Co. has won a smaller, supporting contract to pursue a related approach on the giant, segmented motor. The Aerojet contract for FY '61 is for about $4 million. Size of the GCR award has yet to be established—but it will be for considerably less.

On Mahogany Row

Joining Northrop Corp. this week as a senior v.p. in charge of the company's research and advanced technology is Richard E. Horner, 42, associate administrator of NASA. Horner, who had held the NASA post 15 months, made his departure plans known some time ago (M/R, April 11). . . . W. R. Studhalter is Rocketdyne's new program manager on the J-2 200,000-lb.-thrust liquid hydrogen engine for *Saturn*.

Tops in '59

General Dynamics Corp. topped the nation's defense contractors in 1959 with contract awards totalling $1.5 billion. Boeing—the 1958 leader—was second with $1.2 billion. General Electric dropped from third to fifth place ($915 million), while Lockheed ($932 million) and North American ($925 million) each advanced one position—to third and fourth places respectively.

INTERNATIONAL

Polaris for NATO

The United States is now pushing hard a plan to arm NATO with 300 *Polaris* missiles. Britain and West Germany are expected to go along. However, Scandinavian countries are cool to the idea and France wants control over the nuclear warheads as the price for accepting them on French soil.

Bouillabaisse of Missile Deals

- Aerojet-General and SNECMA (France) have entered into an agreement calling for development work on an IRBM.
- French and German anti-tank missile competitors —Nord and Boelkow—have worked out a joint agreement on a new type of missile. Details are secret.
- SEPR (France) has just revealed details of its agreement with Rocketdyne (COUNTDOWN July 11, July 4) as involving the sale of small liquid-fueled rockets in the U.S. and in Europe, Turkey and Iran. SEPR is also tying up on joint development of new solid fuels with Bombrini Parodi-Delfine (Italy).

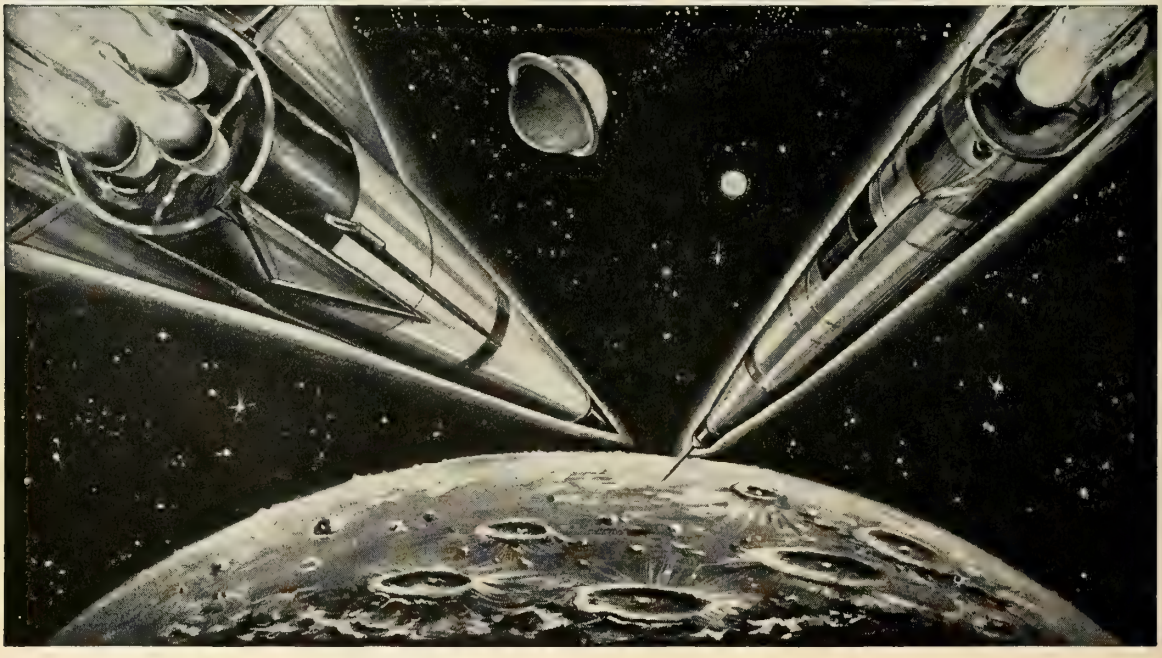
New French Missile

Sud Aviation *SE 4400* surface-to-air missile has been dropped by the military and in its place a new, secret version is being developed which will be both faster and have a longer range. The *SE 4400* may be incorporated into some French space experiments.

Jolly Comment from Abroad

A recent issue of *Flight* magazine, a British publication, displays a picture of an upended *Seaslug* missile being sprayed with water. The caption reads: "Environmental test, British style. Were this an American missile, the test concerned—which is to prove Seaslug's impermeability to driving rain—would be in a specially built million-dollar test facility with a name like TWERPS (Test Water Environmental Rain Proofing System). We British just hoist the thing up with a crane borrowed from the plant department, call out the works' fire brigade, and let them have a jolly good squirt."

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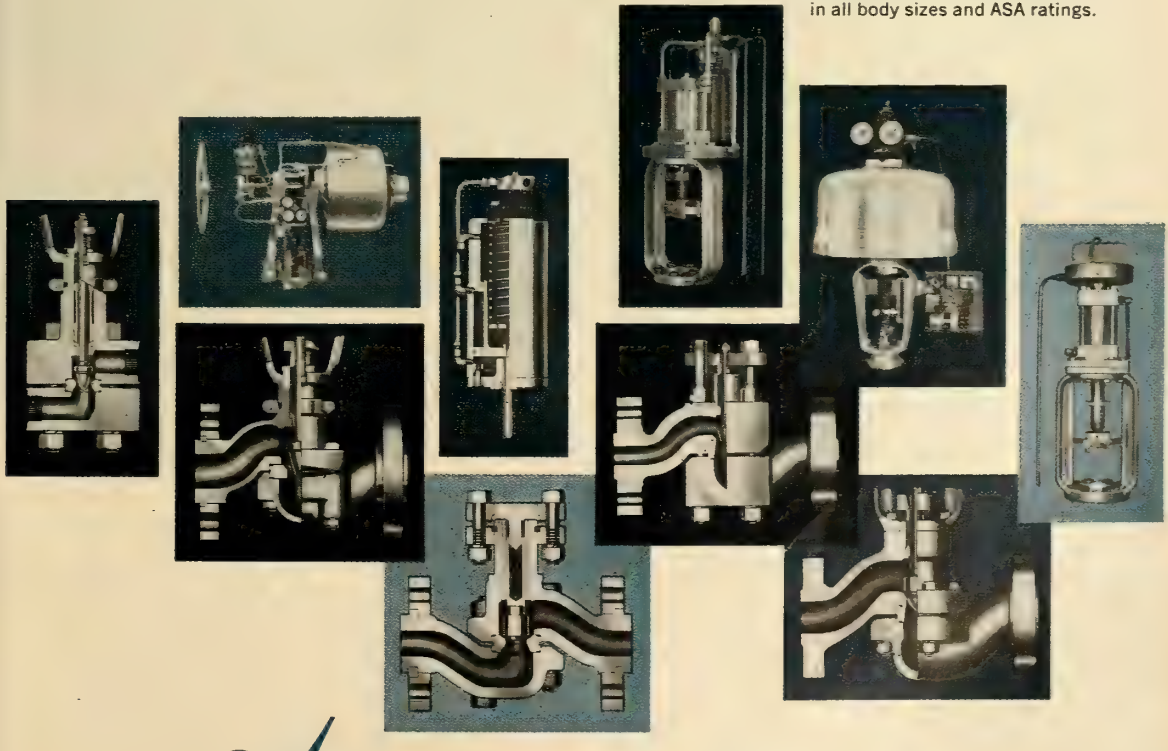
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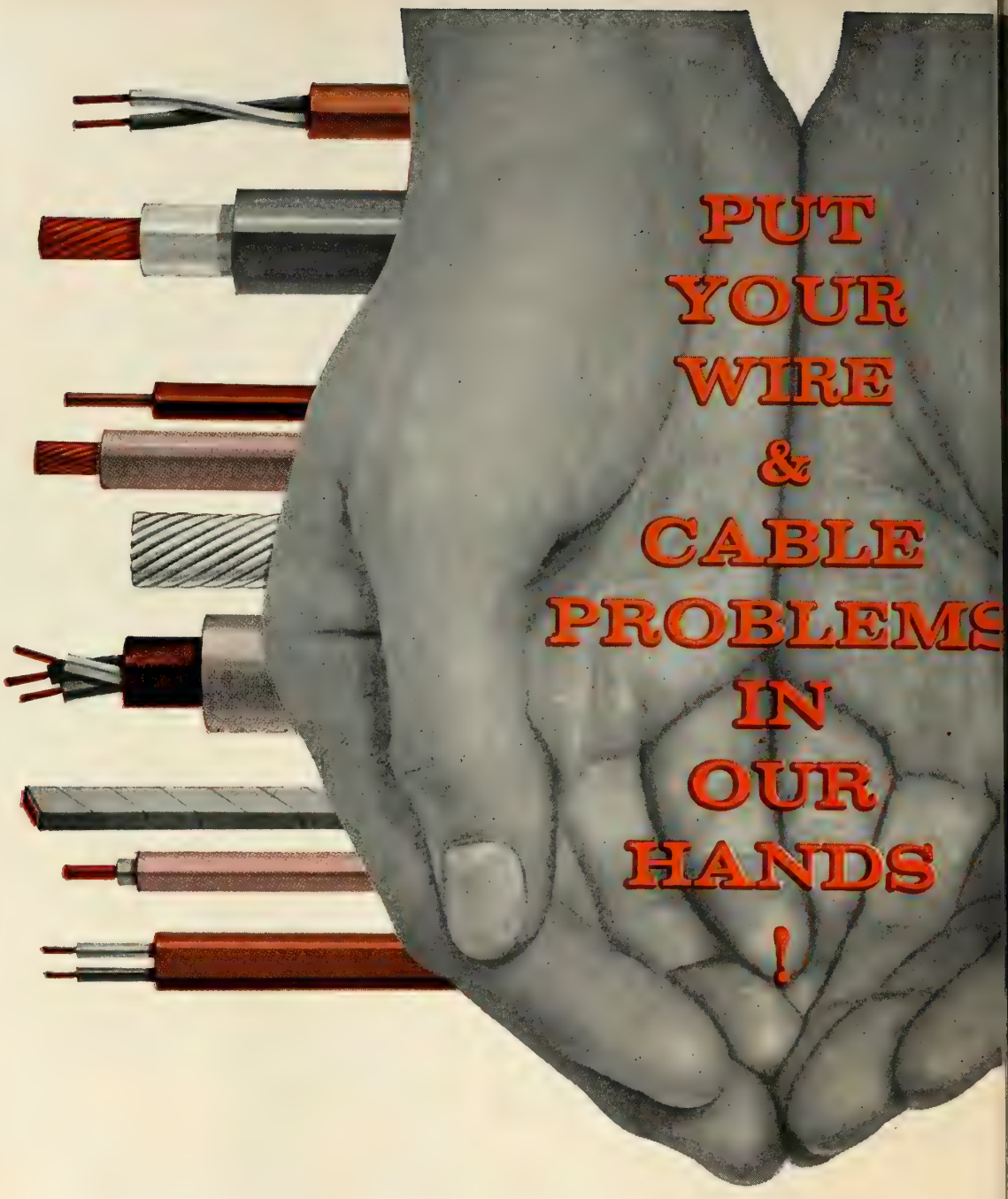
SPLIT BODY CHECK VALVE available in all body sizes and ASA ratings.



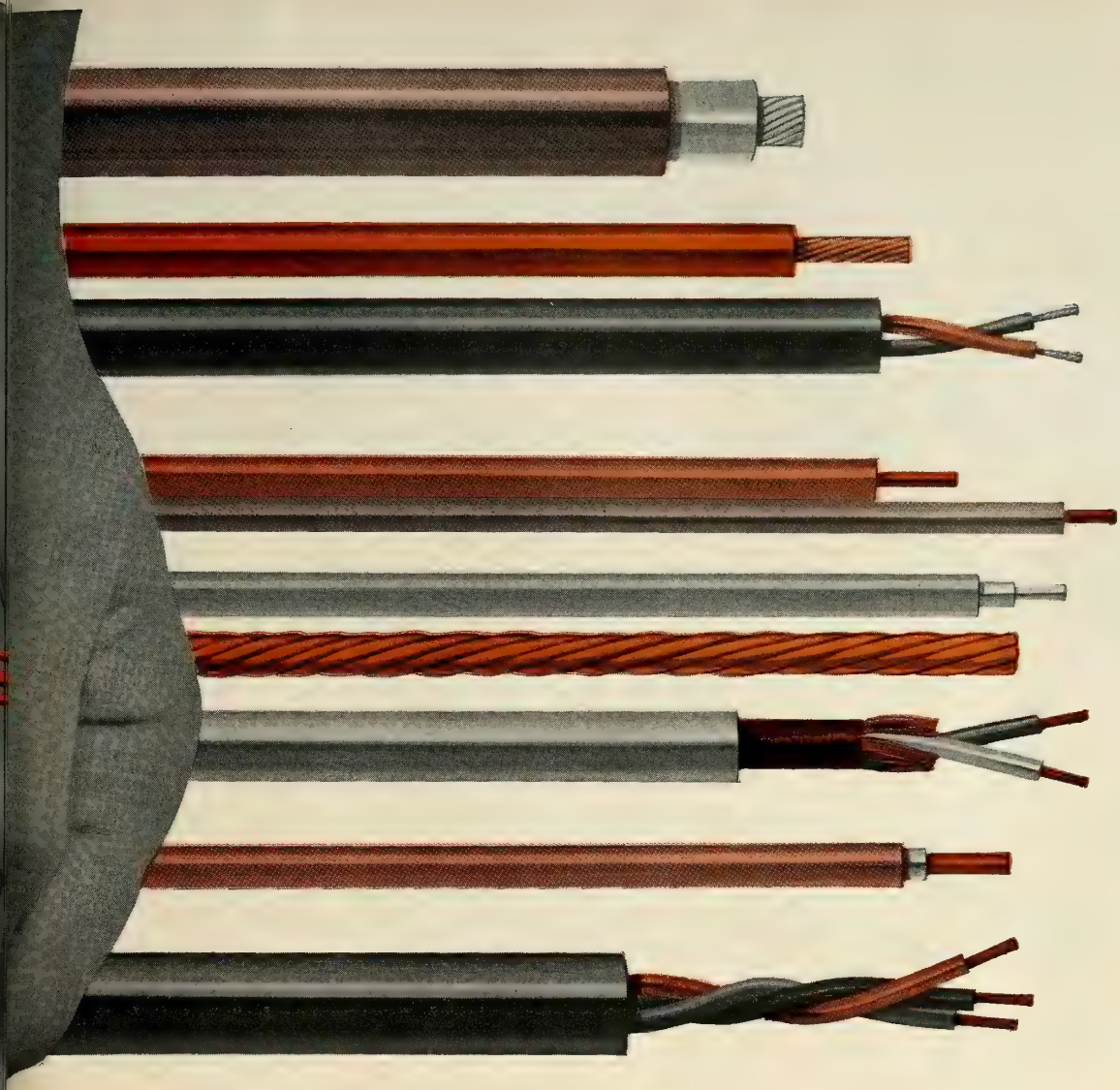
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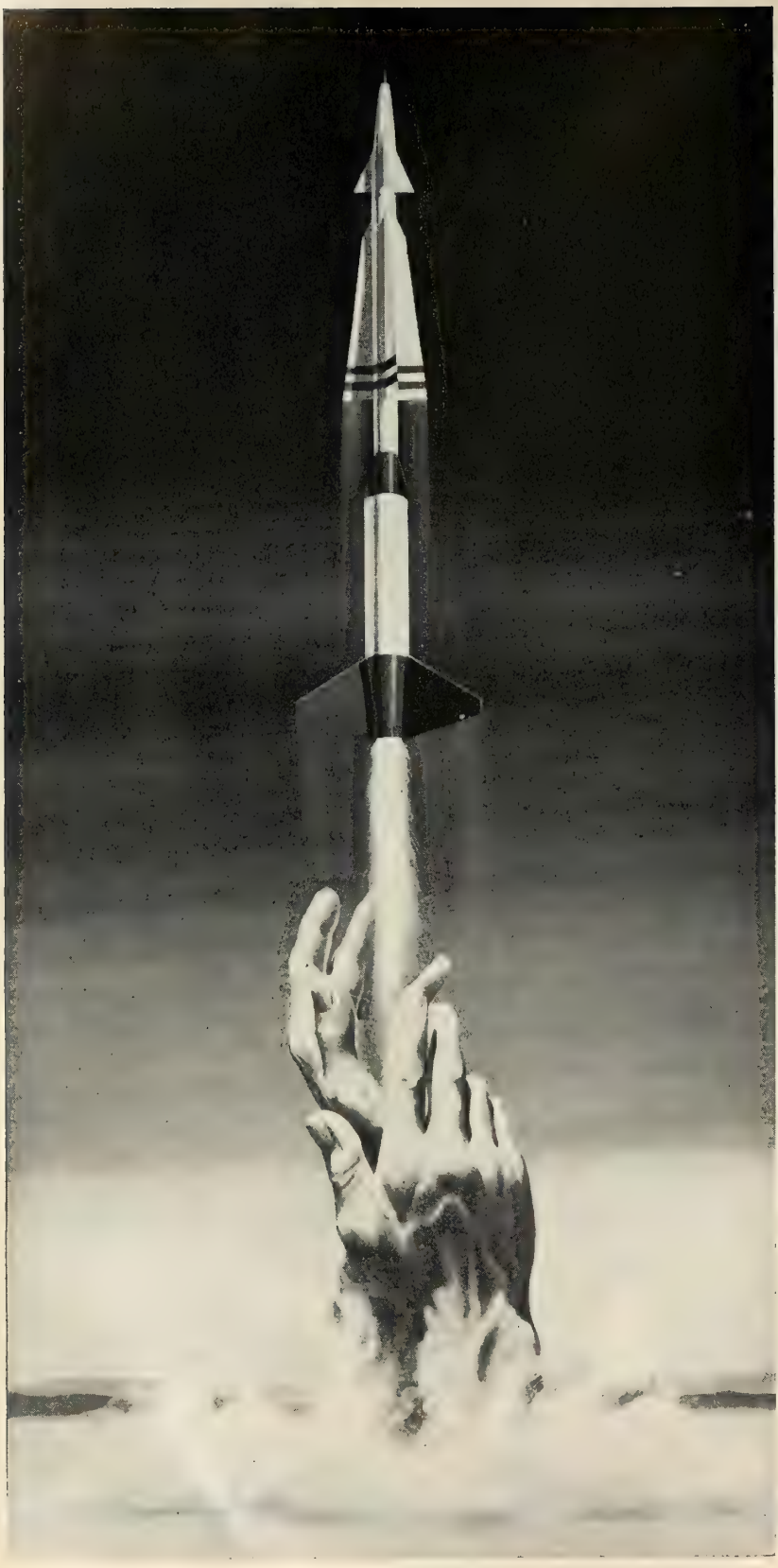
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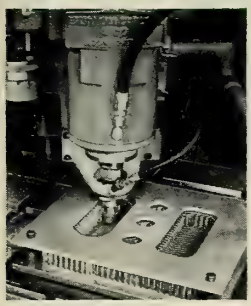
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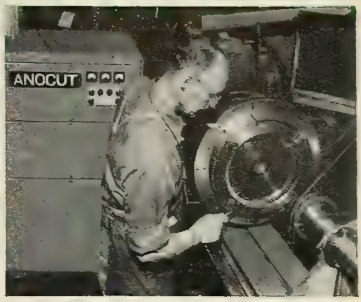
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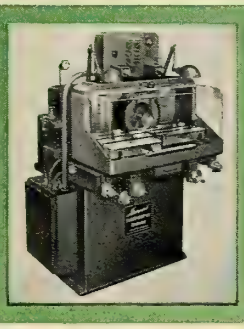
MACHINING POCKETS IN FRAGILE STAINLESS STEEL HONEYCOMB FREE OF LAYOVER AND BURR. PHOTO COURTESY EKSTROM, CARLSON & CO.

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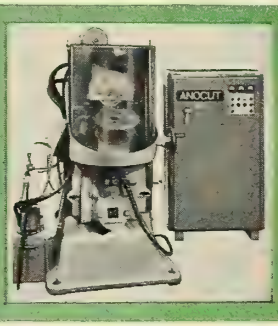


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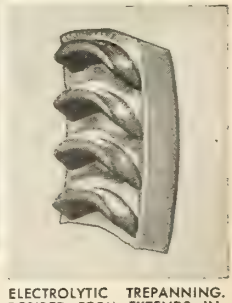
MODEL HCS-59 ELECTROLYTIC CAVITY-SINKER. APPLIES SAME BASIC ELECTROLYTIC PRINCIPLE TO THE SINKING OF IRREGULAR HOLES AND SHAPES FOLLOWING THE CONTOUR OF THE ELECTRODE MADE FOR THE PURPOSE. THE ELECTRODE IS SIMPLY PLUNGED LINEARLY INTO THE WORK MATERIAL.



HEXAGONAL HOLE 1" DEEP, ¼" ACROSS FLATS, IN UDIMET 700. NOTE STRAIGHTNESS AND SHARPNESS OF WALLS WHERE ELECTRODE BROKE THROUGH. CONICAL TIP IN BOTTOM OF BLIND HOLE CAN BE ELIMINATED. INTERIOR-COATED ELECTRODE USED FOR ROUND HOLES IN BACKGROUND.



SEVEN INCH LONG, .078" DIAMETER HOLE ELECTROLYTICALLY "DRILLED" IN UDIMET 700. ROD HAS BEEN SURFACE GROUND TO EXAMINE STRAIGHTNESS OF HOLE. NO WEAR ON ELECTRODE.



ELECTROLYTIC TREPANNING. DESIRED FORM EXTENDS INTO INTERIOR OF SHAPED ELECTRODE. NOTE HIGH FINISH ON BLADE FORM.

ANOCUT T.M. Reg.

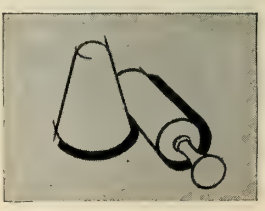
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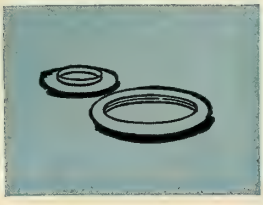
Garlock's unique position in the missiles industry . . .

may be of infinite value to you. *Acceptance:* Right now Garlock is supplying rocket motor components for various phases of development and production of seven different missiles. *Flexibility:* Garlock has the people, the equipment, and the experience to swing into prototype production on short notice, and to follow this with full-scale production as needed. *Diversified Abilities:* Garlock is thoroughly familiar with the design and manufacture of components from a wide range of basic materials—metals, rubber, phenolics, fluorocarbons and other plastics. *Completely Integrated Staff:* Garlock's product design, tool design, pilot manufacturing and production staffs are completely integrated for efficient handling of a project from start to finish. Garlock engineers will work to your design—or with you in developing designs. Write or call Military Products, Garlock Inc., Palmyra, New York.

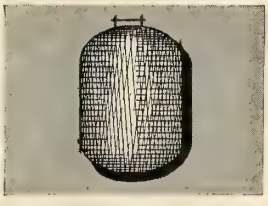
GARLOCK



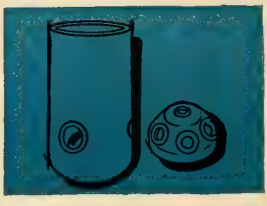
MISSILE PARTS FROM INERT MATERIALS include newly developed asbestos-phenolic compound for nozzles . . . nose cones of fluorocarbon plastics.



GARLOCK METAL FITTINGS FOR ROCKET MOTOR CASES such as blast tube and thrust terminator support rings are machined to extremely close tolerances. Made from special materials affording minimum weight, maximum strength and rigidity.



FILAMENT WOUND ROCKET MOTOR CASES made by exclusive Garlock method results in structure much lighter and stronger than steel.



INSULATION FOR SOLID FUEL ROCKET MOTORS made by Garlock is rubber-like compound which encounters gas velocities of Mach 3, temperatures to 5500° F, prolonged ambient temperatures of 300° F.

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Vanguard • Super Vanguard • Minuteman
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Programs involve guidance, telemetering, data recording and reduction, instrumentation, structures, propulsion, materials, solid state physics, components, heat transfer problems and systems analysis and are constantly influenced by continuing JPL space exploration research providing individuals with challenging assignments in almost every phase of engineering and science. Staff progress in diverse fields of activity is constantly being made.

Pioneering in basic research, applied research and development engineering in space exploration proves to be a stimulating attraction for engineers and scientists with innate curiosity and intense interest in the future of space exploration.

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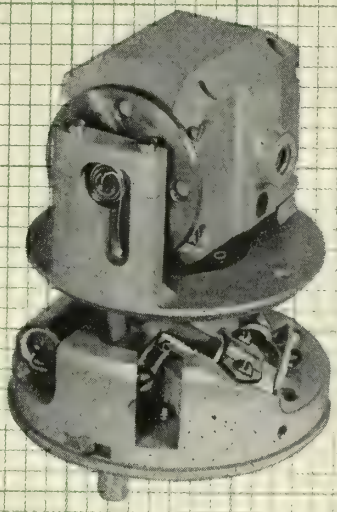
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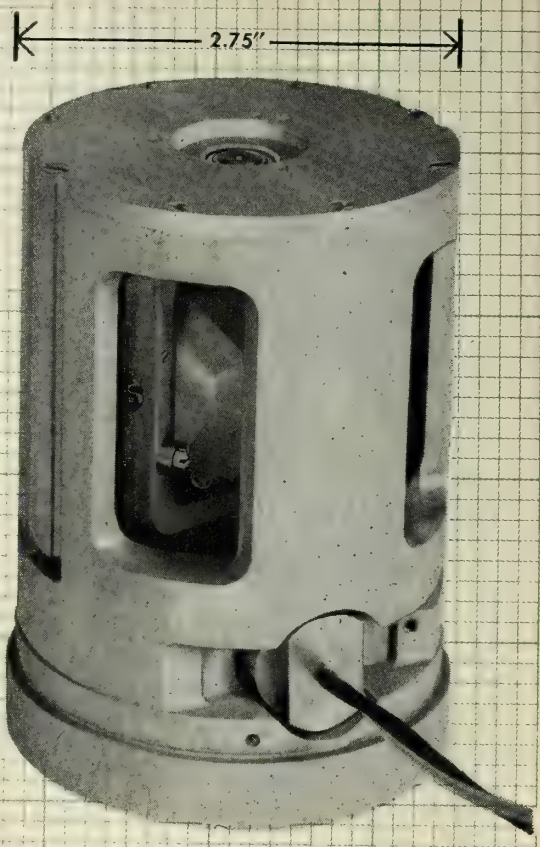
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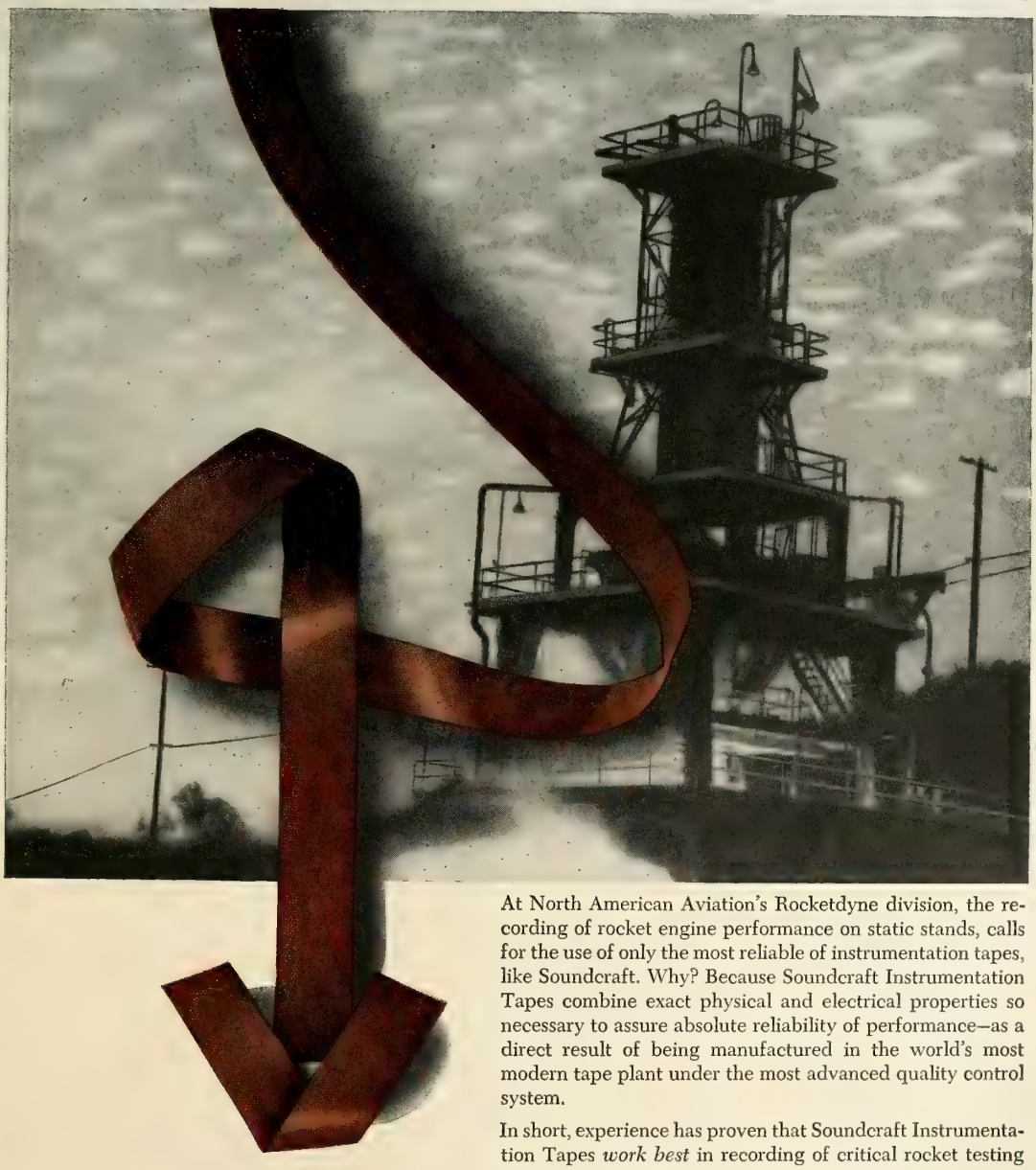
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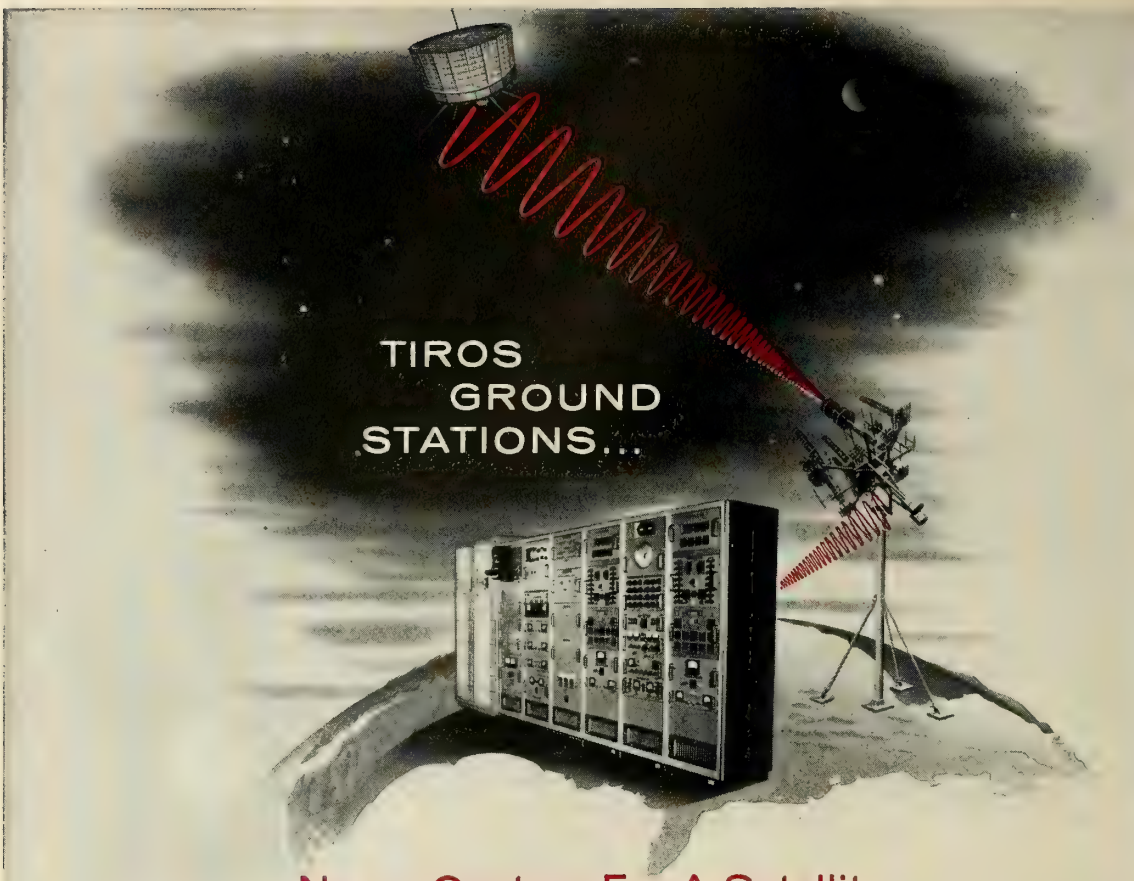


At North American Aviation's Rocketdyne division, the recording of rocket engine performance on static stands, calls for the use of only the most reliable of instrumentation tapes, like Soundcraft. Why? Because Soundcraft Instrumentation Tapes combine exact physical and electrical properties so necessary to assure absolute reliability of performance—as a direct result of being manufactured in the world's most modern tape plant under the most advanced quality control system.

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Nerve Centers For A Satellite

Over 25,000 informative cloud-cover pictures have been received from TIROS I since it was launched on April 1. In two months the satellite had completed 1000 orbits and travelled 27,500,000 statute miles. This means not only that TIROS itself has performed as planned, but that the complex problems of command and control, as well as signal reception and processing, have been successfully surmounted. Like the satellite, the special ground station equipments were designed and built by RCA Astro-Electronics Division under the auspices of NASA and technical direction of the U.S. Army Signal Corps.

Major components at each of the four ground stations include:

- Five TV receivers and four beacon receivers used in diversity reception to minimize signal fading
- A programmer which pre-programs different combinations of operating modes, and a 200 watt command transmitter
- A TV monitor to display the picture signal for the automatic recording camera. The camera is equipped to make either positive or negative films
- An indexer and sun angle computer which generate an index number and sun angle indication for each picture, used for geographical orientation
- An attitude recorder which picks up the earth-horizon signal for spin axis position computation
- Two standard 4-channel tape recorders to back up the monitor
- Two paper recorders to monitor forty telemetered satellite parameters
- An antenna programmer which directs the antenna to follow the orbit of the satellite when it is in range of the ground stations

All program functions are timed by a master clock which is synched to standard time signals from WWV. In addition to normal picture direct transmission and record functions, the programmer can also command spin-up. After two months the spin rate had decreased to 9.4 rpm's due to the effect of the earth's magnetic field. On command from the ground, two solid propellent spin-up rockets on the satellite were fired, increasing the spin to 12.8 rpm's.

AED's own ground station was used to process photos from the magnetic tapes for the first one hundred orbits.

The integrated design and development of these TIROS ground stations is an indication of AED's capability in *total satellite systems.* This capability will become increasingly critical as more and more complex satellites and space probes are launched to advance man's understanding and control of his universe. To discover how you can draw on this broad R & D experience, contact the Marketing Manager, RCA Astro-Electronics Division, Princeton, N. J.

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tempting to Kremlin . . .

Will Castro Get Red Missiles?

by James Baar

The ominous possibility that Russia will provide Cuba with missiles is haunting U.S. strategists this week.

Only a month ago such an idea was generally considered far-fetched. Following the events of the last few days, it has to be taken into consideration in all U.S. planning for the Western Hemisphere.

Cuban Boss Fidel Castro and his red henchman, Ernesto Guevara, are swiftly moving Cuba into the Soviet economic orbit as the last fiscal ties with the United States are snapped.

A Soviet decision to "sell" Castro missiles and provide a military mission to help establish Cuban missile bases would be only another step in implementing a Russian move into the Western Hemisphere.

Unless thwarted by stiff—possibly armed—U.S. action, the Cold War gains for Russia would be enormous:

- Castro would have placed in his hands weapons with which he could cause great difficulties for the United States.
- Cuba could intimidate all of Central America and resume the Castro regime's previously ill-fated attempts to spread the Castro Revolution and expand Cuban territorial holdings.
- Russia would have a new bargaining counter with which to demand withdrawal of U.S. overseas bases.
- The Communist Bloc would have a powerful base from which to increase its activities throughout Latin America.

The Russians are known to have large stockpiles of tactical and intermediate-range ballistic missiles from which they could draw for "sales" to Castro. These missiles could be deployed in Cuba at fixed bases or on mobile platforms.

IRBM's launched from Cuba could hit much of the United States. New York, Washington, Chicago and Denver would be within range. Shorter-range tactical Soviet missiles such as the *Komet 2* could hit much of the Deep South—including the *Polaris*-loading depot at Charleston, S.C., and Cape Canaveral.

But even more important to Soviet and Cuban strategy is that such missiles could hit any city or military target throughout Mexico and the small nations of Central America.



CUBAN-BASED IRBM's (made in Russia) could be launched 1500 nautical miles to strike targets throughout Central America and much of the United States.

They could strike anywhere in the islands of the West Indies and across the Caribbean into Venezuela, Ecuador and northern Brazil.

The Panama Canal could be held hostage.

Castro, armed with Soviet missiles and a growing army, would become the greatest military power in Latin America.

Soviet Premier Nikita Khrushchev would face relatively small losses in exchange for such attractive gains.

The principal loss would be the alarming of Latin American nations. This could result in possible united armed action against Cuba and the stiffening of resistance to local Communist groups.

However, Khrushchev apparently does not consider this a serious risk or he would not have openly defied the Monroe Doctrine with his threat earlier this month to come to Cuba's aid with ICBM's.

Nor would a Latin American war embroiling the United States necessarily not be to Khrushchev's taste. He and Latin America's Communists might well feel that whatever Cuba's fate, the odds are in favor of their emerging in control of many key Latin American posts.

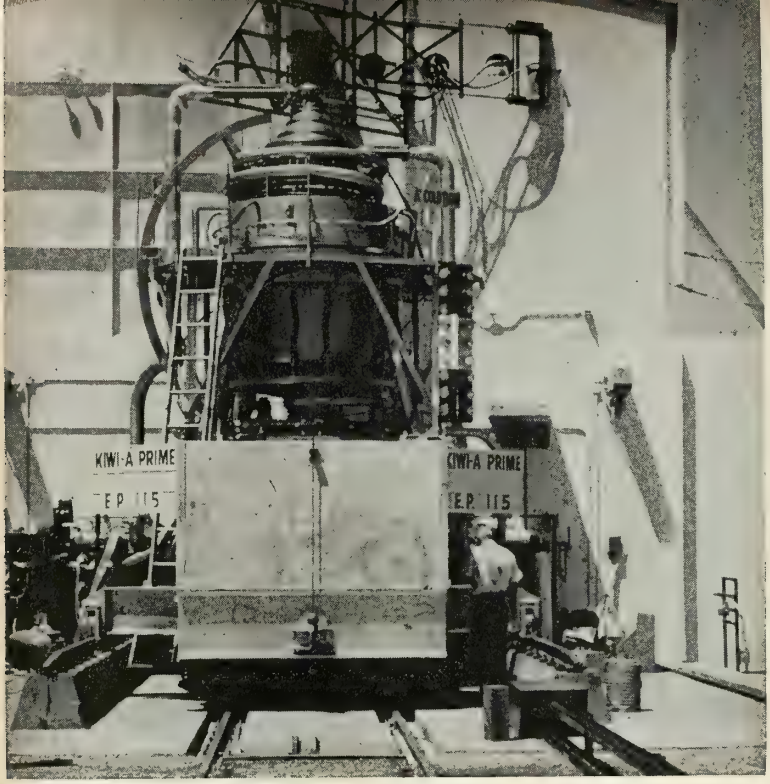
All in all the arming of Castro with missiles must appear very attractive to the Kremlin in the last days of the Eisenhower Administration.

Boeing Gets $247 Million For More Minuteman R&D

The Air Force and Boeing Airplane Co. this last week announced the signing of a $247-million R&D contract for the huge *Minuteman* ICBM program.

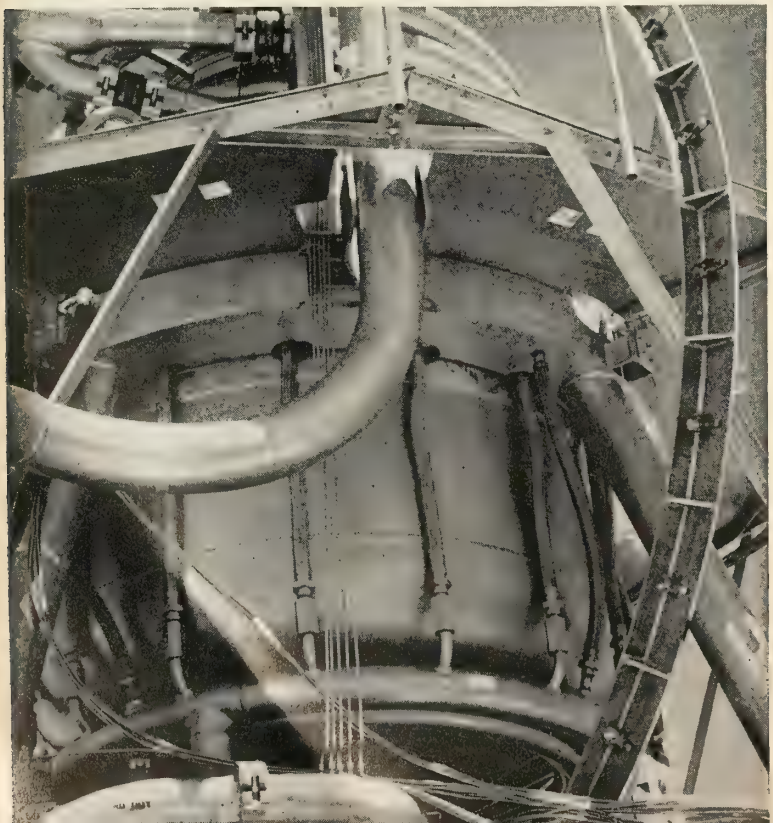
The contract, running through Dec. 31, 1961, replaces a letter contract that authorized Boeing to begin work on the *Minutemen* that will be deployed in fixed bases. A contract covering *Minutemen* that will be deployed aboard trains is expected to be negotiated during the next few months.

The three-stage *Minuteman* is scheduled to be operational in mid-1962.



ABOVE: Kiwi-A-Prime reactor shown on rails in exclusive M/R photo. Its fuel element is believed to represent a major improvement over earlier Kiwi-A.

BELOW: Close-up of Kiwi-A-Prime reactor cold flow unit shows ducting of system used for handling liquids, instrumentation wiring and structural member arrangement.



Theories proven . . .

Kiwi-A-Prime

by Richard van Osten

The U.S. took one more step along the path to a nuclear-powered rocket with the first full power run of Project *Rover's* Kiwi-A Prime reactor at the Atomic Energy Commission's Nevada test site.

Although total power time was approximately 15 minute and full power was maintained for only about five minutes, personnel from Los Alamos Scientific Laboratory expressed extreme pleasure with the July 8 results.

Exact details of the test operation are still pretty much under wraps. But Dr. Keith Boyer, project director for NTS, told M/R the power obtained was "similar" to that achieved with the successful run of Kiwi-A last year.

Output of the solid-fuel (uranium-235) heat-exchanger, direct, open-cycle reactor was not the test's primary object, however. What LASL scientists were trying to achieve was a validation of their design theories. This, they claim, was accomplished.

Kiwi-A Prime is the nearest approach so far to a system and component design that could be flown—not that the reactor is anywhere near a flyable configuration, it is simply "a lot closer," according to test personnel. It is being developed jointly by the AEC and the National Aeronautics and Space Administration.

Security regulations do not permit full disclosure of differences between Kiwi-A and Kiwi-A-Prime. It is known, however, that one major area of improvement is the fuel element—a long-standing problem with all reactor types.

• **Test delayed**—The test went well despite a several hour delay when a methane supply line valve malfunctioned. The methane is used to light off the cloud of hot hydrogen which rises from the reactor nozzle so that it burns rather than accumulate undetected and possibly explode. Operations could have been conducted with-

Run Brings Flight Closer

Testers highly pleased with success of first full-power trial of advanced reaction; Rover director sees program on right track

out the methane flare, but B-57 sampling aircraft took a rather dim view of flying through an unburned cloud of hydrogen. The reactor had to be shut down for the repair, then brought up to power again.

During the full power run, sparks shot out of the reactor exhaust on several occasions. Dr. Alvin Graves, director of LASL's Test Division, said he had no idea what the reason was, but teardown, scheduled to begin the following day, would probably show some slight internal damage.

Another short delay was encountered early in the test when the reactor's scram system (for fast shutdown) was set too close to the operating point.

Next step will be detailed examination of Kiwi-A-Prime following disassembly. Later this year, Kiwi A3, presently still at LASL, will be brought to the site for tests.

• **Kiwi B series**—Kiwi A3 is "almost identical" to Kiwi-A-Prime, LASL says, but the test program is different. The reactor will be run up to power several times, then run to failure.

When Kiwi A3 experiments are completed, the existing test cell (A) at NTS will be modified for additional hydrogen storage in preparation for next year's test program on the Kiwi B series.

In addition to the modified test cell A, a new unit, test cell C, will be constructed for Kiwi B experiments. Some of this construction is complete —extension of the railroad to carry the reactors, a vehicle road and a water line have been installed. First phase of the test cell proper will be built by Okland Construction Co., Salt Lake City, Utah, under a $1.1 million contract.

Work will consist of a heavy reinforced concrete test cell building, a similarly constructed propellant fill station building, furnishing and erecting two prefabricated metal buildings, constructing a cooling tower and an outdoor power substation, installing utility systems, and installing government-furnished equipment. The new test cell is expected to be operational by the summer of 1961.

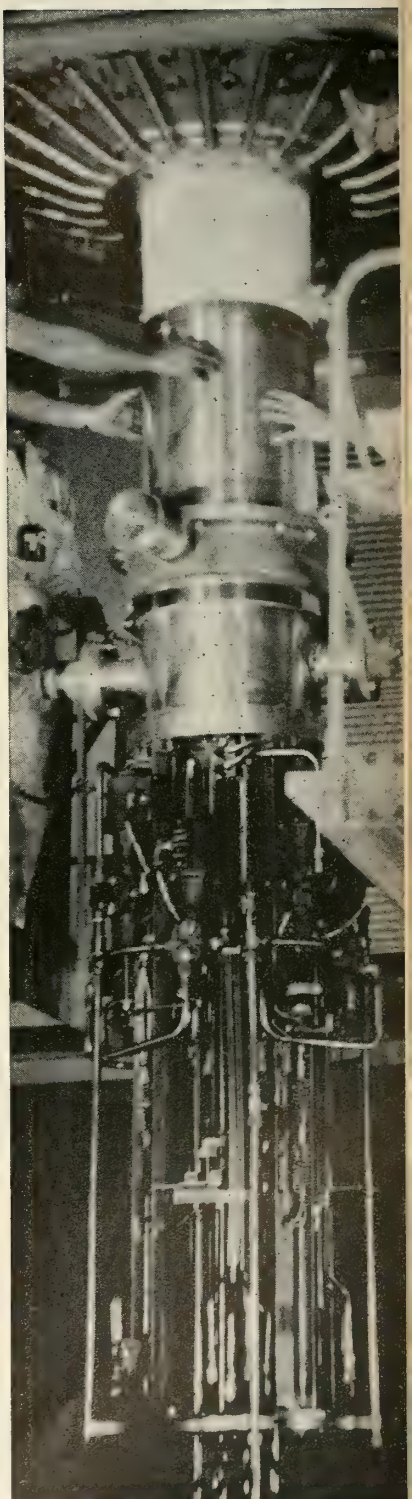
The power run of Kiwi-A-Prime marked still another innovation. This was the first time LASL personnel had tried out a new instrumentation system, which incorporated multiplexed and commutated data pick-off signals which are fed to Ampex recorders. The tapes will subsequently be fed into an IBM 704 computer for reduction.

• **Look for surprises**—The previous system (M/R, July 4, 1960) worked well, but much information was not reduced because of the complexities. With the new system, Dr. Boyer said it is easier to reduce all data rather than select portions to be reduced as before.

Asked his opinion as to the feasibility of the *Rover* project, Dr. Boyer said he was personally convinced they were on the right track—particularly after the successful test of Kiwi-A and now, Kiwi-A-Prime.

"But," he cautioned, "we still have not mastered the problem, and we may be due for some surprises."

The Kiwi-A-Prime test was observed by U.S. Senators Albert Gore (D-Tenn.), Henry Jackson (D-Wash.), and Wallace Bennett (R-Utah), all members of the Joint Committee on Atomic Energy. Other congressional observers were Representatives Craig Hosmer (R-Calif.) and William Bates (R-Mass.). Observers included also representatives from the AEC, NASA, National Academy of Sciences, the Military Liaison Committee, Joint Committee of Atomic Energy, and Dr. York's office.



INTERNAL assembly is installed in hot reactor at Nevada Test Site. ACF assembled hardware. Photos by Frank McGuire.

many applications likely . . .

'Laser' Broadens the Radio Spectrum

by Hal Gettings

A new era in electronics opened up this week with the long-sought development of the laser—an optical maser and key to optical-frequency communications.

The "laser"—Light Amplification by Stimulated Emission of Radiation—extends the radio spectrum from 50 gigacycles (kmc) up to 500,000 gigacycles, which includes infrared and approaches visible light.

An extension of such magnitude vastly increases the number of available communications channels.

This first laser was developed at Hughes Aircraft Company's research laboratories in a company-funded project under the direction of Dr. Theodore H. Maiman, a senior staff physicist.

In addition to radar and communications, a host of other applications are seen for the new device.

The laser is the first true light amplifier. It provides a new scientific tool for investigating properties of matter and performing basic experiments of physics. It can be used as a source of highly concentrated light for industrial, chemical, and medical purposes.

• **Coherence**—The most significant factor of the new development is that the laser is able to generate a "coherent" beam—heretofore possible only in the conventional radio frequencies. "Coherence" signifies the definiteness of the frequency of radiation—the smaller the band, the more coherent the source. Usual light sources—such as a carbon arc or incandescent lamp—generate energy over a relatively wide band of the electro-magnetic spectrum. Consequently, they cannot be focused to a very narrow beam, and dissipate rapidly with distance.

As an example, the best available searchlight aimed at the moon would spread over 25,000 miles—even if it could reach that far.

In contrast, the laser radiates an almost perfectly parallel beam, less than one-hundredth of a degree of arc wide. Aimed at the moon, such a beam would illuminate an area less than ten miles wide. A beam directed at the earth from a satellite at 1000 miles altitude would be concentrated into an area about 200 feet wide. Using it as a "light-radar" could make it possible to take detailed pictures with a super-clarity never before obtained.

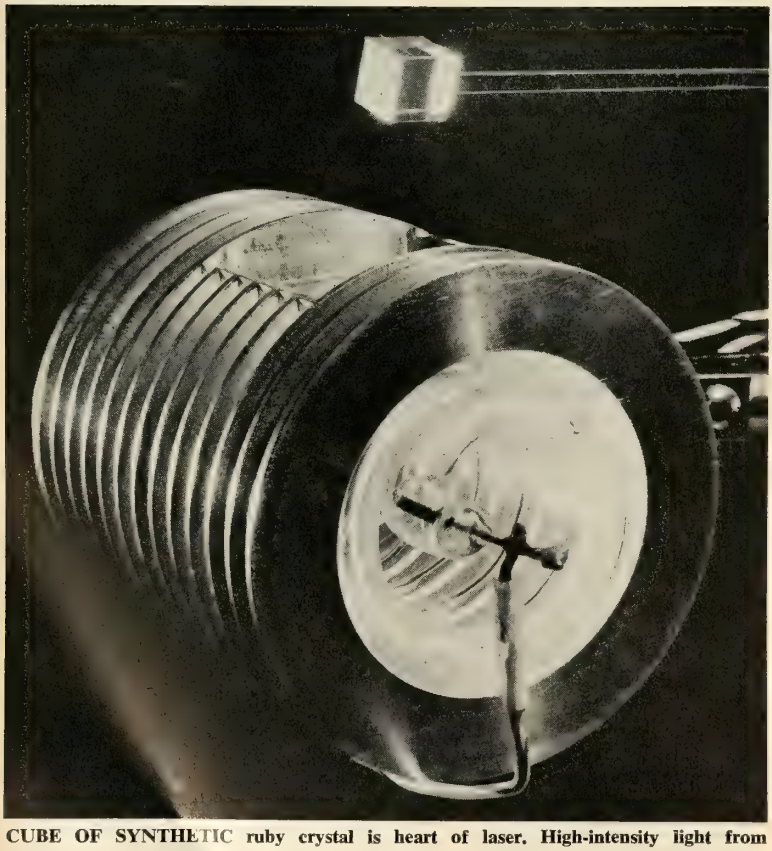
The heart of the laser is a half-inch cube of synthetic ruby crystal. Irradiated by a light source—such as a powerful flash tube lamp—the tightly packed atoms of the ruby are excited to a higher energy state and energy is reradiated in a narrow band of frequencies. The excited atoms are coupled to an atomic resonator and stimulated to emit the radiation together. This is in contrast to ordinary light sources where the atoms radiate individually at random and produce "incoherent" light energy.

• **Glorious color**—Due to its coherence, the laser is a source of very high "effective" temperature, while it itself remains physically cool. By comparison, an ordinary arc lamp would have to be at an impossible temperature of several billion degrees to generate as bright a signal as the laser.

Coherence, too, has an important effect on color. Since the color of light is a manifestation of its frequency band, its purity is determined by the width of the emitted spectrum. Consequently, the laser should be able to generate the purest colors ever known.

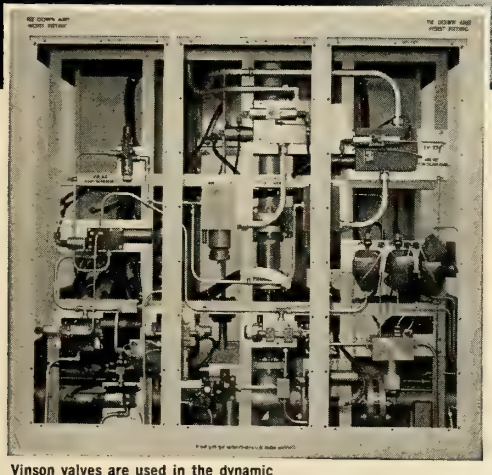
The Hughes effort in this field is one of several programs being conducted in many industrial and educations scientific laboratories. Some are privately and some publicly supported; others are under defense contracts.

Competition in even such an exotic area as this is not unknown. It is fairly certain that parallel or similar significant advances will make their appearance in the near future. The Hughes development is but the first.



CUBE OF SYNTHETIC ruby crystal is heart of laser. High-intensity light from flash tube lamp (glass helix in center) excites ruby's atoms which reradiate sharp beam of coherent light.

WILL IT WORK UP HERE?



Vinson valves are used in the dynamic checkout unit built by Consolidated Systems Corporation for use in the Atlas missile program.

Behavior of helium and nitrogen valves can be predicted if you simulate conditions and pre-test on the ground. Pressure regulators, relief valves, and flow controls must be better than the systems they are checking. It takes knowledge gleaned from experience to design ground support units that guarantee expected behavior of a missile *up here.*

Vinson designed valves and regulators for both the dynamic and static check-out systems for the Atlas. Whether your control problem is simple or complex, consult Vinson engineers.

Differential relief, solenoid and priority *valves.*
Flow and pressure *regulators.*
Reservoirs and *accumulators.*

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Navy Buys High-Accuracy Norwegian ASW Missiles

The Navy is planning to equip two destroyer escorts with Norwegian ASW *Terne* missiles.

The *Terne* is a surface-to-underwater missile that carries a depth-charge warhead. It is manufactured by Kongsberg Vapenfabrikk.

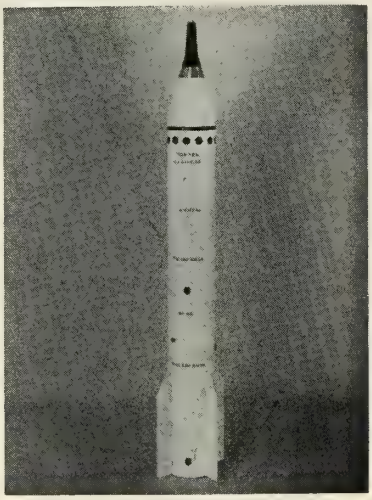
The Navy announced this last week the award of an approximately $1.5 million contract to Arma for the integration of *Ternes* into present shipboard missile systems—presumably *Alfa*—and the modification of existing fire control equipment.

The newest model of the *Terne*—the Mark 7—weighs 264 lbs. The depth charge alone weighs 105 lbs. The *Terne* is 77.5 in. long. It has a 7.9-in. diameter.

Alfa, which has been operational aboard U.S. ships since 1952, weighs 500 lbs. It is 102 in. long and has a 12.7-in. diameter.

Alfa's effective range is about 900 yards. *Terne's* range is believed to be longer. *Terne's* accuracy has been described as "better than a quarter of 1%."

Terne is launched from Norwegian ships with a 2.5-ton deck launcher that carries six missiles, fired singly or in salvoes.



Exclusive M/R photo of *Terne*.

Von Braun Completes Top Staff Appointments

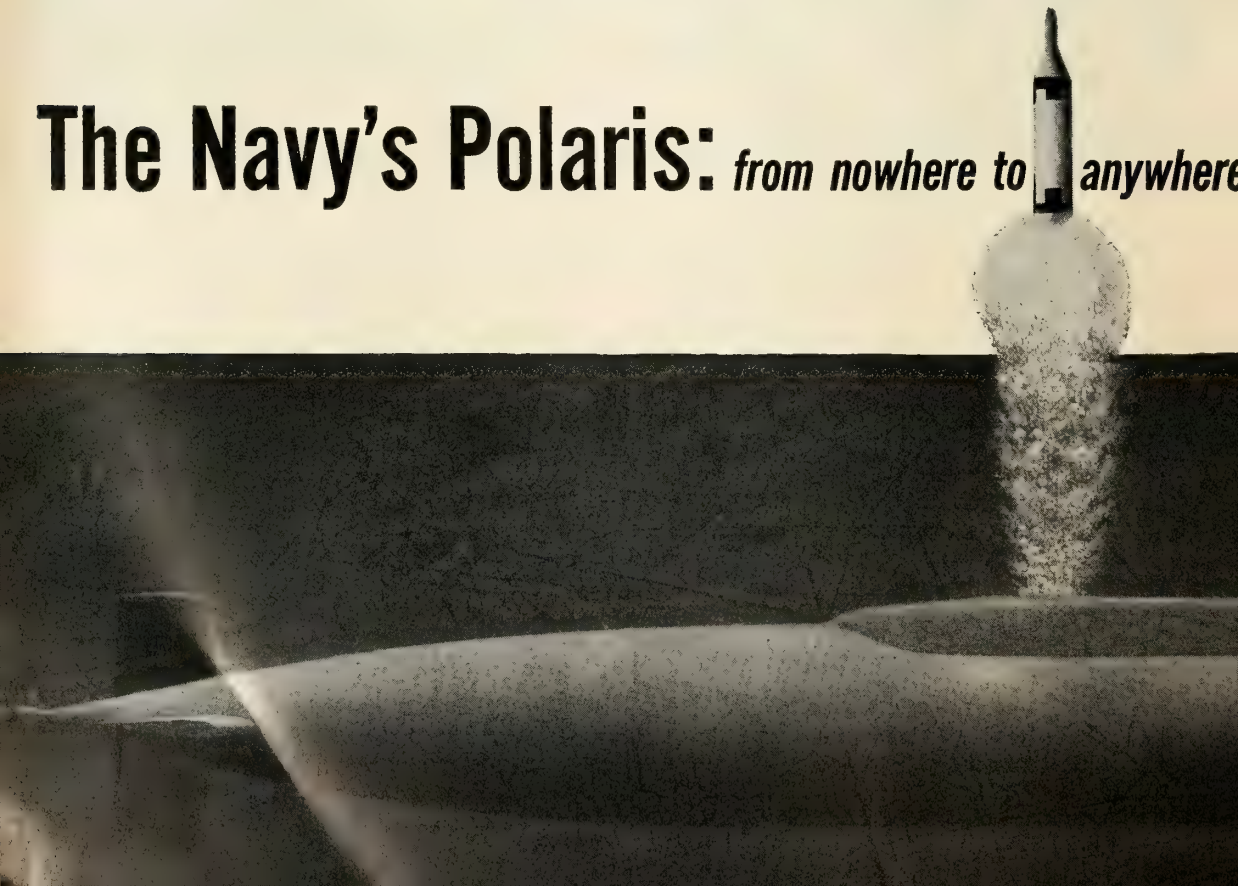
Dr. Wernher von Braun, director of the Marshall Space Flight Center at Huntsville, Ala., last week completed selection of his top staff assistants.

The Marshall Center, which was set up July 1 from von Braun's group in the Army Ballistic Missile Agency, now has a staff of 4900 and eventually will total 5500.

Von Braun made these appointments: Saturn Systems Office, Dr. O. H. Lange; Agena-B and Centaur Systems Office, Dr. Hans Heuter; Weapons Systems Office, Werhen Tiller; Future Projects Office, H. H. Koelle; Technical Program Coordination Office, Dr. George Constan; Office of Technical Services, David Newby; Office of Management Services, V. C. Sorensen; Office of Financial Management, Claude Stockton; Office of Purchasing and Contracting, Wilbur Davis; Management Analysis Office, C. W. Huth.

There are two deputy directors. Dr. Eberhard F. M. Rees, von Braun's deputy for many years with ABMA, will head the operating departments as deputy director for research and development. Delmar M. Morris, government administrator formerly with the Atomic Energy Commission and TVA, is deputy director for administration.

The Navy's Polaris: *from nowhere to anywhere*



NASA Seeks New Western Source of Liquid Hydrogen

The National Aeronautics and Space Administration needs a second supply of liquid hydrogen in the California-Nevada area, it told industry last week.

At a preliminary bidders' conference July 12, representatives of about 15 companies were told that in about a year there will be requirements for additional supply varying from 35,000 to 60,000 lbs. daily for a period of five years. The only major source on the West Coast at present is a Linde Co. plant at Torrance, Calif., which went on stream June 27.

Under a NASA-Linde contract, NASA has first call on up to 275,000 lbs. a month produced at the new Linde plant. Linde has said the plant can produce six tons a day if required.

The NASA group, headed by William P. Kelly, Jr., head of the Procurement Assistance Branch in the Procurement and Supply Division, told the industry representatives that requests for bids would be issued in the near future.

The NASA spokesmen said it was believed that the plant could be built in a year. Several industry spokesmen disagreed, saying the construction would take more time.

It was indicated that the contract to be awarded would provide that the winning company build the plant with its own funds and NASA would be committed to buy from the second plant after first meeting its needs from the Linde plant.

The present NASA contract with Linde calls for the purchase of liquid hydrogen on the following basis: First 100,000 lbs. in any month at 66¢/lb., next 50,000 lbs. at 57¢/lb., next 50,000 lbs. at 55¢/lb., and last 75,000 lbs. at 32¢/lb.

Firms Compete for Contract On Orbiting Observatory

Four companies and seven teams of companies are bidding for a contract to design and develop a 3500-lb. orbiting astronomical observatory (OAO) for the National Aeronautics and Space Administration.

The observatory, largest payload attempted by NASA to date, would carry telescopes and other instruments and point them at parts of the sky with the accuracy and steadiness of a ground telescope.

The OAO would be boosted into orbit by an *Atlas-Agena B* vehicle. Harry J. Goett, director of NASA's Goddard Space Flight Center, told the House Appropriations Subcommittee in March that OAO would go into operation in about 2½ years. This would indicate a flight by late 1962.

The Goddard Center, which will move later this year from Washington to Greenbelt, Md., will have charge of developing the satellite. NASA did not say how much money would be involved in the contract. However, it was understood it would be worth upwards of $10 million to the winner.

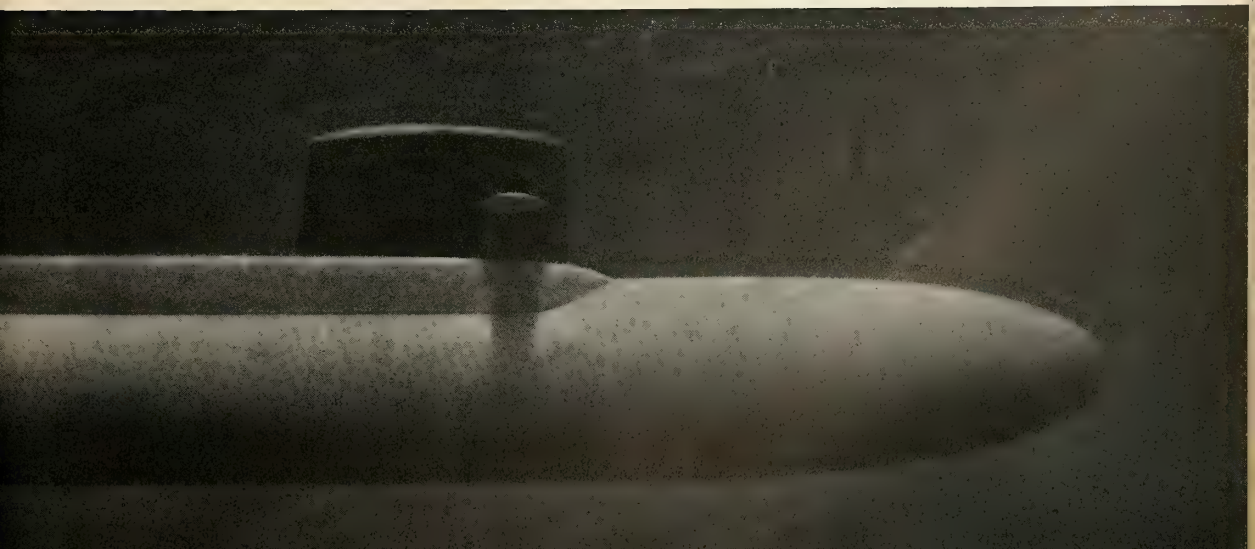
Astronomical observation from above the atmosphere is greatly improved because it avoids the distortion of visible light and the blockage of radiation in many wavelengths caused by the atmosphere. Rudimentary observations by rocket have already changed many of the ideas previously held about the nature of the galaxy.

NASA asked for bids on May 5. Bids were received July 5. Individual companies bidding were Lockheed Missiles and Space Division, Aeronutronics Division of Ford Motor Co., Hughes Aircraft and the General Electric Missiles and Space Division. These were the team bids:

Bendix and Republic Aviation Systems Division, The Martin Co. and General Precision Instruments Inc., Westinghouse Electric and Grumman Aircraft, McDonnell Aircraft and Philco, Aerojet-General and Motorola, the three-way combination of Radio Corp.

Erupting from the ocean that blankets most of the earth, the Navy's Polaris missile will have the range to reach any strategic target. It will be launched from mobile bases that are safe from surprise attack—nuclear-powered submarines that cruise fast and deep for weeks on end, each carrying 16 Polaris missiles. This is the Navy's Fleet Ballistic Missile system. It becomes operational this year. Lockheed is prime contractor and system manager for the Polaris missile.

LOCKHEED MISSILES & SPACE DIVISION



3

VITAL SPACE AGE ANSWERS ...THROUGH ULTRASONICS

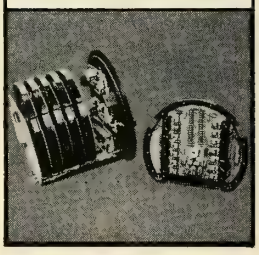
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Acoustica Ultrasonic Sensors provide near-instantaneous, completely safe response to liquid-level changes as small as 1/32" with complete reliability... in practically any liquid... with extreme reliability... infinitesimal power drain... at temperatures from −423°F to +500°F.



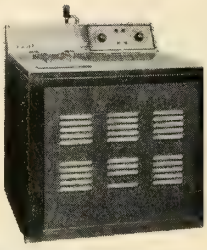
2. HOW FAST?

Acoustica Propellant Utilization Systems... proven both in ICBM flight and in the ground-support environment... report and automatically control the *rate* of propellant loading and the rate and ratio at which liquids are fed to missile engines in flight. They help insure successful adherence to flight plans.



3. HOW CLEAN?

Acoustica Ultrasonic Cleaning Systems assure the absolute cleanliness needed by electronic and mechanical components for in-flight and in-space reliability. With Acoustica's special *Multipower* techniques, parts are literally *blasted* free of even invisible dirt particles for maximum protection against malfunction.



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of America, North American Aviation and Perkin-Elmer Corp., and the four-way combination of Douglas Aircraft, Itek Corp., International Business Machines and Vidya of the Massachusetts Institute of Technology.

Soviets Finish Latest Series of Pacific Shots

Russia completed testing a new long-range rocket by firing it 8070 miles into the Pacific testing range and impacting the dummy last stage "right at the target point."

The July 7 firing was the second and last in a phase of testing which began only two days before. Tass said the first rocket travelled 8078 miles, although the Pentagon estimated the distance as 7700 miles. U.S. Navy planes reported sighting both flights although they could not determine whether the payloads impacted in the target area.

The Soviets expressed complete satisfaction at the results of the two tests. Tass reported that "these launchings yielded all data necessary to complete the development of a carrier rocket designed for further conquest of outer space."

STL Among Four Companies Doing Moon Payload Study

Space Technology Laboratories last week won its first contract with the National Aeronautics and Space Administration.

NASA chose STL and three other companies to make five-month competing studies of design and size of a package weighing about 2500 lbs. that would make a soft landing on the moon. The others are McDonnell Aircraft, North American's Missile Division and Hughes Aircraft.

STL has been free to contract for competitive government business since July 1, when Aerospace Corp., a nonprofit organization, was formed to provide the Air Force with systems engineering and technical direction of missile systems, and took over such work from STL.

NASA announced on July 10 that its Jet Propulsion Laboratory will negotiate contracts with the four companies calling for studies to be completed in December. The individual contracts will be in the neighborhood of $100,000. However, the winner of the competition will be in line for NASA business totaling $50-$100 million over the next several years.

STL has designed payloads for NASA in the past. But the work was done in its capacity as an agency of the Air Force. A division of Thompson-

(Continued on page 62)



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Advanced terrain clearance, terrain weather surveillance, and fire control systems.

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Major producer of ASW systems and sonar equipment, including outstanding transducer developments.

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MEET SOME OF THE AIRCRAFT/MISSILE/SPACE SPECIALISTS BACKING UP THE WESTINGHOUSE SALES ENGINEER:



A. M. Bruning, Engineer-In-Charge, Advanced Development Group
Age: 33
B.E., Johns Hopkins, 1949
M.S., Mathematics, University of Pittsburgh, 1956
Specialties: Arc Heated Aerodynamic and Thermodynamic Test Facilities, MHD Research Facilities
Years with Westinghouse: 8



W. J. Walker, Engineer-In-Charge, Aviation Facilities Group
Age: 42
B.S.M.E., University of Southern California, 1949
Specialties: Wind Tunnels, Sonic Fatigue Test Facilities, Hardened Base Equipment, Launchers
Years with Westinghouse: 11



R. A. Feranchak
Age: 29
B.S.E.E., Youngstown College, 1952
Specialties: Arc Heated Aerodynamic and Thermodynamic Test Facilities, Explosive Forming, Rotating Equipment Test Stands
Years with Westinghouse: 7



R. F. Leepa
Age: 29
B.S.E.E., Lafayette College, 1953
Specialties: Military Power Plants, Radar Antenna Drives
Years with Westinghouse: 6



P. J. Hawkshaw
Age: 36
B.S.E.E., Catholic University, 1950
Specialties: Continuous-Flow and Hot Shot Wind Tunnels, Explosive Forming
Years with Westinghouse: 9



J. McDonald
Age: 43
A.B., Chemistry, Engineering, Physics, University of California, 1938
Specialties: Arc Chamber and MHD Generator Development
Years with Westinghouse: 13



H. C. Lee
Age: 40
B.S.E.E., Chiao Tung University (Shanghai), 1942
M.S., Engineering, Cornell University, 1949
Ph.D., Cornell University, 1951
Specialties: Arc Chamber and MHD Generator Development
Years with Westinghouse: 2



H. A. Zollinger
Age: 30
B.S.E.E., Michigan College of Mining and Technology, 1951
M.S.E.E., University of Pittsburgh, 1958
Specialties: Drive Systems for Loaders, Elevators, Erectors and Launchers
Years with Westinghouse: 9

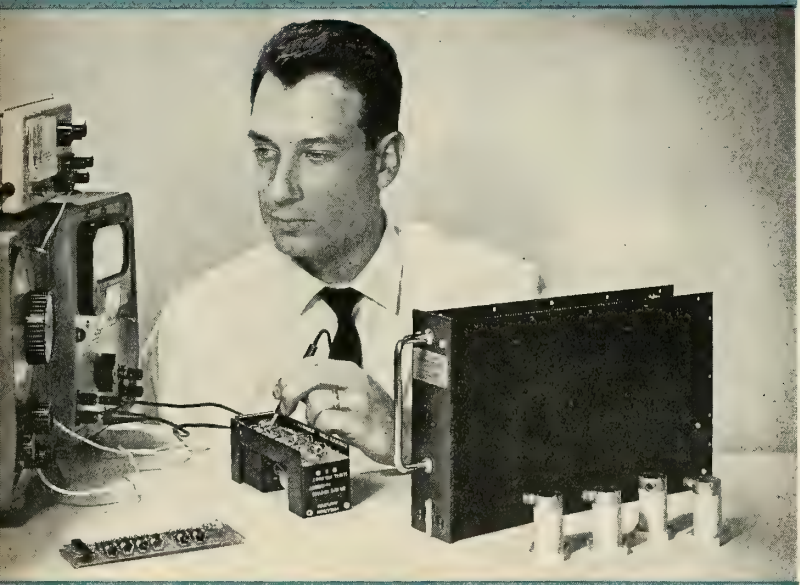
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...to stop it, find it!

That's the first step. Then you've got to monitor or measure it before you can move in for fast control.

Consolidated takes you all the way in finding and measuring vibration...with an airborne system for turbojet and turboprop engines...and meters and filters for analysis of turbine engines in test cells and on run-up stands...with ground equipment that detects and measures vibration in such static industrial devices as pipelines and air-conditioning systems.

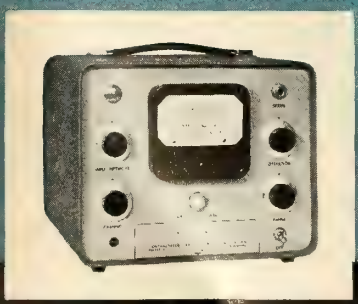


Engineer checks out airborne vibration amplifier at Consolidated Systems Corp.

Where's your vibration problem?

***If it's airborne,* consider Consolidated Systems Corp.'s vibration-monitoring system. Its transistorized design and printed circuitry assure reliability and compact packaging. The four-channel modular amplifier is easily accessible and the four CEC vibration transducers are operative to 500°F. This system requires only 5 watts.**

Write for Bulletin 3011A-X9.



FOR GROUND APPLICATIONS

CEC's portable Type 1-117 Vibration Meter is equally efficient in the field, in the laboratory and on the production line. Provides direct indications of average vibratory velocity and peak-to-peak displacement on a large, easy-to-read meter.

Write for Bulletin CEC 1538C-X1.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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(Continued from page 58)

Ramo-Wooldridge Inc., STL will continue to provide systems engineering of ICBM weapon systems until development is completed. Aerospace Corp. took over the supervision for new missiles and advanced detection systems.

The moon payload, a follow-up to Project *Ranger*, has no name as yet. It will be boosted by an *Atlas-Centaur* vehicle. First flight is expected in 1963. *Ranger* will rough-land a seismometer on the moon's surface about 1962. NASA officials want the soft-land payload to hit at not more than 27 ft./sec., compared with Ranger's speed of more than 300 ft./sec.

A bidders' conference was held at JPL on May 13. Twenty-seven companies filed bids, which were received on June 6.

First Submerged Shot Of Polaris Near at Hand

The *Polaris* test program moved toward a dramatic climax this week as the George Washington prepared to launch the first live *Polaris* while submerged off the coast of Florida.

The test follows nearly 70 launchings of *Polaris* test vehicles beginning in 1957. The program's box score: 46 successes; 19 partial successes; four failures.

The *Polaris'* latest string of launching successes ended July 6 when a malfunction in the 15-ton missile's second stage cut short a flight from a land-based pad at Cape Canaveral.

The next day another *Polaris* veered out of control seconds after it was launched at sea from the Observation Island test ship. A range safety officer destroyed it and the broken missile fell into the Atlantic a few hundred yards from the ship.

GE to Install Trajectory Measuring System at Cape

A $15½-million contract for a new precision missile trajectory measurement system has been awarded to General Electric Co. by the Air Force.

The new system—called MISTRAM—will be first installed at Cape Canaveral. Additional stations will be added later at down-range island sites and elsewhere on the U.S. East Coast. The basic system is scheduled to be in operation by January, 1962.

According to GE, MISTRAM will be more accurate than any trajectory system presently available for U.S. missile test ranges. Basis for the super-accuracy of the system is a method of using phase-stabilization to correct for baseline deviations caused by changes in temperature and equipment. In addition, the system will be able to pin-

←Circle No. 46 on Subscriber Service Card.

point measuring-station locations on the earth by utilizing orbiting satellites.

A novel feature of MISTRAM is the elimination of precision tracking antennas. Signals received from the missile will be processed by a computer to determine its trajectory from derived position and velocity measurements.

TRW Will Build Solar Power Units for NASA

A $4.3-million contract to supply two Sunflower I solar auxiliary power units in two years was agreed upon last week by the National Aeronautics and Space Administration and TAPCO Group, Thompson Ramo Wooldridge Inc.

NASA announced in April its plan to negotiate with TRW for development of the 3000-watt spacecraft APU, designed to operate for a year within nose fairings usable on *Centaur* and *Saturn* launch vehicles. It will weigh about 700 lbs.

The system will consist of a foldable petal-type solar collector that will open to a diameter of about 32 ft. The sun's rays will boil liquid mercury, which will drive a turbogenerator to produce electric power. An energy storage unit will permit continuous operation, even when the craft is in the earth's shadow.

TRW originally estimated the cost of development at $4.9 million.

Getting Named Head Of Aerospace Corp.

Dr. Ivan A. Getting will be the first president of Aerospace Corp., successor to Space Technology Labs as manager of the Air Force missile and space programs.

Dr. Getting is former vice president for research and engineering for the Raytheon Co., and during World War II was director of fire control and Army radar for the Radiation Laboratory of Massachusetts Institute of Technology. He has also been Professor of Electrical Engineering at MIT.

The appointment is effective August 1.

Broad Range of Topics Scheduled at WESCON

Workshop sessions on the wide-ranging aspects of manned-machine systems will be among the primary attractions in the technical program of this year's Western Electronic Show and Convention (WESCON).

Scheduled for Los Angeles, August 23-26, the West's big four-day electronics meeting is jointly sponsored by Institute of Radio Engineers and

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Wherever unbalance is present – in engines, machinery, motors, generators and countless industrial applications – this line of vibration transducers insures fast detection, helps you get right to the heart of the trouble.

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Now widely used by the aircraft and electronics industries, detects vibration instantly in operating jet engines while airborne or during ground tests. This rugged, omnidirectional transducer assures a frequency response of 45 to 2000 cps with constant damping over a temperature range of –65°F. to +500°F. *Write for Bulletin CEC 1628-X1.*

HIGH TEMPERATURE TYPE 4-124

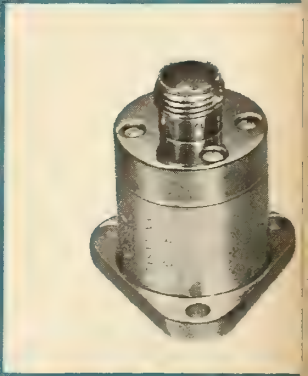
Like Type 4-123A is hermetically sealed against sand and dust, functions perfectly in oily, corrosive and humid atmospheres. When the environment is rugged, Type 4-124 operates at temperature extremes to +800°F. *Write for Bulletin CEC 4124-X1.*



BOTH UNITS SHOWN ACTUAL SIZE

CEC TYPE 4-118

Is ideal for use where space is limited or when a heavier transducer would invalidate test results. Low sensitivity to transverse accelerations and accurate performance in any mounting plane make the 4-118 desirable for mobile tests. Output may be coupled to a recording oscillograph or the unit may be used with a vibration meter or oscilloscope. *Write for Bulletin CEC 1535D-X1.*

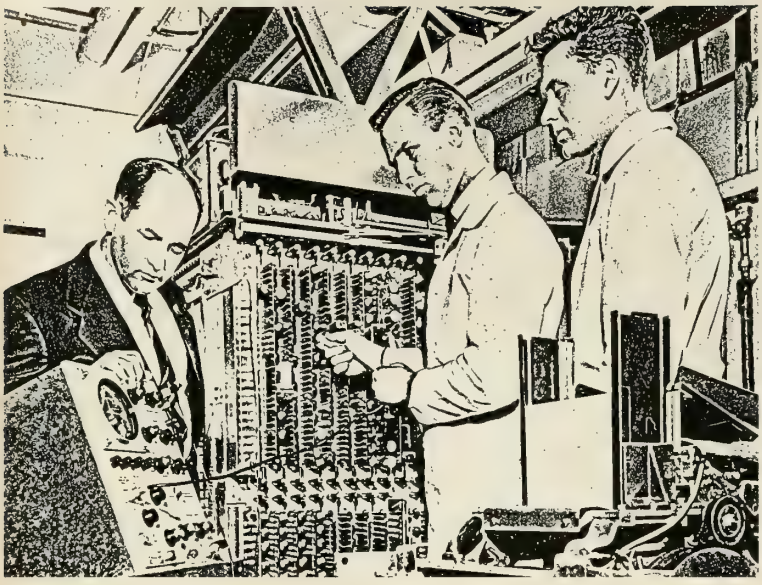


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Western Electronic Manufacturers Association.

Each day's technical program will include a workshop session. Subjects to be included: Management of Manned Machine Systems (moderator: R. L. Clark, DOD); Analysis of Manned Machine Systems (moderator: Lt. Col. A. Debbons, RADD); Synthesis and Design of Manned Machine Systems (moderator: D. T. McRuer, Systems Technology, Inc.); Operation and Training of Manned Machine Systems (moderator: J. Lyman, UCLA).

The program includes 40 technical sessions on electronics and related areas with more than 200 speakers presenting papers. The preliminary schedule lists sessions on the following subjects:

Systems and maintainability; pulse-handling techniques; communications; management of manned machine systems; semiconductor devices and tubes; communication values of the technical symposium; varactors and tunnel diode applications; instrumentation; circuit theory; semiconductor devices;

Computers; stereo multiplex broadcasting; microwave theory and techniques; analysis of manned machine systems; microwave tubes; computer circuits and devices; magnetic data recording; working with engineers; vehicular communications; component and systems reliability; air traffic control;

Antennas; synthesis and design of manned machine systems; microminiaturization; government and industry engineering proposals; the *Pioneer V* experiments; bioinstrumentation systems; military electronics; information theory and modulation methods; operation and training of manned machine systems; coding methods and telemetry.

An innovation in this year's technical sessions will be a women's program on the subject, "Engineering: The Woman's Role."

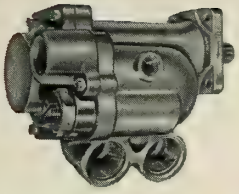
Cole Connector Uses New Alignment Principle

LOS ANGELES—A new principle for self-aligning contacts is used in a connector developed by Cole Electric Co. for ground service equipment of the *Atlas* weapon system.

Cole has just received a production contract for the connector from Convair Astronautics.

Basic principle of the self-aligning electrical connector is that of a universal joint employing a two-ball split-sleeve design. The ball end of each contact pin mates with a split-sleeve socket that is loosely retained with another ball to form a receptacle unit.

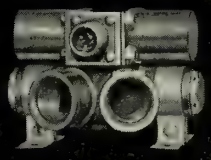
Garter springs on the split-sleeve provide expansion or contraction of



PUMPS — positive displacement types — wide range for handling most types of fluids, speeds to 60,000 RPM



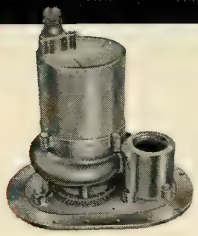
HYDRAULIC MOTORS — compact — gear type / range to 30 HP / speeds to 60,000 RPM — rotation either direction.



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PUMPS — positive displacement types — electric motor driven / operate on wide range of fluids / pressures to 4000 PSI.



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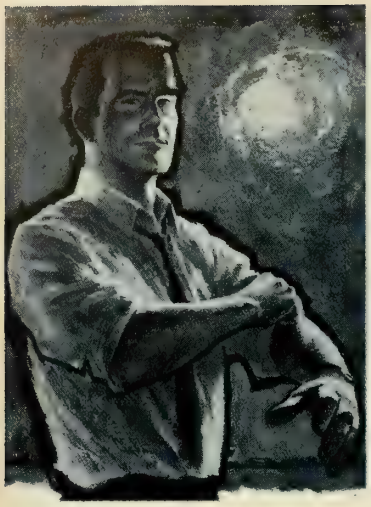
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Assignments are at Warren Air Force Base, Cheyenne, Wyoming; Offutt Air Force Base, Omaha, Nebraska; Fairchild Air Force Base, Spokane, Washington; and in San Diego.

Please send complete resume to Mr. R. Merwin, Engineering Personnel Administrator, Dept. 130-90, 5521 Kearny Villa Road, San Diego, Calif.



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the sleeve to allow easy entrance or withdrawal regardless of the alignment of the pin or connector. Optimum electrical contact is assured.

Cole says the unique two-ball and socket action permits unusual flexibility, allowing the junction to be made quickly and easily even though pins may have become misaligned due to rough treatment, high shock, vibration or extreme temperature changes.

The self-aligning feature also allows angular insertion or extraction without damaging the pins or increasing pressures.

Pressures required to open or close are extremely low. Cole says a 48-contact Cole Connector using #16 pins require an insertion force of 18 lbs. and an extraction force of 15 lbs. compared to 100 lbs. and 125 lbs. for conventional connectors of the same type.

This made it possible to design the *Atlas* system without the use of complex opening and closing devices. Since the self-aligning contact pins can be inserted at an angle without damage, the Cole connector opens and closes like a book.

Use of this hinged action makes possible a lower weight and cheaper unit than the use of screw-on, screw-jack or power-lever types, the company says, and connection and disconnection also is faster and easier.

The unit has been built for rough use. In tests, the connector was dropped more than 5 ft. to pavement some 2000 times without major damage.

Cole reports that the self-aligning principle makes it possible to design a connector with virtually any number of contacts of various capacities. Contact pins for the connectors are available in 15, 30, 75, 150 and 300 amp. capacities and any combination of pins sizes can be used in a single connector.

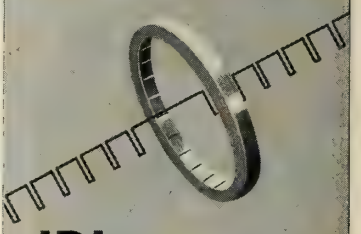
This was done in the connectors for the *Atlas* system, which originally called for a number of different connector designs to accommodate the many cable configurations.

Cole simplified the problem by designing just one basic connector to serve all types of cables.

Pentagon Studying Whether Ads Are Allowable Costs

The Department of Defense is currently conducting a detailed analysis of all trade publications to determine whether or not advertising in them is an allowable item of cost under the Armed Services Procurement Act, according to a letter written by Gen. Arno Leuhman, chief of Air Force information, to the publisher of Air Force Magazine.

Time-Sharing Problem?



IDL MAY HAVE A SOLUTION –

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency.

In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.

Then IDL introduced multi-fingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

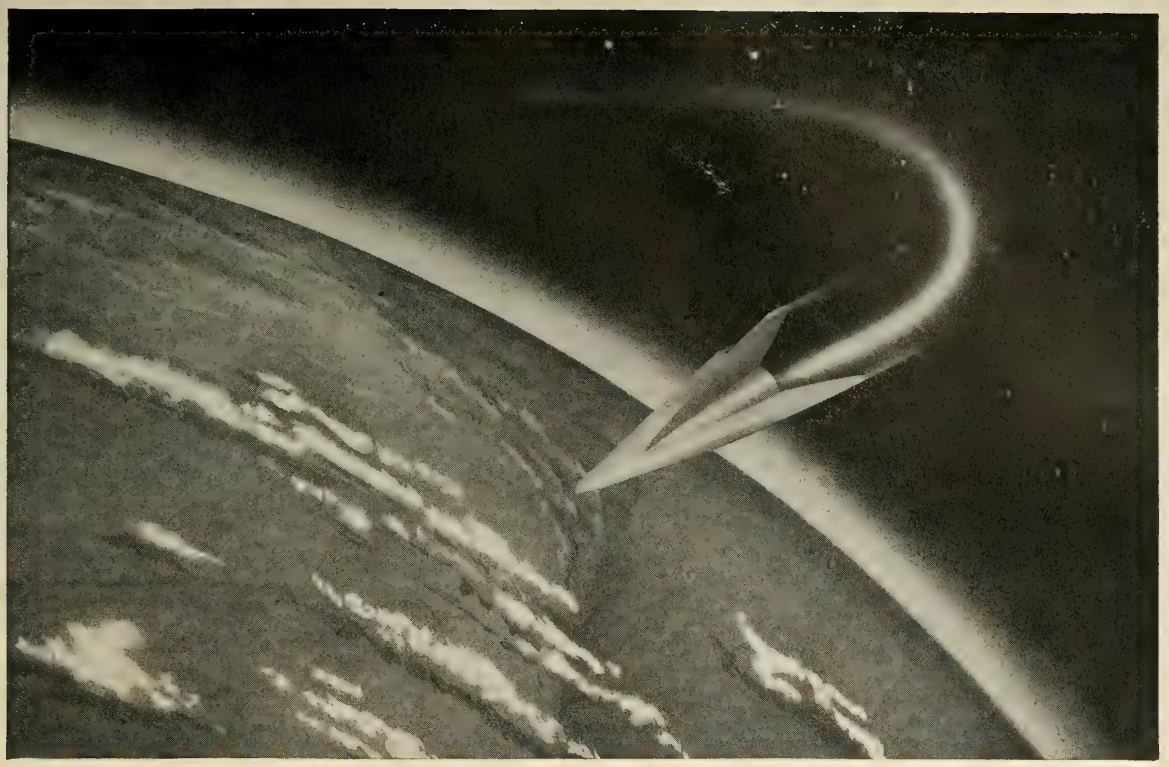
For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60 data channels, each operating at 5 rps.

IDL *For further information, write for Technical Bulletin No. 500660; or let us propose a solution to your Time-Sharing Problem.*

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Return from Space

The first astronauts will return from outer space in ballistic capsules with parachute recovery. The re-entry vehicles used by subsequent space travellers, however, will return to earth in controlled glides much as conventional aircraft do.

This problem of "controlled return" is undergoing intensive study at Grumman, with preliminary designs of re-entry vehicles well under way. Collateral projects include space defense weapons, orbiting astronautical observatories, manned lunar vehicles, and upper stages of booster vehicles.

For these and future studies, Grumman is building a team of space engineers and scientists with the following qualifications:

. . . **Navigation and Guidance.** Minimum of 5 years' experience in guidance and navigation and components for missiles and space vehicles.

. . . **Celestial Mechanics and Trajectories.** Minimum of 5 years' experience in celestial mechanics, missile and space vehicle trajectory analysis and related areas.

. . . **Communications.** Minimum of 5 years' experience in theory and design of radar and communication systems with special emphasis on radio guidance, radio and radar tracking and communication systems for missiles and space vehicles.

. . . **Dynamics.** Minimum of 5 years' experience in dynamic analysis, the theory of rigid and elastic body dynamics and/or the design and instrumentation of attitude control systems for missiles and space vehicles.

Send your resume in strict confidence to Mr. A. Wilder, Manager Engineering Employment, Dept. GR-86 to arrange for a mutually convenient interview.

Grumman

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Technical Countdown

ELECTRONICS

New Techniques for Anti-jamming

An interesting concept applied to the problem of anti-jamming protection for communication satellites is termed "graceful degradation." Aim is to have a system capable of stepped-up performance during ECM attack but to automatically lower operating requirements when the satellite is not subject to jamming.

Yes, We Have No Communication Satellites

Most of the work in perfecting a practical communications satellite system is still ahead of us, according to F. R. Kappel, president of AT&T. Contrary to some "over-enthusiastic publicity," he says, a limited system is five years away and commercial applications about 10 years in the future, "if all goes well."

Reliability High for Titan "Athena"

Reliability of the *Titan* guidance computer, Athena, is reported to be rated at 99.92% after over 21,000 hours of continuous operation of four models. Remington Rand Univac has just received AF contracts of over $26 million for production of the solid-state computers.

Ozone vs. Weather and People

An ozone analyzer being developed by Armour Research Foundation at Illinois Tech is expected to shed some light on the part ozone plays in determining atmospheric circulation. Another application is as a monitor for manned space vehicles cabins flying through the ozone layer between 40,000 and 150,000 ft. Even low concentrations of ozone (2 ppm) can cause severe lung irritation.

Down-range Pickle Jar

A "pickle-jar navigation aid" helped a down-range telemetry ship reach its assigned position southeast of Ascension during an *Atlas* shoot some time ago. Devised on the spot by Pan Am technicians, the jar was used as a lighted buoy to determine ocean current drift during a storm that blocked out conventional navigation fixes.

Negative Ions for Health?

A recent Air Force study demonstrates that positive ions, originating mainly from carbon dioxide, promote various harmful effects, including an increased vulnerability to trauma. Negative ions, originating from oxygen, are said to have beneficial effects. Conclusion: fill space cabins with negative ions.

ADVANCED MATERIALS

PH Stainless Process Licensed

Armco Steel granted a license to Republic Steel to produce and sell Armco's 17-7 PH, 17-4 PH, and PH 15-7 MO. Precipitation-hardenable stainless steels are used extensively in supersonic flight environments.

Mach 27 Wind Tunnel in Operation

Boeing has commenced full-scale operation with a "Hotshot" wind tunnel. Hypervelocities are attained by use of electrical energy impulses equivalent to five million horsepower stored in 2280 capacitors. Temperatures up to 14,000°F and simulated altitudes of 50 miles can be reached in the 56-foot tunnel.

ASW ENGINEERING

Batteries vs. Rockets

Solid-fuel rockets for torpedo propulsion will have a hard time pushing batteries out of the picture. Many in the Navy feel that solids have a long way to go technically and that more money in battery research would produce the breakthrough needed to give required high-energy levels.

System is the Thing

ASW weapons should be designed as a system, according to some manufacturers in the business. They say the Navy should decide on a comprehensive and feasible system and go to work on implementing it with appropriate vehicles and hardware.

Drone Helicopter for ASW

A Gyrodyne *DSN-1* drone helicopter made its first at-sea landing aboard the USS Mitscher July 1. The experimental model is the first remote-controlled helicopter built expressly for use in destroyers. It will be used to carry homing torpedoes to kill enemy submarines.

PROPULSION

Agena Engine Passes Restart Tests

The Bell 8081 engine for Lockheed *Agena B* has reportedly passed a series of successful restart tests under simulated vacuum conditions. Tests were conducted at Arnold Engineering Development Center, Tullahoma, Tenn.

Test Sled Hits Mach 3.5

A 2.5-ton monorail sled was boosted to a record velocity of 2650 mph at Holloman AFB last month. The 48-foot sled, largest ever fired at Holloman, covered 5½ miles in 15 seconds. It was propelled by three Hercules Powder Co. *Nike* boosters.

Swan Song for X-7

Final flight is scheduled this week for the Lockheed *X-7*, a ramjet-powered test missile that holds the West's air-breathing-vehicle speed record of Mach 4.31. The program at Holloman AFB will end with this flight, the 130th. *X-7*'s have a success record of 75% in testing ramjet engines and gathering data on exotic fuels over the last 13 years.

Research Needed to Advance Air-breathers

Research in three areas is needed to advance the high-Mach-number air-breathing engine science, speakers told an AGARD meeting in Milan this spring. The areas: high-temperature recombination rates of hydrogen-air and hydrocarbon-air; effect of shock on flow, mixing and combustion; and turbomachinery design.

How Does a Solid Rocket Burn?

Ignition of solid propellants has been shown to occur entirely in the gas phase, contrary to a widely held technical view. So says the Air Force Office of Scientific Research. Bolstering the agency's notion is a partly developed mathematical theory of composite propellant burning based on experimental studies of ammonium perchlorate combustion.

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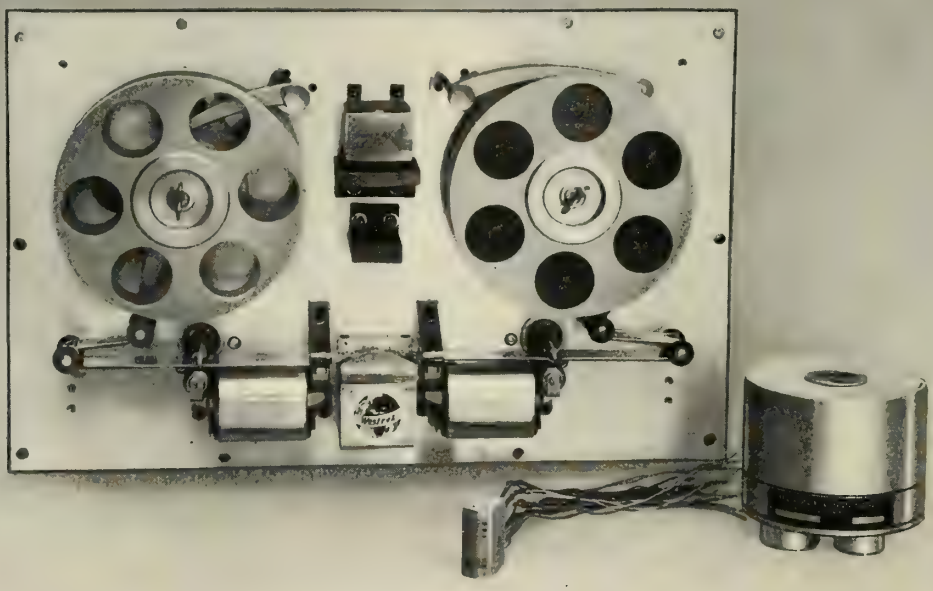
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PERFORATED TAPE READERS A new Westrex perforated tape reader handles 8 levels of information; reads in both directions at continuous speeds up to 1400 characters per second; stops on character at 200 characters per second. Starting time 22 milliseconds, stopping time 1 millisecond. Remote control operation and logic level output to meet your specific needs. Solid state electronics, with miniaturized etched circuit, plug-in modules. End of tape sensing by logic read out.

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MINIATURE AIRBORNE TAPE RECORDERS Designed to withstand impacts of 1500 G's, a new Westrex miniature recorder can simultaneously record and monitor 14 tracks of information. With 14 tracks to the inch, unique shielding provides a crosstalk ratio of over 40 db at 5000 c.p.s. Precise gap alignment, obtained by optical lapping methods, maintains gap scatter within plus or minus 50 microinches. The positively-driven tape-pulling mechanism, and virtually continuously supported tape, are features which reflect our unique and proprietary knowledge in this field. The entire hermetically-sealed recording unit is contained in a single cylinder 3 inches high and 4 inches in diameter.

For information on this and other Westrex products, address your inquiry to Mr. L. A. Call, Westrex Corporation, Recording Department, 6601 Romaine Street, Hollywood 28, California.

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1960 Propulsion Progress . . .

Hydrogen-LOX Development Exceeds Forecasts

- ***Rapid progress of LOX-liquid hydrogen system is year's most important trend***
- ***Engine hardware is area of greatest solids improvement***
- ***Nuclear rocket gets firm development objective***
- ***Ion engine development programs spur electrical propulsion***

An interview with Elliot Mitchell, assistant director for propulsion, Office of Launch Vehicle Programs, NASA.

The most significant propulsion trend of the last 12 months is the unexpectedly rapid progress of the liquid hydrogen-LOX system.

This is the opinion of Elliot Mitchell, top propulsion specialist of the National Aeronautics and Space Administration. He says that NASA, taking advantage of the trend, has decided to give maximum support to development of a large LOX-hydrogen engine and to exploit the system for upper stages of advanced vehicles such as *Saturn*.

Mitchell, assistant director for propulsion on the staff of Maj. Gen. Don R. Ostrander, NASA director of launch vehicle programs, declared in an interview that Pratt & Whitney Division of United Aircraft has made tremendous progress in its work on a 15,000-lb.-thrust hydrogen engine for the *Centaur* and *Saturn* programs.

"The performance of this engine, including combustion problems, has come along extremely well," Mitchell said. "The handling of hydrogen on a large scale is a lot more reasonable than any of us had optimistically hoped."

The NASA propulsion chief recalled that Rocketdyne Division, North American Aviation, was chosen this spring to develop a LOX-hydrogen engine of 200,000 lbs. thrust, more than 13 times the power of the Pratt & Whitney engine. And the P&W powerplant itself will be uprated to about 17,500 lbs.

Mitchell was asked for his assessment of progress in all major propulsion areas in the last year. He expressed these opinions:

• **Storables**—The combination of nitrogen tetroxide and hydrazine-type fuels has gained momentum, he said. "If we are talking storable liquids, this combination is reasonable and provides a higher impulse."

Mitchell said, however, that not enough is known at present to endorse the use of any storable propellant system for use in space. "We need to understand theoretically and experimentally how high-energy particles affect propellants, the chamber material and their interaction."

Both NASA and the Air Force are making plans for experimental studies simulating radiation and other space environment effects on storable propellants, he added. Industrial contractors have been asked to make proposals.

Mitchell noted also that work is progressing rapidly on the *Saturn* booster and the 1½-million-lb.-thrust F-1 engine. Although no breakthroughs are involved in these LOX-kerosene engines, he said, they are great engineering jobs that are progressing very successfully.

As for *Saturn*, he said the anticipated heat problems have not been severe—"the result of a combination of good fortune and damned good engineering." He added:

"The thoroughness of the Marshall Research Center team's approach under Dr. Wernher von Braun is overwhelming. It is a team effort that is a pleasure to watch."

• **Solids**—The spectacular success of the *Polaris* and *Minuteman* systems in the last year has demonstrated that large solid motors can be reduced to reliable practice, Mitchell asserted.

The area of greatest progress has been in engine hardware rather than in the propellant itself, Mitchell reported. Hardware improvements have taken place in development of high-performance cases, production of reliable, useful thrust vectoring, and termination and solution of insulation problems.

Mitchell said he does not expect any tremendous progress in the near future on improving solids except for some entirely new propellant that might come from the research sponsored by the Defense Department's Advanced Research Projects Agency. And in such a case, he asserted, experience shows that such a new fuel could not be brought into operation in less than five years.

Improvements in the near future, he said, will come from marginal increments of 5 or 6 seconds in specific impulse, better mass ratios and other little tricks.

"But as we go into systems significantly better in I_{sp}, we will find ourselves aggravating many problems that we are handling relatively simply today," he continued. "We may encounter breakthroughs we don't see today, but I feel significant gains in performance will come hard."

Another important development in solids is continuous processing, Mitchell declared. This will be the manufacturing method for any future programs based on large-volume production.

In motor case fabrication, Mitchell predicted a wider application of fiber glass and plastic, which he said has very great growth potential, both in performance and cost.

For large-volume production, steel cases probably will maintain a cost

(Continued on page 84)

Reliability Replaces Size Reduction As Main Objective of Integration

- *Reliability is biggest advantage*
- *Cuts promised in cost, size and power consumption*
- *Integrated circuits demand integrated processes, teams*
- *Need for materials research grows*
- *New assembly and processing techniques required*

by Dr. H. W. Welch, Jr.*

There is much speculation over the impact of recent advances in solid-state integrated circuits on the future of electronics.

Without speculation, it should be possible to review recent activity in this field and provide a measure of progress. This, subtracted from what we know we need to accommodate our present electronics capacity, should give us a less speculative idea of what remains to be accomplished.

To measure progress, we should ask, "Where have we been trying to go?"

The implication of the terms first applied to describe the integrated circuit effort—microelectronics and micromodules—was that reduction in size was the objective.

• **Main objectives**—Recently, however, there has been more emphasis on the reliability—rather than small size—of the equipment manufactured with the new methods. Higher reliability is expected to result from reducing the numbers of interconnections and more closely controlling assembly procedures.

Ultimately, costs should be lowered through reduction in parts inventory, reduction in number of manufacturing processes, and general applicability of mass-production techniques.

Along with size reduction, there may be an increase in speed of action and a decrease in power consumption. These three factors have become important as complexity has increased in terms both of total number of components and of number of different kinds of components. This is particularly true in data- and information-processing systems, which have increased in complexity faster than have signal processing systems.

Increase in reliability and speed, decrease in cost, size and power consumption have emerged as the real objectives we hope to achieve by new approaches to circuit construction. These, plus one other, are no different than the objectives we have had for years.

The other objective—and probably the most important—is to enable systems to perform under environmental conditions never experienced before. As a by-product of the effort we may expect systems to perform new functions in applications not previously conceived or attempted.

• **New approaches, technologies**—These objectives are being approached through greater application of solid-state phenomena and the development of closer integration of circuits.

In the past, circuits have been integrated topologically—through point-to-point interconnection of a variety of components in a readily discernible network. Now we are looking toward three basically different methods of integration in which the network is increasingly less discernable: integration by the overlapping of thin films of solids having a variety of electrical and magnetic properties; volume junctions in semiconducting, dielectric and magnetic solids; and complete molecular integration such as exists in the coupling between electron spins and the lattice in magnetic solids.

To construct integrated circuits by these methods it has been necessary for industry to expand its capability to perform the necessary processes.

Previously, to take an extreme view, the equipment manufacturer had only one process to perform in electrical assembly: soldering. Some had developed capability for printed wiring. Other processes were performed in the mechanical packaging and protection from environment.

With the new approaches to integration, four new technologies become essential for a complete processing capability: semiconductor technology (single-crystal growth, diffusion, alloying, etching, thermo-compression bonding, etching, etc.); thin-film technology (evaporation, sputtering, pyrolysis, masking, surface cleaning and preparation, etc.); electronic ceramic technology (mixing, extruding, pressing, firing, annealing, glazing, grinding, etc.); and solid encapsulation technology (chemical preparation of glasses, deposition of inorganic, non-metallic solids, surface preparation, annealing, etc.).

Along with these process technologies, the measurement of basic electrical properties of solids—conductivity, dielectric constant, magnetic permeability and environmental testing—must be accomplished in order to know that a process has been successful. In addition, means for internal examination of solid-state characteristics such as crystal structure, diffusion depth, impurity concentration, grain structure, etc., must be available.

Most important, does the resulting circuit have the electrical characteristics to perform the functions for which it was designed? In other words, could it be designed in the first place

**Director of Research and Development, Military Electronics Div., Motorola Inc.*

and is it reproducible from written process specifications and drawings? This question must be answered by and to the satisfaction of the systems and equipment engineers with their methods of measurement from the terminals of the resulting circuits.

• **Teamwork required**—Integration of processes leads to the need for integration of people into a team. Chemists, physicists, electronic engineers, electromagnetic engineers, mechanical engineers, metallurgists, ceramicists, and techniques highly skilled in vacuum techniques, evaporation, heat treating, chemical processes, and such, must work in close communication as a team to accomplish the end result.

This is borne out by the observation that any completed circuit is so closely tied together mechanically, thermally, and chemically, as well as electronically, that diagnosis of a malfunction might involve any or all of the mentioned disciplines.

The interconnected components approach has led to specialists in resistors, capacitors, transistors, inductances, insulated wire, etc. The integrated-circuit integrated-process approach requires close integration into a team of people with the same special qualifications.

Where We Stand

Now that we have established a yardstick against which progress can be measured, let us see how far we have progressed.

Most significantly, for the first time in the history of electronics, a number of teams of scientists and engineers have been established with the common objective of building electronic systems from the basic solid materials rather than components made by specialists. Ten to 15 such teams exist within the broad spectrum of disciplines mentioned above. The average size is from 20 to 30 qualified scientists and engineers.

My estimate would be that between 300 and 500 scientists and engineers have been assigned to this effort and that less than 15% of these are electronic circuit engineers. This concentration of effort is bringing a refreshing new look into the electronic industry.

• **New discoveries**—Integration of processes has brought many of our solid-state scientists closer to the application with the result, surprising to some, that they are discovering problems of basic nature that they did not know existed. Electrical properties of thin films such as conductivity and dielectric constant are better understood, as are chemical and physical properties such as effects of impurities and vapor pressure.

Chemical interactions between masks, substrates, and circuit elements not isolated physically from one another have been discovered and eliminated by changes in processing techniques. Better control of processes of deposition, diffusion, alloying, crystal growth, surface preparation, etc., has been achieved. New methods for performing these processes have been developed. Crystal growth by the dentritic process, through constraining apertures, and by the epitaxial process is better understood. Each of these methods lends itself to the integrated-process approach to circuit construction.

The suppliers of electronic materials are having demands placed upon them for higher purity and better particle size control. Quantities are still not large enough to make the chemical industries really excited, but they are cooperating.

The semiconductor industry—in addition to looking at new approaches to crystal growth—has developed methods for placing more than one transistor or diode in one semiconducting substrate and have added resistance and capacitance within the same substrate to make complete circuit functions.

• **Adding materials**—Much attention has been given to deposition of tin oxide and high-resistivity metals, and the anodization of tantalum for resistance elements. All of these approaches meet the high designability and reproductibility criteria. Anodization of tantalum and deposition of quartz have met the same criteria for the formation of dielectrics. Conducting and magnetic metallic film deposition has reached a high degree of maturity.

Preparation of ceramic, glass, quartz, beryllia, and alumina substrates is now better understood. Problems of smoothness, cleanliness, and shape control still exist. Substrates other than semiconductor suitable for epitaxial growth of semiconducting solids remain to be found.

Solid encapsulation at low temperatures with glass and inorganic solids of more regular crystalline structure has been achieved but not brought to a high degree of maturity. Organic encapsulants suitable for long-life application have not been developed.

• **Searching for shapes**—A generally acceptable solution to the problem of interconnection and packaging of subassemblies of integrated circuitry has not materialized.

It is generally agreed that modules with more than one circuit element per substrate are desirable. The upper limit will be determined by a complex compromise of factors such as yield per process, yield per module, encapsulation and packaging, replacement frequency and expense, deterioration due to chemical interaction, tooling costs, quantity to be manufactured, etc. It is unlikely that a single standard module shape will be accepted.

The hybrid approach of combining integrated circuits with more or less standard components is beginning to be generally recognized as necessary for immediate application. This is particularly true where precision resistors, high selectivity, flat response over precisely determined pass bands or impedance transformation are needed.

We have established teams and developed and improved processes. What has actually been accomplished in the development and manufacture of integrated circuits? I prefer not to answer this question but would like to give the reader a check list which may provide a sobering as well as a challenging influence.

The following is a list of functions presently performed in electronic equipment over a frequency range from d-c through microwaves, over a wide range of power levels, and over wide environmental extremes. This list is reasonably complete in that almost any electronic equipment can be built if all functions can be accomplished.

- Frequency generation
- Pulse generation
- Amplification
- Rectification
- Impedance transformation
- Radiation and absorption (antennas)
- Attenuation
- Frequency modulation
- Phase modulation
- Amplitude modulation
- Electromagnetic signal detection
- Electromagnetic signal mixing
- Electrical-to-light conversion (and vice versa)
- Electrical-to-heat conversion (and vice versa)
- Electromechanical conversion (and vice versa)
- Frequency discrimination
- Pulse counting
- Isolation and circulation (unilateral attenuation)
- Amplitude limiting (function generation)
- Bandwidth limiting (filtering)
- Analog addition and multiplication
- Digital addition and multiplication
- Long and short-term signal storage
- Tuning or control of other functions (frequency, bandwidth, attenuation, etc.)
- Frequency multiplication or translation

(Continued on page 86)

1960 Guidance Progress . . .

Notable Gains Made in Gyros, Microelectronics

- *Technology is keeping pace*
- *Hardware progress in gyros*
- *Impact of microelectronics*
- *Lagging accelerometer development*
- *IR scanner accuracy needs improvement*

by Charles W. Benfield*

Development of new and better techniques and equipment for space navigation and guidance has received noteworthy attention during the past year. Seldom have so many attacked a technical problem with so much vigor, enthusiasm, and ingenuity.

The year witnessed some significant hardware progress in gyros—the primary element in precision and reliability in space guidance.

Minneapolis-Honeywell announced start of production on a gyro with a ceramic, self-generating gas spin-bearing. This instrument is 2.75 in. long, 2.182 in. in diameter and weighs half a pound. The company claims a factor of 10 improvement in accuracy and a 30:1 reduction in bearing noise over the gyro's MIG predecessor. The precisely balanced rotor is suspended in its ceramic bearings on a film of gas only 25 micro-inches thick—yet stiffer than the steel ball bearings it replaces.

Jet Propulsion Laboratory is conducting development work of a more exotic nature. A precisely machined sphere, coated with superconductive metal, is supported on a magnetic field at cryogenic temperatures. Thus de-coupled from external torques, the spin axis of the sphere remains fixed in inertial space like the axes of the planets themselves.

Achieving the same result in a different approach, Minneapolis-Honeywell experimentally proved the feasibility of electrically suspending a beryllium sphere in a vacuum. A major program is underway to bring this radically new gyro into production for a shipboard inertial navigation system for *Polaris* submarines. Its applicability to space guidance systems is also being extensively studied.

This device and the JPL cryogenic gyro both hold promise for orders-of-magnitude improvement in accuracy and stability over conventional gyros.

General Electric announced development of a cryogenically suspended, spherically symmetrical rotor wheel spun up by torque coils located in its cylindrical, axial cavity and suspended on a spherical array of magnetic bearings in a vacuum chamber. An experimental cylindrical rotor was spun up to 20,000 rpm with coast-down time of 16 hours. While similar in principle to the JPL gyro, the GE device will be a different configuration, and may possibly have some unique advantages.

Accelerometer development was lagging a bit; there were many exotic dreams of cryogenically or electrically levitated seismic masses, gaseous inertial masses and "chemical" accelerometers—but little new hardware forthcoming. Still dreamed of is a 10^{-15} g threshold sensor for observing minor forces. JPL is developing a miniature quartz pendulum accelerometer.

• **Some leaps forward**—Microelectronics development is paving the way toward realization of the extremely complicated, super-reliable, electronic brains for automatic guidance of space vehicles.

Progress in this area took a surprising forward leap with a number of feasibility models by Westinghouse, including a button-sized, five-watt audio amplifier and a video amplifier dwarfed by a paper clip. RCA's micromodule program has produced working models of whole devices based upon stacks of 0.310" square by 10-mil thick ceramic wafers. Such techniques offer equipment component densities of 250,000 parts per cubic foot. Texas Instruments advertised off-the-shelf availability of a match-head-sized multivibrator.

Microelectronics development programs are well under way at General Electric, Bell Labs., Clevite, Sylvania, Pacific Semiconductor, Fairchild Semiconductor Corp., Philco, Transitron, Honeywell, and many others. As usual, much unpublicized basic research at government laboratories is behind such industrial progress. Talk of 10^{11} components per cubic inch is occasionally heard from the more optimistic participants in serious discussions on the subject.

• **Hardware to come**—Determination of "local vertical direction" and altitude above a planet by infrared is under study by many laboratories. Several horizon scanners have reached the hardware stage, and many disk scanners are on the drawing boards. Present accuracies leave much to be desired.

Hardware solutions are required in this problem area, before a space craft can be brought to a safe landing upon a strange world. The problem of measuring vector velocity relative to a planet is receiving much theoretical attention at JPL and elsewhere.

Star trackers now have over ten years of progressive development behind them, and many companies are studying their adaptation to space navigation. Accuracies to one arc-second are expected to be achieved in working hardware.

IBM and American Bosch Arma have announced progress in miniaturization of high-speed digital computers for space navigation. Both companies are expected to make considerable use of microelectronics developments.

Philco's Dr. Golay has proposed using radio interferometry for accurate distance measurement in deep space.

The Navy's *Transit* satellite program gives excellent promise for a payoff from the space efforts by providing a high-accuracy, all-weather navigation scheme for vehicles on or near the earth's surface. This program is progressing very well indeed; eventually the doppler techniques developed may be applicable to near-earth guidance of spacecraft.

High-precision ground-based radar, working with space-borne transponders, is receiving much attention for tracking and for injection guidance, particularly for near-earth and cislunar operations. It is to be expected that the first manned lunar flights will be closely tracked by radar and notified of their position and velocity by radio.

*Systems development engineer, Minneapolis-Honeywell Regulator Co., Military Products Group

TCM Moves Into Missile/Space R & D

- ***Extended range and measurement capabilities***
- ***New techniques for space***
- ***Low-level multiplexing***
- ***Hybrid-systems investigation***
- ***New components and subsystems***

by Conrad H. Hoeppner*

Telemetry advanced at a faster rate during the past year—and its applications received greater publicity than ever before.

Foremost among the year's accomplishments were extended range, greater numbers and varieties of measurements, and development of more efficient systems.

Transistorization of telemetry receivers is now almost complete, providing greater compactness and reliability.

Pulse code modulation telemetry—already well established in static testing, data reduction and sled tests—has been used for the first time in space vehicles. It is in production for two major missile programs: *Minuteman* and *Titan*. The first PCM ground receiving station for missiles has been installed at the Atlantic Missile Range, following installations for aircraft testing at Edwards AFB, Norair, Douglas and Republic.

PCM telemetry is unique among data handling systems in that it employs "computer language." Data, as it is received, is in a form for direct entry into digital computers for further processing, computations, corrections, plotting and printing. All of the bugs are not yet worked out of these telemetry systems; and advanced PCM system is still under development for Wright-Patterson AFB.

• **Biggest boost**—Probably the most significant adjunct to PCM telemetry systems has been the low-level multiplexer. While this device is not limited in its applications to PCM methods, it is a logical companion to the PCM voltage encoder.

Prior to the development of the low-level multiplexer it was necessary to use an amplifier following each low-level transducer of the thermocouple, strain-gage and resistance-bridge types. These made equipments large, power-consuming and difficult to maintain.

There are now 11 low-level multiplexers in data-processing systems in operation in the Thiokol Utah plant. These operate to a resolution of ten microvolts and a full-scale of ten millivolts. They are subject to errors caused by temperature changes and vibration, but are being developed to appear soon in aircraft and missile test programs.

• **The new challenge**—Telemetry has been forced to expand its scope to accommodate the new demands for scientific data. Mainly used heretofore for measuring temperatures, accelerations, positions, motions, and electrical characteristics internal to missiles and aircraft, it is now being employed to explore space.

The measurement of radiation density, ion density, atmospheric composition, visible and ultra-violet light, magnetic fields, particle impacts and the transmission of photographs, have required new transducers and also new data conditioning equipment to "normalize" the measurements for transmission over telemetry links.

There have been new demands on the telemeter for handling greater quantities of data with greater accuracy over longer distances. In many cases this has led to pre-transmission processing and reduction of data.

• **Thinking revolution**—A three-year comprehensive study of telemetry methods and systems sponsored by the Department of Defense has been completed. This study was unusual in the fact that measurements were made to decide upon controversial assumptions for calculations. Many of the results revolutionize thinking along certain lines and have revised previously established standards.

A conclusion of the report was that a combination pulse amplitude modulation and pulse code modulation system would prove most useful for future military test applications. The PAM portion would be used for low-accuracy data and the PCM high-accuracy data.

Needless to say, such a system is not now in use; its advent would make obsolete many millions of dollars worth of telemetry equipment now installed in test sites throughout the country.

Other noteworthy developments:

• The Telebit system of variable bit rate, allowing exchange of information speed for transmission distance.

• Wide-band recorders for recording on magnetic tape the greater information rates provided by modern telemeters.

• Use of large receiving antennas even at high frequencies to enhance the telemetry signal. One system at Vandenberg AFB employs omni-directional direction-finding antennas used in conjunction with extremely narrow band receivers to point the large telemetry antenna in the proper direction—a problem which becomes more serious as the size of the receiving antenna is increased.

• Use of light diffraction and optical filters to simulate electrical filters employed in data separation, interpolation, and extrapolation. An extremely precise filter characteristic is applied to a very large number of data channels by a relatively small and simple device. Methods are being explored to permit its use in actual data systems.

It is also heartening to note the gradual infiltration of government-developed telemetry techniques and equipments into American industry. The dissemination of information about telemetry is much slower, however, than the passage of information through the telemetry system.

Telemetry has moved in to investigate the destructive effects of wind-induced vibration to electrical transmission lines and telephone lines. Applications to mobile equipment, rotating equipment, flaw-detection and sensing portions of industrial process control are just beginning.

One of the leaders in the military telemetry field, for instance, has entered into a royalty agreement which permits a newly formed commercial organization to apply its developments to industrial applications. Equipment developed by this company will be supplied to the electric utility industries and to the medical field.

**President, Electronics Corp., Chairman, IRE PGSET, and Member of M/R's Editorial Advisory Board.*

Range Accuracy Poses New Challenges

- **New guidelines for progress**
- **Microwave systems**
- **New frequencies, techniques**
- **Improved equipment**

by W. C. Wootton, Jr.

Secretary, Inter-Range Instrumentation Group

NEW GUIDELINES established during the past year set the stage for future developments in telemetry and range instrumentation. It is evident that although significant progress has been made in the recent past, the most significant is yet to come.

The final report of the Aeronutronic telemetry study, released in early 1960, provided industry with the guidance it had awaited.

And another important direction developed in May, when the 1435-1535 mc radio frequency band was endorsed anew for missile telemetry used by the Inter-Range Instrumentation Group (IRIG) and Aeronautical Flight Testing and Radio Coordinating Counsel.

• **Pulse code modulation**—To meet the need for increased accuracy and more efficient operation, PCM telemetry systems are being developed. Many of these, especially those for Air Force projects, have unique characteristics and do not meet standards recommended by the Aerospace Industries Association or IRIG for PCM telemetry systems. Picatinny Arsenal and several others, however, are developing standard PCM systems for use on the missile test ranges.

Contrasting the PCM developments are several systems being developed to instrument the *Saturn* booster. One of these is a 216-channel PAM-FM-FM system. The other is a frequency deviation system with a high data bandwidth capacity.

Pulse amplitude code modulation (PACM) as opposed to PCM was recommended in the Aeronutronic study report for future missile telemetry operations. In this system the PCM signal is amplitude modulated with additional channels of analog data. Size and weight are slightly greater than that of a PCM system alone, but efficiency is increased without appreciably changing the radio-frequency requirement.

PAM channels are used where requirements exist for medium accuracy (1% error) analog channels. The PCM channels are provided to meet high accuracy requirements or where it is desired to use digital techniques. It is believed that variations of PACM-FM will effectively meet the majority of future missile telemetry requirements.

• **Microwave systems**—The need to move missile telemetry operations out of the VHF telemetry band (216-260 mc) by 1970 has prompted work on systems that would operate in the microwave frequency region. A development model of a 2200 mc transmitter was built recently by General Electronic Laboratories under an Air Force contract. Another airborne unit designed to operate at 2200 mc was built by Spectralab Instrument Company and turned over to the contracting agency at White Sands Missile Range for evaluation.

While these recent developments have been encouraging, even greater hope is held for the 1435-1535 mc band where airborne package size can be reduced. It is believed that developments in these microwave bands must be continued at the fastest possible rate if a reliable and operational system is to be available by 1970.

Ground station equipment compatible with the new airborne units is also being developed. Examples are the fabrication of a 2200 mc traveling-wave maser capable of being mounted on the rear of a parabolic dish, and Radiation, Inc.'s development of a 2200 mc correlation detection receiver.

• **Receivers, antennas, and transducers**—Several of the national test ranges have sponsored receiver improvement programs and emphasized the development of optimum capability for PCM and time-multiplexed signals. Since much effort has already gone into receiver front end improvement, emphasis is now being placed on the detection process.

A number of automatic tracking antennas have been developed to meet the growing need for this type of antenna in both space and missile testing. These generally have relatively high gain and can be used as acquisition aids to other instrumentation systems, in addition to their use in the telemetry system.

A Users' Symposium on Telemetry Transducers was held for the first time this past year, to review transducer development effort, both in the United States and abroad. It was apparent from this meeting that additional effort was needed to standardize transducer terminology and to establish calibration and testing procedures. To this end the National Bureau of Standards Telemetering Transducer Group has been working to develop test methods for dynamic testing of transducers, while Wright Air Development Division has been working to standardize testing and calibration procedures.

• **Studies and reports**—Many study and evaluation reports on telemetry have been released recently. These include "The Case of FM-AM Versus FM-FM Telemetry" by Dr. L. L. Rauch, for Wright Air Development Division; a number of reports by Naval Ordnance Laboratory at Corona; a number of Naval Air Development Center reports; and an IRIG Recommendation, No. 101-60, "Magnetic Tape Recorder/Reproducer Standards for Telemetry Applications."

AF Does Something About Reliability

- ***Reliability and maintainability biggest challenge***
- ***New programs for configuration control, commercial equipment use, calibration standards, understandable maintenance data***

The Air Force in the past year has been doing something about those much bandied-about words in Ground Support Equipment—reliability and maintainability. This is the word from the Aircraft and Missiles Division, Chief of Staff for Materiel.

It's being accomplished through new and strengthened programs in configuration control, buying commercial equipment when it will do the job, setting up calibration standards, and getting technical data for the field maintenance airman in a form which he can understand.

Within the past two months, even a definition of GSE has been adopted to take some of the confusion out of the many terms used in the field.

Since management problems are often best resolved by the application of management techniques rather than by developing new definitions, Air Force has settled on this GSE definition:

"Any or all implements or devices which are required on the ground to make a weapon system, support system, control system, sub-system or equipment operational in its intended environment. This includes all equipment required to install, launch, arrest, guide, control, direct, inspect, test, service, adjust, calibrate, appraise, gauge, measure, repair, overhaul, assemble, disassemble, handle, transport, safeguard, record, store, actuate, maintain or operate the system, sub-system, end item, or component. This definition applies regardless of method of development, funding or procurement."

• **Maintainability through standardization**—With the end goals of using less manpower, fewer tools and the minimum in supplies and logistics, Air Force is striving for optimum standardization of ground support equipment, realizing that in many instances full standardization is not possible.

Such optimum standardization holds true for the whole gamut of GSE —transport/erector vehicles, materials and fuel handling equipments, launchers, electronic check-out and data processing systems.

With more standardization, Air Force feels better maintainability will be the result. With this working philosophy, many directives and instructions are being pointed toward the design engineer to have him design equipment which can be maintained with minimal effort and cost.

In this effort, Air Force is practicing what is termed configuration control. For example, it doesn't want 100 fork lift trucks of five or more configurations, but rather, 100 of the same configuration.

This, in turn, has lead to increased purchasing of commercial equipment when available without designing new varieties. For instance, in recent months the trend has been to get away from using military engines in some vehicles and purchasing commercial types when available.

• **Boiling down data**—In the complex GSE field, Air Force is also taking a long hard look at contractors' preparation of technical data for equipment maintenance.

"Our fault is that we've gone overboard with an excessive amount of data and have lost sight of the man who must use this data to maintain a particular piece of equipment," one officer commented. Biggest problem is to get the data out of the PhD class, and make it simple, readable and understandable.

Previously, Ballistic Missile Division had responsibility for technical data in the missile programs. It has now been moved to Air Materiel Command, which is reviewing all specifications and formulating revisions to make it more usable in the hands of the technician.

• **One system of calibration**—In still another area—calibration support for missile systems—the Air Force has realized there has been a lack of uniform action in the establishment of calibration and repair facilities for base precision measurement equipment, particularly with respect to the support of contractors during the installation and checkout phase.

This has been because separate contractor facilities have been established at some missile bases while, at other locations, Air Force commands had made arrangements for the base calibration facility to be used in support of the contract.

The Air Force accordingly has ruled that the establishment of separate missile base contractor installation and checkout facilities for calibration and repair of precision measurement equipment is not in its best interests and will result in unnecessary expense.

So the Air Force's calibration system, rather than separate industrial systems, will be used exclusively. One reason: the Air Force feels that its operating personnel can get valuable experience and training when they recognize the exact calibration needs of a particular weapon system at an early date.

Further, a single source for standards of known accuracy with respect to the National Bureau of Standards will be available. Since the same source will be used during and after installation and checkout phase, no post inspection-and-checkout phase operational difficulties should arise due to differences in contractor-versus-Air Force calibration systems.

In one ballistic missile program, Air Force discovered that the unusual large amount of R&D GSE left over when phasing into the operational system required some 13,000 calibrations. This has since been reduced by some 40%.

Foundation Research Speeds Ideas for Navy

- ***BuWeaps program stimulates scientists***
- ***Eliminates ponderous decision processes***
- ***Makes individual responsible—and saves money***

by John F. Judge

The Navy is cultivating Missile Age ideas through a unique, red-tapeless program—Foundation Research.

Initiated about 10 years ago in the old Bureau of Ordnance, the program spread to the Bureau of Aeronautics in 1957. Since the two bureaus merged to form the current Bureau of Weapons, the Foundation has become an $8-million-a-year idea mill.

Bureau officials couldn't be happier with the results.

The original objective was twofold—to give the individual station money to exploit the promising ideas of its employees, and to create an attractive working atmosphere. Both purposes are being fulfilled.

The effect on the morale of the scientists is reflected in the high retention rates of the various laboratories.

Originally the funding was allocated as a definite fraction of the annual budget of a particular station. Now money is distributed in proportion to the possible contributors of new ideas. The amount is still less than 5% of a station's total budget.

Each station involved in the program administers its own funds.

• **Streamlined routine**—In operation, the program begins with an idea or a suggestion from an individual. The proposal is submitted to a small board composed of the installation commander, the chief scientist, and the laboratory, or project directors.

The proposal is rated for merit; if it is approved, initial funds are allocated for the program and the scientist goes to work. Many such projects are subsequently removed from the Foundation and funded under supporting research. Still others begin and end within the Foundation—supplying needed information and data for present or future use in allied fields.

For a long time, no formal reports were required. But they were encouraged—for fiscal ammunition if for nothing else.

The bulk of the projects are basic in nature. Some, which concern weapons systems, are classified, but the majority are published in various forms.

Foundation research led to over 300 such published papers from the Naval Ordnance Laboratory at White Oak alone.

One classic idea resulted in the air-to-air *Sidewinder* missile. Another, now being pursued at the Naval Air Material Center, Philadelphia, has attracted national interest. M. J. Devine's work in solid film lubricants is being closely watched by both government and industry.

Computers are being redesigned or created from scratch. The miniaturization of antennas is another fruitful area.

A striking example of the effectiveness of the Foundation Research idea is the current program at the Naval Air Materials Center. In one year the grants there rose from $41,000 for three projects to $310,000 for 15 projects.

The wide range of disciplines involved can best be illustrated by describing some of the areas covered by the researchers.

• Statics and dynamics of fluids—to provide a theoretical basis for the solution of hydraulic, hydrodynamic and gasdynamic problems.

• Hydrogen embrittlement—knowledge of the mechanisms problems of hydrogen embrittlement and the embrittling characteristics of a deuterium bath.

• Plastics, elastomers and fibers—research and development of organic metal-cordination polymers possessing exceptional thermal stability, gamma radiation resistance and strong mechanical properties.

• Solid film lubrication—Determination of the mechanisms by which metal surfaces are lubricated by solid films and to provide a definite working theory. Investigation of lubricity as a function of solid structure, particle size, film hardness and lubricant-bearing reactivity. This is the study that aroused national interest.

• Radiant heating—Determine the effects of infrared heat on the structural efficiency of aircraft and missile components and to correlate the laboratory and flight test effects with true aerodynamic heating.

• Brittle metal effects—Determination of the role of oxygen in the brittle behavior of metals. The study is aimed at understanding the effect of such behavior in the refractory metals.

• Energy absorption—Obtain fundamental information on energy absorption materials for the general purpose of improving the state of the art. There are an increasing number of developments in which, if energy is added to a device, a certain portion of this energy is absorbed or reconverted at the end of the cycle. *Polaris* missile recovery is one such development.

• Heat—Developing methods for measuring the heat of interior and exterior surfaces of aircraft and missiles undergoing constant changes in heat conditions and thermal shock. This study is directed toward answering a need for heat measurements under materials such as fiberglass, ceramics and thin specimens of honeycomb construction.

• Strain gages—Definition of the areas of future effort in the elevated strain gage field.

• Polyamide polymers—effects of exposures to ionizing, ultraviolet and thermal radiation.

Besides NAMC and White Oak, stations included in the program are: Naval Ordnance Testing Station, China Lake, Calif.; NOL, Corona; Naval Weapons, Dahlgren, Va.; NUO, Newport, R.I.; NAL, Johnsville, Pa.; Naval Missile Center, Point Mugu, Calif.; and the David Taylor Aerodynamics Laboratory near Washington, D.C.

Expenditures involved are small in comparison to the net worth of Foundation Research. Dr. Edward S. Lamar, Chief Scientist, Research, Development, Test and Evaluation, BuWeaps, points out that no good ideas ever came from a full stomach. The basic principle is to keep the researchers a little hungry—and emphasize brainpower rather than chrome-plated equipment.

Augmented Field Ready to Expand

- *USAF, NASA, industry boost the science*
- *Solar flares found hazard to space travel*
- *Instrumenting animals for flight tests*
- *'Bathtub' research on weightlessness*

by Lt. Col. David G. Simons and Dr. Hubertus Strughold*

A firm groundwork has been laid for an expanding aerospace medical activity during the past year. On three fronts—military, civilian and industrial—new organizations have been created or augmented and put into operation.

Organized this past October, the Air Force Aerospace Medical Center, located at Brooks AFB, San Antonio, united under one command USAF's School of Aviation Medicine, Epidemiological Laboratory and the Medical Service School. This integrating move shows the growing importance of aerospace medicine to the Air Force. Further evidence is that Congress has authorized an $8-million building expansion program at the facility.

In the same vein, it is notable that early this past March the Office of Life Sciences was created by the National Aeronautics and Space Administration. Heading it is Dr. Clark T. Randt.

This office formed the fifth major division of NASA and ranks equally with the offices of space flight programs, launch vehicle programs, advanced research programs, and business administration.

The ambitious program of research in all aspects of space biology and medicine outlined by Dr. Randt for his office is matched by the decision of most major aircraft companies to establish a space medicine research group. Thus the growing base of space medicine research is being widened further by the appearance of such groups in Boeing, Martin, Northrop, North American, Douglas, Lockheed, Convair and Chance Vought.

• **Solar flares a problem**—Satellite, balloon and space probe experiments have clarified the radiation hazards to be expected in manned space flight. It is known that the core of the inner Van Allen radiation belt maintains a steady radiation intensity. *Explorer VII* has now clearly demonstrated the variable nature of the outer Van Allen belt. This variation was particularly evident for the ten days following the large magnetic storm of this past March 31.

Early this past spring, many exciting results significant to space medicine came from *Pioneer V*. The vehicle was about five million miles from earth and it was a time of intense solar activity. It was learned, for example, that the well-known cosmic radiation disturbance called a "Forbush decrease" occurs on a solar, or galactic scale. It is clearly unrelated to terrestrial influences.

This finding serves warning that variations in cosmic radiation intensities may occur during space flight, resulting from galactic disturbances encountered by the sun in its path through interstellar space.

Balloon studies conducted over Minnesota together with the *Pioneer V* data confirm the growing suspicion that solar flares represent a major radiation hazard during interplanetary travel. In order to reduce a "typical" flare exposure to an acceptable 10 Rem (roentgen equivalent man) within a four-foot radius living compartment would require a calculated 10,000 pounds of carbon.

From an early report from *Pioneer V* it was discovered that a ring current of about five million amperes circulates at a distance from 7 to 13 earth radii from us. This current represents a radiation hazard of undetermined magnitude. However, the likelihood that the current is composed of low energy particles is encouraging.

The Russian *Lunik II*, which approached the moon last September, reported no radiation belts corresponding to the Van Allen belts surrounding the moon. This is good news to prospective space travelers.

• **Monkeys instrumented**—This past December, NASA's *Little Joe* rocket flight to test the *Mercury* capsule recovery system under the most adverse dynamic flight conditions included two SAM monkeys. The subjects were painstakingly instrumented through several techniques new to space flight animal experimentation.

An eye-motion detector which sensed the changes in voltage distribution resulting from eye motions recorded the occurrence of nystagmus—the sweeping eye motion produced by motion sickness and other disturbances of equilibrium. These sweeping motions were observed during the period of high accelerations which occurred in all three axes during the emergency escape phase of the test flight. These continued through the short 20-second interval of weightlessness.

The psychomotor task test, which required the animals to pull a lever in response to a flashing light, showed a marked loss in performance during the acceleration and weightlessness phase. The vectorcardiogram, an advanced technique for indicating the electrical vector forces produced by the muscular contractions of the heart, revealed significant changes during the same acceleration and weightlessness phase.

• **Two-man crews okayed**—The initial run of SAM's two-man space-cabin simulator in March confined two Air Force volunteers in a reduced-pressure, oxygen-enriched atmosphere. They were completely isolated for a 14-day period. It was found that the important weight-saving measure of distilling waste water for all non-drinking purposes proved acceptable and practical.

The experiment also showed that the assumed rates of water loss through respiration and sweating under reduced pressure conditions are significantly in error when applied over this period of time.

The usually proposed nutritional energy requirements of approximately 3000 calories per man per day appear to be significantly lower, approximately 2200 to 2500 calories.

The fact that no major psychological disturbances were observed points to the feasibility of two-man crews for space missions of durations on the order of two weeks. Crews of this size are desirable for work scheduled and mutual emotional support considerations.

A major question concerning the

(Continued on page 92)

Col. Simons is chief of the Bioastronautics Branch, USAF School of Aviation Medicine. Dr. Strughold is Professor of Space Medicine and Advisor for Research at USAF Aerospace Medical Center, and an M/R advisor.

A Crisis in Electronics Standards

Meeting sponsored by NBS and AIA notes emergency created by lack of standards for higher frequencies and begins search for answers

Lack of national electronic standards for new higher radio frequencies is causing confusion, excessive delays, and loss of money for both industry and the national defense program.

This was pointed out at the recent 1960 Conference on Standards and Electronic Measurements at National Bureau of Standards Boulder Laboratories by Lloyd B. Wilson, chief of the primary standards lab of Sperry Gyroscope. He said that military needs and the space program are requiring accuracies of measurement unheard of a few years ago and for which calibration instruments do not exist.

The Conference is the first of a series of measurement research conferences between industry and NBS initiated by Aerospace Industries Association to probe each field of measurement in depth to determine which needs are most urgent and how they might best be met.

The AIA-NBS conference was the first to provide a discussion of mutual problems between the men who develop electronic standards and those who use them. Industry personnel represented firms who had indicated that they particularly needed better standards for measuring microwave power and attenuation. NBS representatives included project leaders and section chiefs who are responsible for developing standards and measuring methods and providing calibration services.

As revealed at the conference, NBS Radio Standards Laboratory has made dramatic progress in developing new standards. Examples: A technique for measuring small attenuations to accuracies exceeding one ten-thousandth of a decibel and a microwave standard of power at X-band frequencies that has been the world's most accurate to date.

It was pointed out, however, that the Laboratory has been swamped by the needs created through the amazing growth of electronics during the past decade.

• **Where standards fall short**—A primary purpose of the meeting was to suggest action which might be taken by NBS, the electronic industry, military, and scientific organizations to help meet the emergency. That an emergency exists was confirmed by specific situations reported at the conference:

• The million-dollar development of radomes is proceeding more by trial and error than through test and analysis because precise phase and amplitude measurements do not exist in the required frequency range.

• One firm has to use its precision measurement laboratory facilities to test sections of coaxial cable from the production line since adequate production-line standards are not available.

• Klystron tubes—used to generate high-power signals for radar detection systems—are being over-designed just to be sure that they are powerful enough to do the job. This is necessary because there is no way to precisely measure the peak microwave power generated by these tubes.

• The performance measurement of modern radars requires the testing of many new and complex items of equipment. Quite often the radar is considered to have failed when the fault was within the test instruments.

(Continued on page 82)

Avco Builds Record Noise Generator for Sud

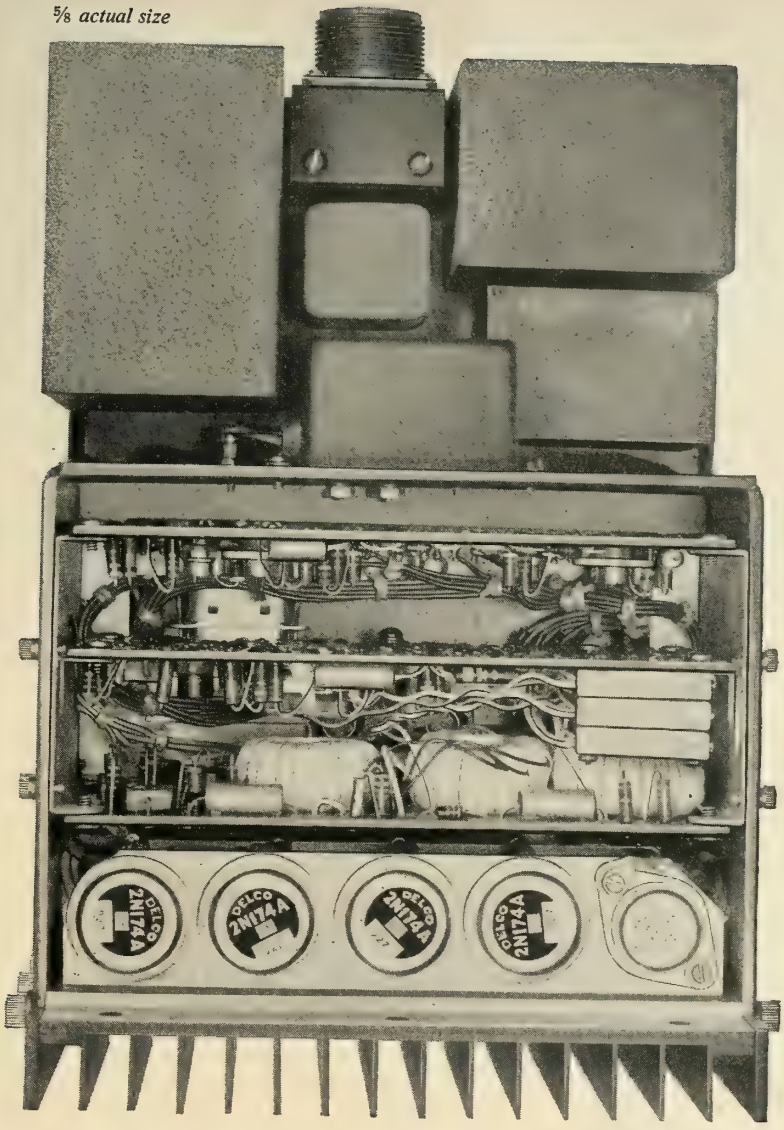


This acoustic noise generator—capable of producing the highest sound pressure level ever achieved in a large-capacity reverberant chamber—has been delivered to Sud Aviation by Avco-RAD, Wilmington, Mass., designer and builder. The French aircraft/-missile firm will use the noise facility to test components and systems in its research center in Cannes, France.

The rocket-engine noise simulator pumps 146 decibels into a 200 cubic foot pentagonal reverberant chamber where individual octave band sound pressure levels can be maintained within ±3 db with a specimen as large as 20 cubic feet.

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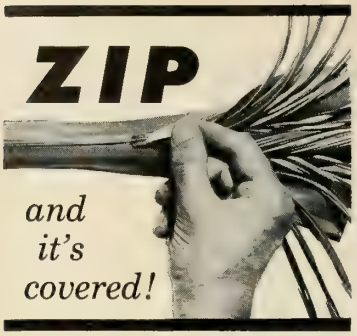
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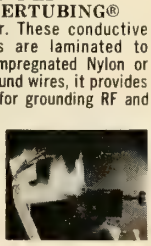
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(Continued from page 80)

• Measurements of microwave power, for example—made on different days by the same equipment—will disagree by 50%. Yet, as one speaker pointed out, some radar systems are operated close to breakdown and it is necessary to hold a given power level to keep a system operating. Under such conditions, a 5% error in measurement becomes the difference between operating and not operating.

The meeting revealed what is possible now in microwave power and attenuation, and NBS obtained a better idea of what accuracies are most urgently needed. Discussions indicated that in a few cases NBS can provide interim standards—even within current facilities—that will be a great help to many users.

As an example, NBS currently provides calibrations of microwave power measuring instruments between 8200 mc and 12,400 mc. By using different techniques, calibration can be extended to lower frequencies in the near future. This service will provide somewhat lower accuracy but will help meet many of the immediate needs expressed at the conference.

• **Equipment lacking**—On the other hand, however—even though the techniques are known—many standards cannot be extended to new frequency ranges because of lack of personnel and equipment.

For instance, an urgent need exists for the extension of a current microwave attenuation standard to three higher frequency ranges. Yet, to evaluate this technique at even one new frequency range in the millimeter wave region requires $11,000 worth of new equipment—more than the present total annual equipment funds allotted to the project involved.

Dollars alone are not the answer. NBS representatives were asked to estimate how long it might take—at today's activity level—to develop minimum acceptable standards which do not presently exist for the frequencies (up to 100 gigacycles) and quantities most needed today. Based on many unknowns, the estimates—varying with measurements involved—ranged from five to ten years for most quantities. And an increase of several times the current budget would shorten this delay no more than half, according to NBS. The main time delay would be the hiring of capable personnel and their initial training.

Estimates make no provision for the new needs which will arise and must be met during the next few years.

Participants agreed that it is frequently difficult to discover whether an expressed need is realistic. Examples were given of "impossible" accuracies specified to "play safe." They further agreed, however, that most of the stated accuracies described at the conference are really and urgently needed.

AIA industry representatives were asked to state not only what was needed but also why this was required —to help estimate the urgency of the needs. NBS described for each field the state-of-the-art in research, development, and calibration. From discussion of the presentations, tentative recommendations evolved for action by the Bureau, industry, the military, and scientific organizations. These will be carefully reviewed by AIA and then officially presented to the groups involved.

Niobium Oxidation Cause Isolated by NBS Studies

The oxidative behavior of niobium —a potential high-temperature structural candidate—has been studied in detail at the National Bureau of Standards.

The oxidation problem is caused by the continual nucleation and growth of porous niobium pentoxide—which incessantly presents fresh metal surface to oxygen.

Investigators at NBS oxidized niobium specimens under controlled conditions in a sensitive vacuum microbalance. Examinations after different periods of oxidation led to the discovery.

Electron diffraction patterns of the initially formed oxide showed certain features of both niobium oxide and niobium dioxide. Although little or no change occurred in the predominant interference color, indicating that the film thickness remained constant, a continual increase in weight showed that oxygen was still being absorbed by the system.

Pentoxide globules form beneath the initial film and push upwards until the film's tensile limit is reached, rupturing the original oxidation film.

The globules coalesce into a continuous, porous layer which increases in thickness. The metal surface is continually exposed to oxygen because the large volume increase which accompanies the conversion of niobium to its pentoxide hinders the formation of a stable interface between the metal and the pentoxide. The reaction becomes a surface reaction of constant rate and rapid oxidation results.

The study was sponsored by the Air Force Office of Scientific Research.

3M Materials Memo

News of materials for the aerospace industry... selected from the 27,000 products of the 3M Company



■ Where good contacts count

Good reliable connections are useful in any circles these days, but in electrical circuitry they're imperative. Of course, sometimes it's difficult to reconcile reliability with today's high speed fabrication techniques. Our ELECTRICAL PRODUCTS DIVISION has recently come up with a means of doing just that. It's the new "SCOTCHLOK" BRAND type UR connector. Although it's the functional equal of twist and solder jointing methods for communication cable, it's way out ahead on speed and convenience.

The whole secret lies in their unusual construction. They're made of a transparent thermoplastic material filled with silicone grease and use metal finger-like connector elements, built into a top closure button. The cut wires are inserted into the sleeve of the connector and the button closure is squeezed into the body of the unit, using a special crimping tool. Depressing the button removes the wire insulation, grips the conductors, insulates the joint, and provides a positive seal for the silicone grease. Thus, a complete splice is made in one operation, involving no stripping, twisting, soldering or insulating. And visual inspection of the joint speeds up quality control, too.

"SCOTCHLOK" UR connectors can handle any two or three wire combination of #19 to #26 AWG solid or #20 to #26 AWG stranded wire. They can be used virtually anywhere a splice is made and on nearly every type of wire used in the communications industry. This would include wires insulated with miscellaneous plastics, paper, enamel, rubber, Teflon, or other materials. Your local Electrical Products representative will be happy to show you how "SCOTCHLOK" connectors can literally put your operations on a push-button basis.

■ A case of non-support

A flame would have a tough time surviving if it had to depend on 3M's new printed circuit board construction. Designated as "CUCLAD" #6097, this newest member of a range of printed circuitry materials offers some really distinguishing (or perhaps we should say extinguishing) features. Containing special flame retardant additives in its laminated glass cloth-epoxy backing, this "CUCLAD" board offers a high degree of flame retardance without the usual brittleness. This means easy machining with little waste. In actual test, the flame extinguishes itself in one to two seconds after the torch is withdrawn.

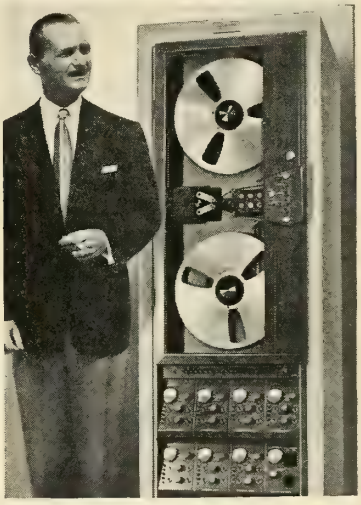
No. 6097 includes qualification to Mil-P-18177B Type GEB and NEMA grade G-11; is available with one or two ounce electrolytic grade copper foil bonded to one or both sides. This bond offers a peel strength as high as 11 pounds per inch and is resistant to standard plating and etching solutions. What's more, it offers you the option to either standard dip or float solder the finished circuit. "CUCLAD" #6097, a versatile performer, is made more so by coming in a broad thickness range of from 1/64″ to 2″ in individual sheets, 36″ x 42″.

If printed circuitry is a burning issue with you, why not have your local MICA INSULATOR DIVISION representative give you more information on this exciting product—or fill in the coupon below.

■ Need a megacycle memory?

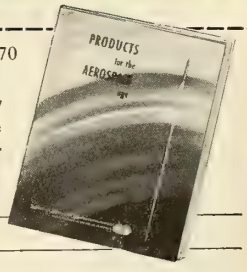
Are the high frequency requirements in telemetry and radar signal recording proving to be fast company for your current equipment? Our MINCOM Division's new model CM-100 recorder-reproducer permits you to think big in terms of band width, but not cost. Not a one-track memory by any means, the CM-100 can pack 7 channels of data on a single ½″ Scotch Brand magnetic tape. It literally permits you to stretch out these precious minutes of recording time by offering the capability of recording and reproducing greater band width at significantly slower speeds. For example, you enjoy 12 minutes of recording time in the one megacycle range running at 120 ips. You'll find that it pinches minutes for you like this at each of its 6 speeds. These speed variations, by the way, are available to you at the mere touch of a finger.

Our MINCOM Division proudly points to the fact that in addition to these virtues, the CM-100 represents somewhat of a first in versatility. It actually handles the work of two systems by storing both analog and pulse data with equal ease. This means that it's at home in practically any instrumentation application for telemetry or laboratory. For the full CM-100 story, contact your local MINCOM representative or clip the coupon.



3M Company, Missile Industry Liaison—Dept. VAB-70
St. Paul 6, Minn.

Please send more information on ☐ "CUCLAD" #6097 Printed Circuitry Material ☐ "SCOTCHLOK" BRAND type UR connectors ☐ "MINCOM" CM-100 Recorder-Reproducer ☐ 3M Products for the Aerospace Age.



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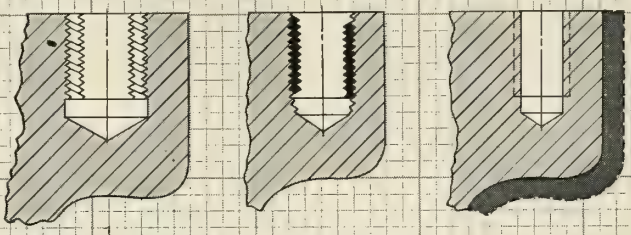
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Solid bushing requires oversize boss

Heli-Coil Insert permits standard boss proportion

Space and weight saved by *Heli-Coil* Insert

As seen in the illustrations above, *Heli-Coil* Inserts save 56% in space, 63.5% in weight.

Heli-Coil stainless steel wire inserts have a smaller outside diameter than any solid bushing. Therefore, with ***Heli-Coil*** Inserts you can design boss radii to a minimum, yet stay with standard boss configurations. This means *savings in space and weight,* and material-savings as well.

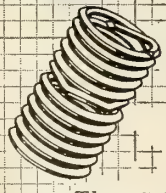
This feature is vitally important for miniaturization in aerospace design, in electrical and electronics equipment design, and for general industrial applications.

NO OTHER TYPE OF INSERT OFFERS SUCH SAVINGS!



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Permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration and shock. Made of 18-8 stainless steel wire, cold-formed into a diamond-shaped cross section, work-hardened to a tensile strength of approximately 200,000 psi. Conforms to mil specs and all commercial and industrial thread forms.



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The Heli-Coil line of products includes: inserts and related taps, tools and gages. Tables of boss radius and weight comparison are available.

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PROPULSION

(Continued from p. 71)

advantage because the volume will reduce the unit cost of tooling up. But Mitchell said fiber glass and plastic cases are cheaper when small numbers are involved. He contended that the lightweight material could not be ruled out even for the largest conceivable solid rockets.

The NASA propulsion chief voiced enthusiasm for the Air Force Project *3059* plan to explore the feasibility of a very large solid motor, on the order of a million lbs. thrust. He said:

"We in NASA are extremely interested and fully understand the need of getting as much data as necessary to determine where a large solid booster fits into the space picture. We are following and participating in the Air Force plans very closely."

• **Nuclear rocketry**—"In the last year, we have seen the transition of nuclear rocket propulsion from essentially a loose research effort and a reactor program to a much firmer and essentially a defined program with a firm development objective—a flyable nuclear engine."

Mitchell recalled that NASA officials have said a test is scheduled for 1965. "This is becoming a major area of buildup of effort," he added.

Mitchell said the joint NASA-Atomic Energy Commission work is making excellent progress—particularly in work on the reactor, the feed systems and the hydrogen turbine pump.

• **Electrical propulsion**—The last year has seen marked increases in R&D efforts by government agencies, non-profit organizations and industry on electrical devices, Mitchell asserted. As a sign of the progress made, he cited decisions by both NASA and the Air Force to develop ion engines. "We hope that in a year or so these engines will have demonstrated a reasonable operating time."

The engines are to develop 0.1 lb. thrust and draw 30 kilowatts of current from a SNAP-8 nuclear powerplant. Total weight of the system, including the thrust device and powerplant, will be a few thousand lbs., he said.

Progress in ion devices has included reduction of interception of ions by accelerating and focusing electrodes, and increases in power conversion efficiency (ratio of Kinetic power in the thrust beam to total power input).

A critical problem still remaining is beam neutralization, he continued. "We are obtaining better insight on this problem but I don't think we have any clear experimental data as yet to indicate whether it can be accomplished."

Pioneer V Found Radiation Peril Past Van Allen Belts

Radiation will be a major hazard for man throughout the zone between the earth and Venus—not just in the Van Allen belts.

This is the most important finding of *Pioneer V*, the U.S. space probe that was tracked and telemetered for 108 days to a distance of 22,462,740 miles from Britain's Jodrell Bank radio telescope.

Man in space beyond the Van Allen belt will need extensive protection from the radiation in solar flares, Dr. Abe Silverstein reported last week.

Silverstein, director of the Office of Space Flight Programs, National Aeronautics and Space Administration, made his estimate at a press conference called by NASA to report on the end of efforts to communicate with the 94.8-lb. planetoid now swinging in a solar orbit between those of the earth and Venus.

Silverstein gave no figures on radiation intensity. However, in a paper given before the American Geophysical Union on April 29, three physicists headed by J. R. Winckler of the University of Minnesota reported that intensity can rise as high as 30 or 40 roentgens per hour during a magnetic storm.

Without shielding, a half-day's exposure at such a level would be lethal for about half of the persons exposed, according to the calculations of the National Committee on Radiation Protection.

The report on *Pioneer V* was given after NASA Administrator T. Keith Glennan presented a model of the space vehicle to Dr. A. C. B. Lovell, British astronomer and director of Jodrell Bank, in recognition of the cooperation of the staff of the 250-ft. dish antenna.

Silverstein listed these other scientific discoveries realized during the *Pioneer V* flight:

- An interplanetary magnetic field exists. Its intensity fluctuates in relation to solar flare activity.
- A ring current of five million amperes, 25,000 miles in diameter, exists at 40,000 miles from the earth.
- The earth's magnetic field extends at times out to 65,000 miles and oscillates with solar flare activity.

Pioneer V, launched from Cape Canaveral at 8 a.m. (EST) on March 11, sent intelligible signals with its 5-watt transmitter on command until 7:33 a.m. (EDT) on June 26, at which moment it was traveling away from the receiving antenna at 18,621 mph and had traveled 60% of the distance that separates the orbit of earth from the orbit of Venus. At the time, it was 78.9 million miles from the center of the sun.

- **A flock of firsts**—Silverstein said its technological firsts included the greatest range over which man has maintained control over an instrumented vehicle, the greatest range over which man has tracked a man-made object and the first instrumented space laboratory making measurements of the interplanetary magnetic field, the plane of the magnetic field and total flux and energy level of radiation in interplanetary space.

Also, Silverstein said, *Pioneer V* established a record in the distance at which an interplanetary guidance system was used. He explained that the vehicle had Doppler capability for measuring position in space, which are parts of advanced guidance systems to be used in future space vehicles.

Other scientific achievements, he continued, include the first measure-

(Continued on page 95)

from the smallest to the largest missile part . . .



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By training and aptitude the engineering mind is above the average; it is inclined to want to know the answers — the WHY, WHERE, HOW, WHAT, WHEN and WHO of things. By and large, it is a *doer's* mind motivated by dreams.

To such men, PHILCO, the pioneer in electronic field services, offers new horizons to reach for in a variety of fields, including the research, engineering, design and systems modification associated with the nation's global communications network, world-wide defense works, missile systems and components.

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CIRCUITRY

(Continued from p. 73)

• Switching

I would further point out that, in order to perform these functions, we have found it convenient, if not necessary, to generate, transmit, control and store electrical energy in the forms of electrical current, electrical flux, magnetic flux, and electromagnetic wave flux.

Semiconductor devices provide control of current; magnetic and dielectric materials, such as thin magnetic metallic films, ferrite and ferroelectric ceramics, will provide the control of the other three forms. This fact adds to the incentive for inclusion of electronic ceramics and thin films in the four technologies mentioned in the introductory paragraphs.

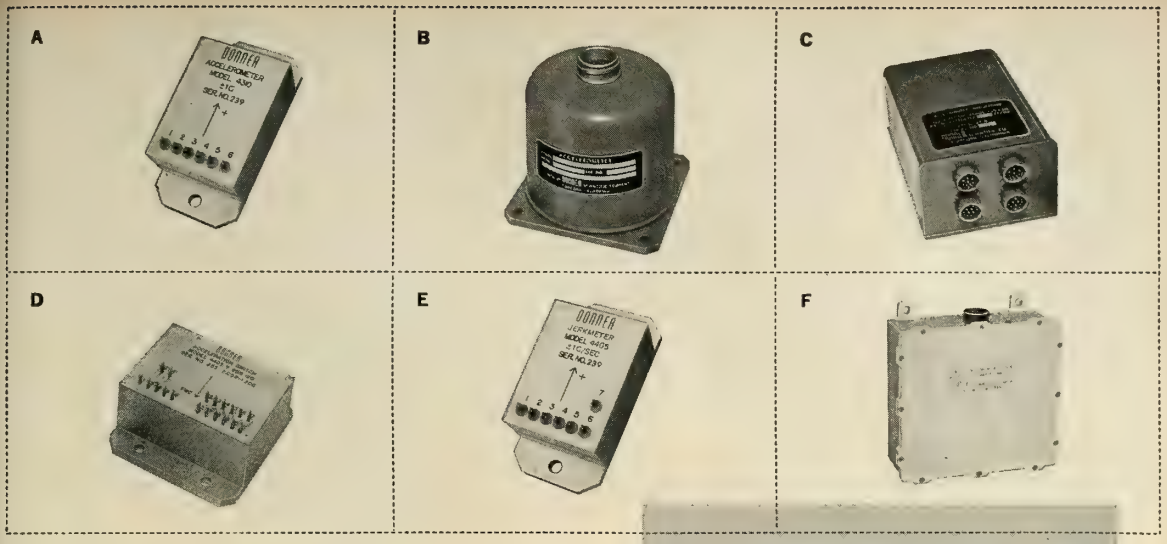
Substantial progress in integrated circuits will be achieved when we have performed all of the functions listed above over a range of frequencies, power levels, and environments. We must have succeeded in processing the four forms of electrical energy in a variety of circuits. The uninhibited approach of "Tell me the function you want performed and I'll invent a way to do it," is not practical for the accomplishment, in two or three years, of everything we have been able to accomplish in 40 years of development of the electronic art.

It is important to realize that we are not starting over but improving our techniques for production in order to meet the problems of greater restrictions on size, cost and power consumption, increased demands on reliability and speed, and new environments. The effect on the electronic materials, components, and equipment manufacturing industry will be far-reaching but gradual. We have ample time to act if we are alert to the new developments.

'Rotochutes' Will Attempt To Slow Re-entry Vehicles

Experiments with helicopter-like rotating wings to slow down and guide fast-moving re-entry vehicles to a landing will be conducted under a $448,000 Wright Air Development Division award to Kaman Aircraft Corp.

In the first phase of the contract, Kaman will employ its "rotochute" to attempt to land a 200-lb. package released at subsonic speeds from 50,000 ft. Recovery of much larger packages released at supersonic speeds from extremely high altitudes will be tried later on. The rotochute has two spring-actuated rotor blades which are motor-driven after snapping into position.



A. Model 4310 0.1% Linear Accelerometer. **B.** Model 4525 Angular Accelerometer. **C.** Model 4710 Integrating Accelerometer. **D.** Model 4403 Acceleration Switch. **E.** Model 4405 Jerkmeter. **F.** Model 7005 Airborne Analog Computer.

A Short Guide to Donner Scientific

LINEAR, ANGULAR, AND INTEGRATING ACCELEROMETERS, ACCELERATION SWITCHES, JERKMETERS, AIRBORNE ANALOG COMPUTERS, *and other systems*

Model 4310 0.1% Linear Accelerometer—This high output, high resolution transistorized accelerometer is designed for demanding measurement and control applications met in telemetry, gyro-erection, programming, and short range inertial guidance.

Key specifications: non-linearity plus hysteresis, within 0.05% deviation from best straight line; standard ranges, between ±0.05 g full range and ±30 g full range; resolution, better than 0.0002% full scale; weight, 3.5 ounces; standard output, ±7½ v dc and/or ±1.5 ma full scale; options, biased output, liquid filled units, and/or 28 v dc operation; 0 to 5 v dc output; price, standard unit, $450.

Model 4525 Angular Accelerometer—Chief applications for this unique force balance accurate angular accelerometer are closing the servo loop on ground launching equipment for missiles, detecting roll, pitch and yaw acceleration once they are airborne, and measuring induced angular acceleration when a missile is vibrated by a linear shaker.

Key specifications: ranges, from ±2 radians/sec² to 50 rad/sec² or any intermediate grouping; frequency responses, essentially the same as that of a linear second order system; nominal full scale output, ±20 volts; resolution, 0.01% full scale or better; linearity, 0.1% of full scale; hysteresis, less than 0.01% full scale; damping, 0.6 ±0.1 of critical; size, 3.7" diameter x 3.7" high; available in nitrogen filled and liquid damped versions.

Model 4710 Integrating Accelerometer—The all solid state Donner integrating accelerometer is used to both close a set of contacts at predetermined velocities and provide analog outputs relative to acceleration and velocity. These outputs are used in turn to actuate various control dynamics in missiles and aircraft. Velocity contacts can be closed at any speed from a few feet per second to 50,000 feet per second, up to accuracies of 0.25 percent over extended operational periods.

Key specifications: temperature range, 30° F to 150° F; vibration, will withstand ±15 g through 2000 cps; acceleration ranges, from 1 g to 100 g; shock, will withstand short shock pulses of 75 g and long pulses of 50 g; weight, 2 pounds.

Model 4403 Acceleration Switch—Donner acceleration switches are used to accurately determine the point of thrust termination in missile and satellite vehicles. Because of their high natural frequency, they offer excellent dynamic response.

Key specifications: ranges, 0.05 g to 100 g; unregulated power, 28 v dc ±10%; temperature range, 30° F to 150° F; output, relay closure; weight, approximately 12 ounces.

Model 4405 Jerkmeter—Unique Donner jerkmeters operate as subminiature servosystems of the force-balance type responsive to jerk along the sensitive axis of the linear unit and about the sensitive axis of the angular unit. Basically, each system consists of a transistorized accelerometer with an integrator inserted into the servoloop to generate a jerk signal. Applications include monitoring rate of change of g's in jet aircraft and using the signal to predict impending disaster, providing a velocity damping term, inertial indicator of first motion, and any other use where constant acceleration is required.

Key specifications: ranges, acceleration ±1 g full range to ±30 g full range; jerk, ±0.5 g/sec full range to ±20 g/sec full range; output full scale, acceleration and jerk, 7.5 v dc; weight, 7.5 ounces.

Model 7005 Airborne Analog Computer—Technically known as a "maximum altitude sensor," this all solid state system is a fixed purpose analog computer housed in a magnesium case only 5 inches long. It is used to actuate rescue devices in the capsule developed for the project Mercury.

Under abort conditions, the computer provides output information which fires the explosive bolts holding the escape tower onto the top of the capsule and energizes the system which causes the escape tower jettison rocket to fire.

OTHER DONNER SYSTEMS—

Donner Scientific specializes in the manufacture of accurate fixed and general purpose analog and digital systems designed to analyze, measure, and control inputs interlocking time, acceleration, jerk, velocity, and other dynamic inputs. Typical systems include accelerometer timer switches, airborne signal conditioner and event markers, escape and re-entry sub-systems, linear acceleration summing and storage devices, and peak reading vibration storage devices.

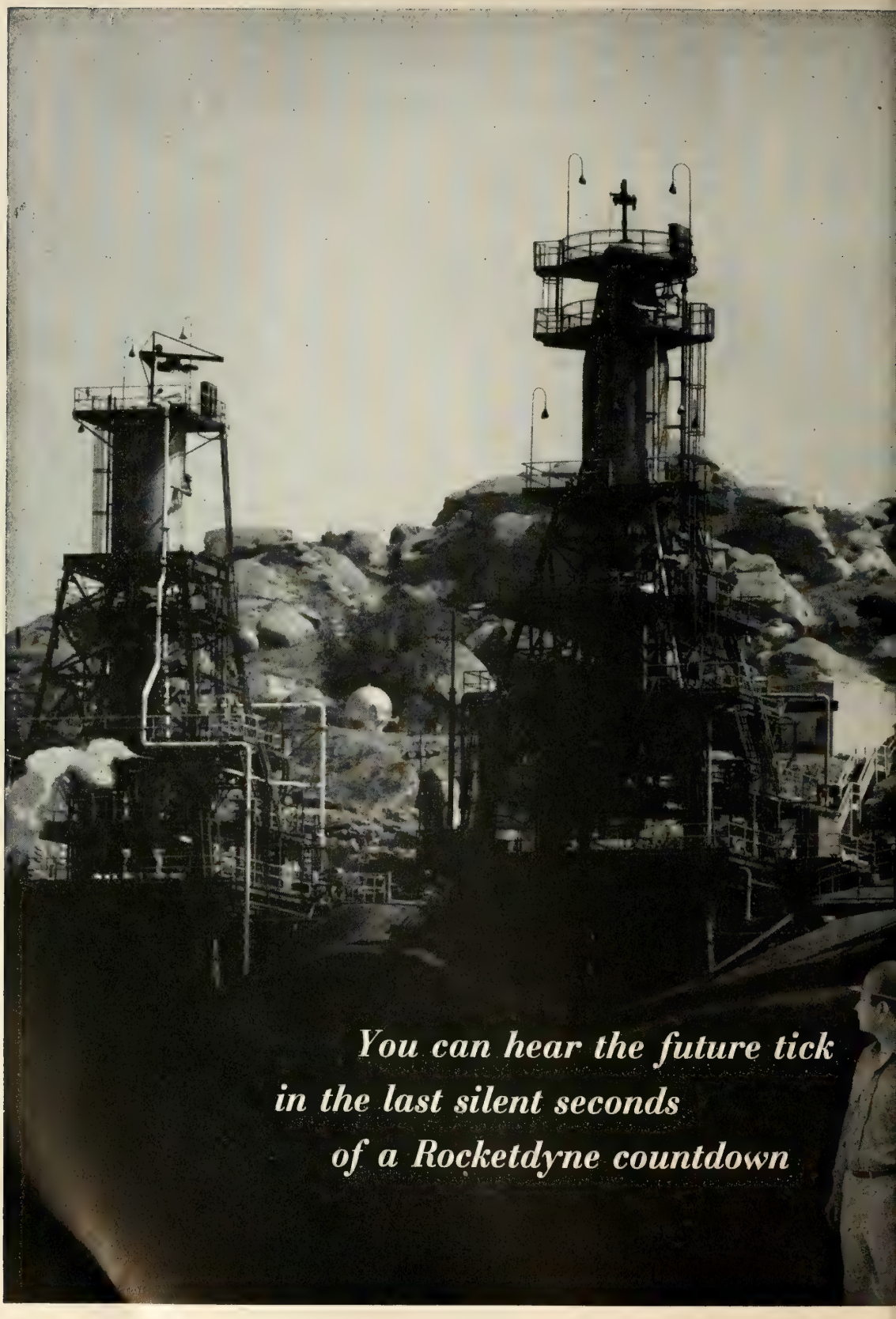
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28

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You can hear the future tick
in the last silent seconds
of a Rocketdyne countdown



FOUR...THREE...TWO...ONE... a moment of silence. Then a giant speaks—and a bolt of man-made lightning flashes.

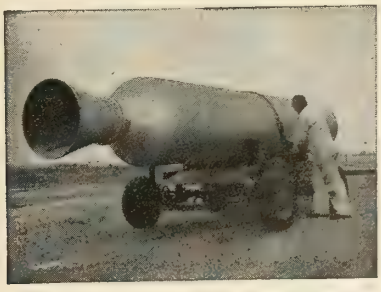
Nearly every hour of every day, Rocketdyne technicians near that dramatic moment as they test and tune the space engines of today.

The best-equipped test facilities for high thrust rocket engines in the nation are at their command. Rocketdyne's finely instrumented test structures are located in California's Santa Susana Mountains; Neosho, Missouri, and McGregor, Texas.

Rocketdyne engines have powered most of the military and scientific projects conducted by the Air Force, Army, and NASA. Now huge boosters of one and a half million pounds of thrust are emerging from the technical heritage of Atlas, Thor, Jupiter, and Redstone.

And even while today's countdowns go on, plans for tomorrow's assault on space are being made. At Rocketdyne, engineers and scientists are investigating such advanced forms of propulsion as ion engines, nuclear engines, plasma jets, and magnetohydrodynamic engines. Meanwhile other groups are at work on high-energy liquid and solid propellants, and dramatic new devices for both liquid and solid propulsion systems.

Rocketdyne, a 12-year pioneer in rocket technology, was first with power for America's long-range ballistic missiles—first with power for Outer Space.



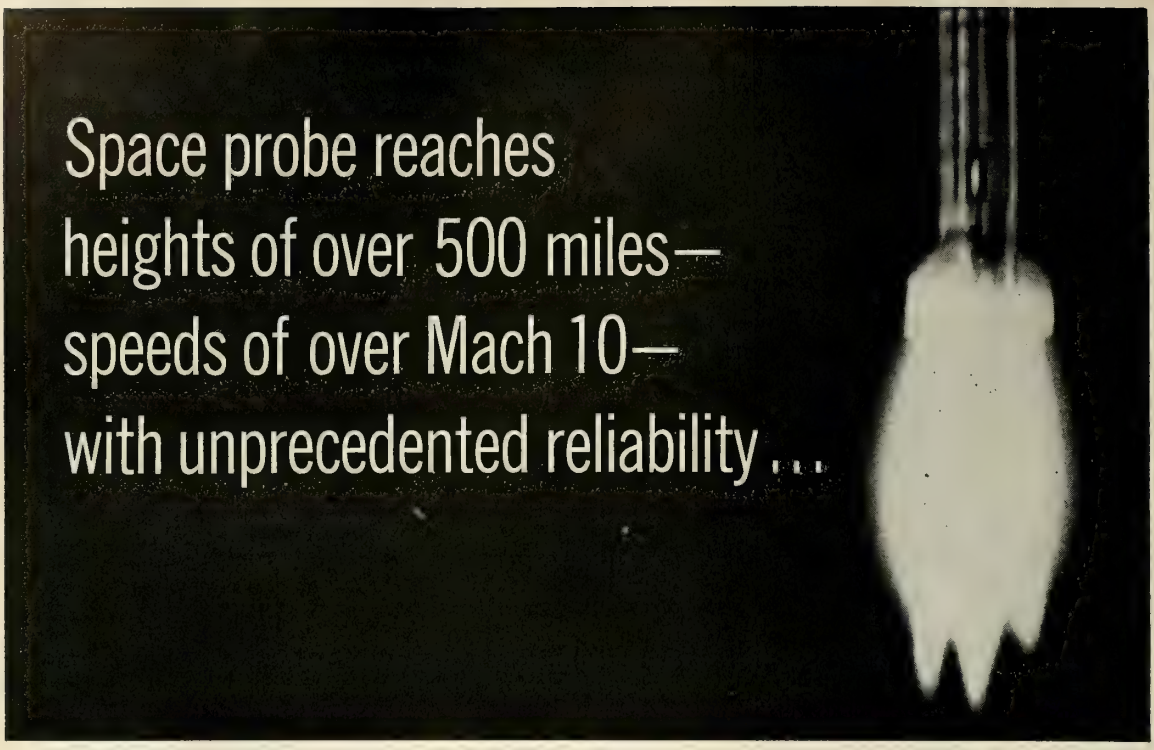
MEGABOOM—a giant solid propellant rocket motor produced at Rocketdyne's McGregor, Texas, solid fuel facility—delivers 100,000 pounds of thrust, boosts test sled to 1,200 mph.

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One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Gamma. A liquid propellent rocket engine, the Gamma powers the Saunders-Roe Black Knight, Britain's highly successful space research vehicle. An extremely reliable powerplant, the Gamma produces a total sea-level thrust of 16,400 lb (7,438 kg) and nearly 19,000 lb (8,618 kg) outside the earth's atmosphere, for a total powerplant weight of under 700 lb.

At the Woomera rocket range in Australia, the Gamma has sent Black Knight over 500 miles into space at speeds in excess of Mach 10 with unprecedented reliability. For, to date, every Black Knight vehicle has been launched successfully.

Since Bristol Siddeley's rocket division began work in 1946, it has developed a wide range of components. *By combining these components in single or multi-chamber layouts, thrust requirements from 500 lb up to 100,000 lb can be met.*

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Bristol Siddeley Maybach diesel engines power Britain's fastest express train.



The Bristol Siddeley Orpheus powers the Fiat G 91, NATO'S light fighter.



The Bristol Siddeley Proteus powers the Britannia airliner.

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Step-up Urged in Ocean Study

Oceanography must be increased by a factor of four over the next 10 years—both in participants and in the present $36-million level of funding.

This statement came last week in a report on "Ocean Sciences and National Security," released by the House Committee on Science and Astronautics.

The committee pointed out the Soviet Union has accelerated its ocean research efforts in what may be a deliberate attempt to overtake and surpass oceanography in the United States.

In its recommendations, the committee stressed the threat manifested by the Soviet fleet of more than 500 submarines and said it is essential that we develop the capability in ASW for complete surveillance of the oceans to minimize the possibility of a surprise submarine attack.

It said the present level of scientific oceanic research and inventory of ships and shore facilities are evidence the field "has been badly neglected."

Examination of the Navy and National Science Foundation oceanic programs, the committee said, reveals that until Fiscal 1960, they appeared lacking in emphasis, vigor and adequacy of funding.

• **One manager**—The committee said the Navy, until recently, has not pursued a broad program in oceanography, despite its relevance to the Navy's ASW mission. The committee said this has been true even though the Navy is now the largest single supporter of oceanic research.

To remove the disparity between the current level of effort and the needs for national security, the committee said it is necessary that the Federal Government organize, manage, and coordinate the necessary program. It said the responsibility should be:

• Development of a national program in oceanic research and identification of goals.

• Budgeting of funds for a balanced program embracing all elements of oceanic research both for peaceful and military applications.

• Implementation of the national program by both in-house and contract research.

• Deliberate fostering of education and training in oceanography.

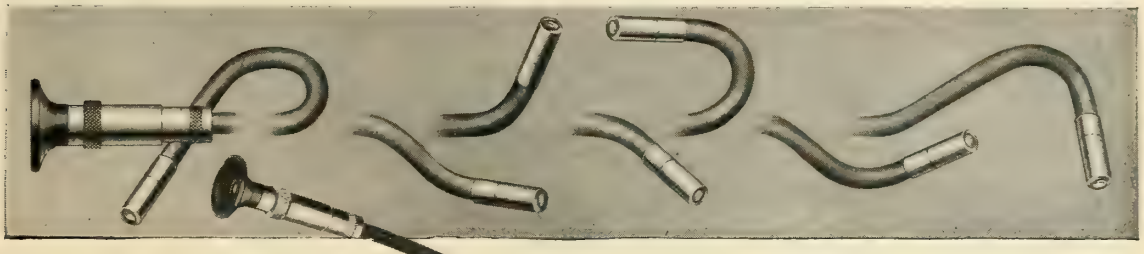
The report, authored by Dr. Edward Wenk, Jr., senior specialist in science and technology, Library of Congress, contained these other highlights:

• Marine subjects are being investigated at nearly 100 establishments which are subordinate to some 16 USSR ministeries and agencies. Leading oceanographic research institutions in the USSR are the Institute of Oceanology of the Academy of Sciences, the State Oceanographic Institute of the Main Administration of the Hydrometeorological Service, the Arctic and Antarctic Scientific Research Institute of the Main Administration of the Northern Sea Route and the All-Union Scientific Research Institute of Fish Economy and Oceanography.

• The number of professional oceanographers in the USSR is estimated as high as 800 to 900.

• The USSR's oceanic research fleet numbers between 50 and 75 non-military vessels with lengths greater than 50 ft. Included is the Severyanks, first submarine in the world to be used solely for oceanographic research.

The U.S., on the other hand, operates about 52 ships with an average age of 18 years, has about 500 to 600 professional oceanographers; and roughly 70 separate organizations engaged in oceanic research. Only 16, however, are large facilities.



Focusing eyepiece provides clear definition at various working lengths.

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A.C.M.I. Fiber Optic *Flexible* Borescopes

FOR visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

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Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

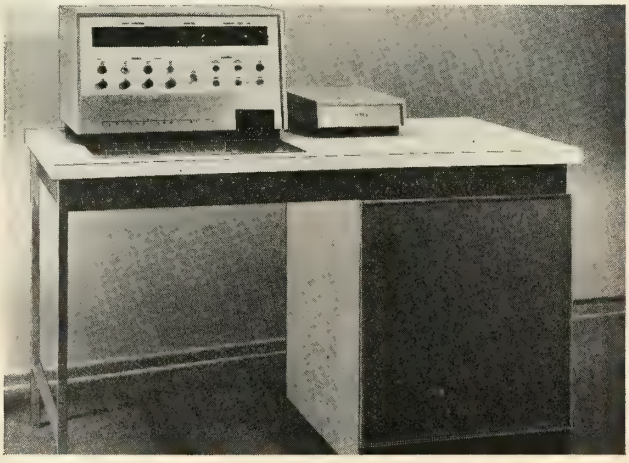


Report No. 8
WR 2000 Computer Module Test Set

Our new WR 2000 test set automatically tests "black box" modules having electrical inputs and outputs. It is presently being used to test modules of several different computer systems. Input command functions to the modules are obtained from a 5-place ratio transformer and are automatically programmed through a unique programming patchboard, which provides the WR 2000 with the versatility required to test a wide range of airborne analog computer systems. Output transfer functions of the modules are automatically read out through a 4-place ratiometer. Up to 10 input command functions and up to 10 output transfer functions for each input command are possible for each module. This SM/I test set can be operated by relatively inexperienced personnel, and its overall accuracy of measurement ranges from 0.01 to 0.25% of full scale, depending on type of test performed.

Physical Characteristics

Size	48" L x 25" W x 29" H — Table Area
Weight	200 lbs.
Power Requirements:	
115V 60 cps	300 watts max.
115V 400 cps	150 watts max.
28V DC	150 watts max.
Accuracy	0.01% to 0.25% full scale



For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

SM/I SERVOMECHANISMS/INC.
Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

SPACE MEDICINE

(Continued from p. 79)

hazard posed by prolonged exposure to weightlessness received a partial answer in the seven-day "bathtub" water-immersion experiment of Dr. Duane Graveline at the Aerospace Medical Center this past January. Will prolonged weightlessness requiring no muscular effort to maintain body position against the pull of gravity result in serious muscle debilitation and weakness?

Spending only one hour in each 24-hour period out of the bathtub to permit skin care and replacement of electrodes, the subject noted, "each time I got out I was weaker and more eager to get back in." A startling observation was the fact that he averaged only about an hour's sleep in each 24-hour period.

Monitoring his brain waves (EEG) proved that most of this was light sleep, with very infrequent 10- to 20-second periods of deep sleep. A marked decrement in skilled performance occurred, easily noted after comparing the pre- and post-experiment tests. This experiment points up one of the most serious and challenging problems of extended manned space flight.

The specific advances reportable through this past year appear to be small compared to the progress that needs to be made. However, the year has been a period of organization and consolidation that should blossom into many worthwhile achievements in the coming 12 to 18 months.

The opinions expressed are those of the authors and do not necessarily represent official USAF policy.

Rocket Power/Talco Pushes Studies of Oxidizing Salts

Advanced studies in improvement of solid rocket propellants are being carried out at the research laboratories of Rocket Power/Talco, Pasadena, Calif. Efforts are aimed at incorporating desirable properties of propellant oxidizing salts, such as perchlorates and nitrates, into propellant binders.

Accomplishment of the objective would result in a substantially homogeneous compound having excellent physical properties and high specific impulse.

Rocket Power/Talco scientists point out that the best present solid propellants consist of a minor proportion of binder and light metals with a preponderance of oxidizing salts, suffering in performance because of the need for separate components of binder and granular ingredients.

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Daystrom Gets Award For Added Work on Julie

Bureau of Naval Weapons has awarded Daystrom, Inc. a contract of about $2 million for continuing classified research and development work on the *Julie* system, an important part of Navy's anti-submarine warfare program.

Daystrom's Electric Division pioneered the *Julie* system for the Navy, beginning in 1953. The system makes use of the explosive echo ranging technique for the detection and location of submarines. Accurate timing between creation of the sound and receipt of its echo permits calculation of the distance between the submarine and the source of the sound.

In working on the system, the division developed a unique three-part setup. Its new laboratory building at Poughkeepsie, N.Y., includes a 12-by-8 ft. indoor acoustical water tank and other facilities to simulate the ocean environment.

To handle tests too large for the laboratory and yet under controlled conditions, *Julie* utilizes an artificial lake 1800 ft. long, 900 ft. wide and 135 ft. deep. Originally an abandoned stone quarry, it is the largest underwater test range in the country maintained by private industry.

To do original work in oceanography and to test ideas and equipment in the sea itself, the division keeps an 86 foot research vessel, the State Star, especially equipped and instrumented. The vessel works off the East Coast and in the Caribbean, often in conjunction with Naval ships and aircraft.

Martin to Develop Master Air Force Checkout Plan

A 15-year master plan of checkout systems for manned and unmanned weapons will be developed for the Air Force under a contract just awarded to Martin-Baltimore.

The study will set design standards and define checkout systems requirements up to 1975. It is also aimed at establishing methods of standardizing and integrating systems hardware to increase efficiency and save money.

Competition for the unfunded contract was unusually heavy: some 42 companies submitted bids. Martin estimates the work will cost them about $100,000 and require about seven months to complete.

Checkout equipment of 17 different weapons systems will be evaluated in the study. These include eight produced by Martin: SM-68 *Titan, Pershing,* TM-76 *Mace* and TM-61 *Mata-*



More than 40,000 parts, each of which must meet the most stringent reliability standards, make up the U. S. *Atlas* intercontinental ballistic missile, built by prime contractor Convair (Astronautics) Division, General Dynamics Corporation.

Among these parts is the Bristol Syncroverter* chopper . . . adding to its record of service in U. S. guided missile systems of almost every type since their very beginnings.

Billions of operations. To insure the reliability so necessary in aircraft and missile operations, Bristol Syncroverter choppers are constantly under test at Bristol, with and without contact load. One example: We've had five 400-cycle choppers operating with 12v, 1ma. resistive contact load, for more than 26,000 hours (2.96 years) *continuously* without failure—over 37-billion operations!

Many variations of Bristol Syncroverter choppers and high-speed relays are available—including external-coil, low-noise choppers. Write for full data. The Bristol Company, Aircraft Equipment Division, 173 Bristol Road, Waterbury 20, Conn.

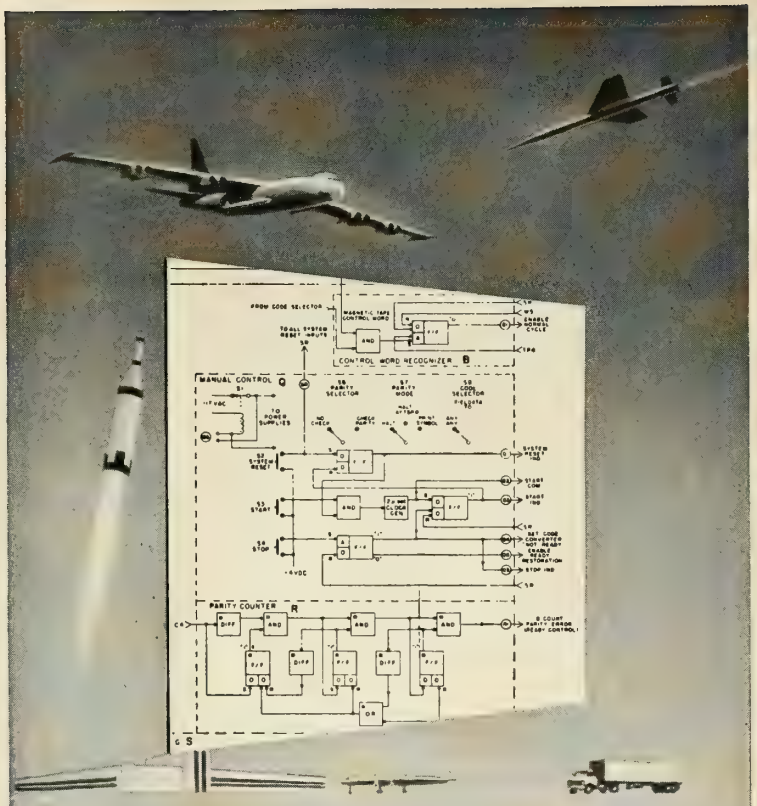


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*T.M. Reg. U. S. Pat. Off.

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The Application of

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• • • in tracking, timing, guidance and test systems is a familiar problem to Anelex® Systems Division engineers.

For almost ten years, they have worked together in the development of logical solutions to special military problems of air, land and sea operations, including equipment for MIL Spec environments. During this time, they have also developed unusual systems for industrial and commercial applications.

Finished equipment required for these systems is produced by the Anelex manufacturing facility under direct supervision of the engineering group. This division is staffed by technicians and skilled craftsmen who have specialized in the production of sophisticated data processing equipment.

We will be glad to tell you frankly and promptly whether your particular requirement is within the capabilities of our Systems Division.

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dor, Bullpup, 199-B ALBM (ex-*Bold Orion*), *Dyna-Soar,* and the RB-57D SAC reconnaissance bomber.

Other checkout systems included: SM-80 *Minuteman,* GAM-77 *Hound Dog,* IM-99 *Bomarc, Nike-Zeus,* GAR *Falcon,* GAM-87 *Skybolt,* B-58 Hustler, *Midas* early-warning satellite, and the *Samos* reconnaissance satellite.

IBM Demonstrates Its Mercury Tracking Network

A real-time teleprocessing system to serve as the connecting link between data input from widely scattered centers and central data processing was demonstrated in Washington recently for NASA and members of Congress.

Developed by International Business Machines Corp., the IBM 7281 Data Communications Channel will be installed soon at the Goddard Space Flight Center, Greenbelt, Md. Its 32 channels will tie the center's two IBM 7090's, also to be installed, to a worldwide network of tracking stations.

Transmitted information from any location in the network will be received by the 7281 which changes the impulses into a digital output. This can be stored and/or fed immediately into a computer for processing. Total elapsed time for teleprocessing, said IBM's Federal Systems Division, is measured in milliseconds.

Principally designed for Project *Mercury,* the tracking network inputs will be from radar, telemetry, and other related sources.

With the high-speed computers and the 7281, more reliable and precise control of the *Mercury* capsule is now possible. Real-time control obviates data delay in both directions—that is, to or from the capsule or the observing stations.

The equipment was demonstrated at the dedication of an impressive black-light display of U.S. space programs. Titled "Threshold of Space" the IBM exhibit dramatically shows what has been accomplished.

Joint Contract to Develop Mobile Nuclear Powerplant

A highly compact 2-to-3-megawatt nuclear powerplant for military use in isolated areas will be developed jointly by Allison Div. of General Motors and Nuclear Development Corp. of America.

The contract, awarded by the Atomic Energy Commission, grew out of a Department of Defense request for such a mobile system. The Army's Corps of Engineers particularly needs a high-output powerplant which can operate for long periods of time with minimal service requirements.

Pioneer V

(Continued from page 85)

ment of the interaction of solar wind and the earth's magnetic field, the first measurement of the size of the solar system by means of a space probe and a discovery that the so-called Forbush decrease in cosmic-ray intensity at the beginning of a solar flare is not confined to the region surrounding the earth.

Pioneer V exceeded the long-distance communication record by more than 55 times. The old record was held by *Pioneer IV*, the 13.4-lb. U.S. planetoid fired past the moon March 3, 1959, which was tracked out to a distance of 407,000 miles. Silverstein said the longest distance of communication claimed by the Soviets was 396,000 for *Lunik I*, their 3245-lb. vehicle fired past the moon Jan. 2, 1959.

Since last March, *Pioneer IV* has traveled 760 million miles in its orbit.

• **Failure analyzed**—Most of the communication from *Pioneer V* came from its five-watt transmitter. The probe also carried a 150-watt transmitter, which was left idle during the first four weeks of its journey. The larger transmitter responded promptly when commanded on for the first time on May 8. However, its use was limited because of the apparent deterioration of the spacecraft's 28 flashlight-sized batteries. The 5-watt transmitter is powered by batteries recharged by solar cells in four paddles stretching out from the body of the satellite.

NASA said any one or all of the three reasons might account for the failure of communication. They are:

• The spacecraft may be out of earth range of the 5-watt transmitter.

• Battery failure or leakage may have been induced by the extreme vacuum of interplanetary space.

• Some key component or system may have failed.

NASA and Space Technology Laboratories, which built the *Pioneer V* payload, are making a complete analysis of the performance, including the 138.9 hours of data transmission.

First Missile Destroyer For Royal Navy Launched

LONDON—The Royal Navy has launched its first guided missile ship, the destroyer Devonshire. It should be ready for fleet service in early 1962.

Missile armament will include a *Seaslug* mounted on the quarter deck and two *Seacats* abaft the after funnel. The vessel will also have the latest ASW detection equipment.

Three sister ships—Hampshire, Kent and London—will be in service by 1963.



Photo courtesy Radio Corporation of America

aerospace

Components for RVX and TIROS Projects by LAVELLE

Major successes in the nation's accelerated space vehicle and missile programs include precision sheet metal components made by Lavelle. Among these is the fabrication by Lavelle of the structure of the new U. S. earth-circling TIROS weather observation satellite produced for the National Aeronautics and Space Administration by the Astro-Electronics Products Division, RCA. An artist's view of TIROS in orbit is shown above.



Pictured also is the recovery of the first successful RVX series re-entry vehicle after ICBM range flight. The aluminum alloy nose cone structure for this test was fabricated by Lavelle under sub-contract from the General Electric Company's Missile and Space Vehicle Department.

Some of the reasons why Lavelle has been selected to be a part of such dramatic projects are illustrated in a new brochure. Write for your copy.

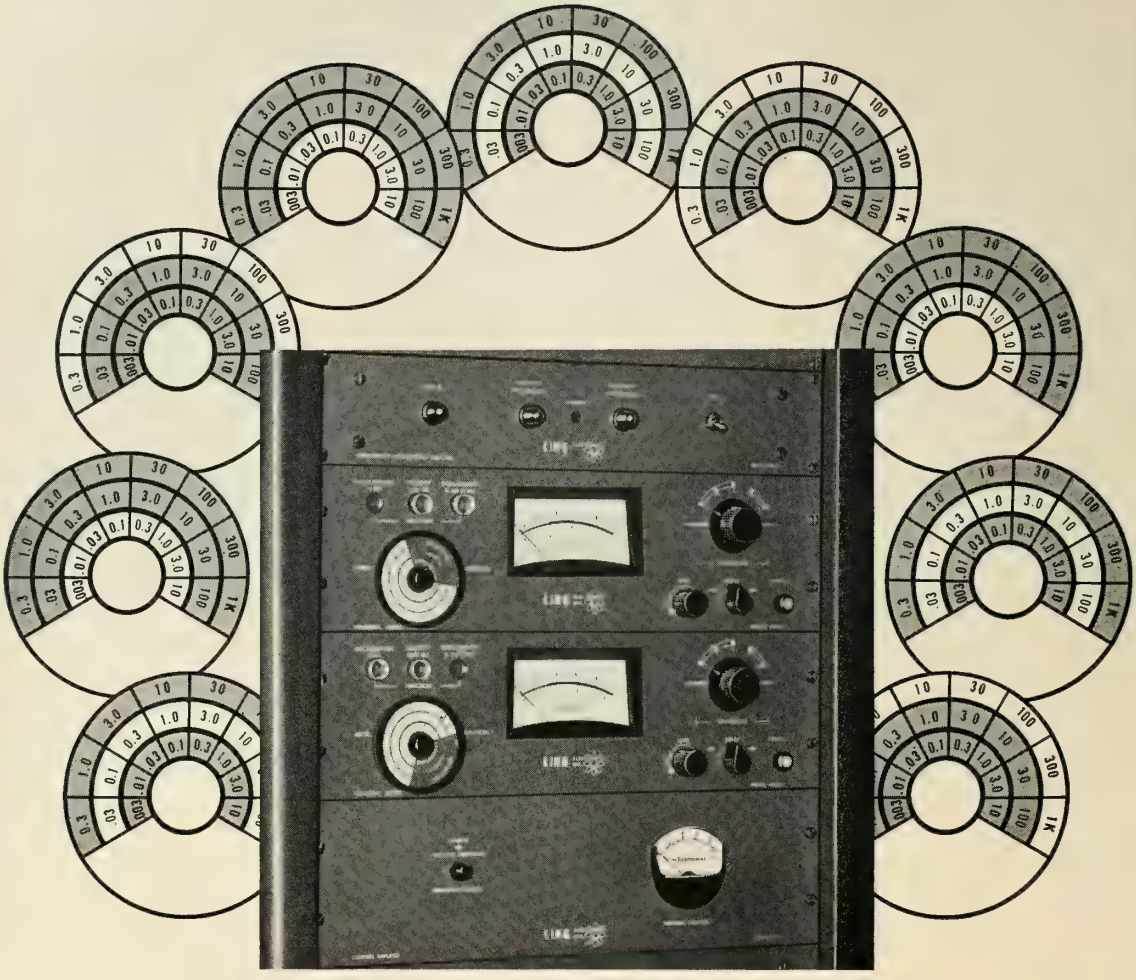
Photo courtesy World Wide Photos, Inc.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.

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AUTOMATION IN VIBRATION–Vibration variations of 1000 to 1 automatically controlled by NEW LING S-14 SERVO

Ling introduces another advance in vibration testing—a new electronics servo system that offers a dynamic range of 60 db, plus remarkable accuracy and ease of control. This new variable response S-14 Servo System performs automatically, while frequency cycling with a sine-wave signal source. It simultaneously monitors any two values of acceleration, velocity or displacement, then automatically selects the larger as the controlling signal, and maintains it constant. Automatic thumpless transfer between the control functions takes place—you simply set the desired limits on the corresponding vibration meter. Reaction time is inversely proportional to frequency, and as a result, controlled levels of plus or minus 3% are attainable over a wide dynamic range. Like other Ling designs, the S-14 is flexible—the basic system can be expanded to handle 4 separate signals, or to permit automatic control from 3 or 4 control signals. For details, write Dept. MR-4 at our Anaheim address.

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LING ELECTRONICS

The flexibility of the S-14 Servo System at the left, is just one more example of the way Ling design anticipates your needs of the future. Since the complete control package is made up of separate components, the system not only meets your present demands, but can readily be expanded. The basic two-level system includes 2 vibration meters, 1 control amplifier, 1 control selector,

By simply adding the appropriate number of meters and selectors, the system can be expanded to meter 3 or 4 separate signals with automatic transfer between control functions.

Transfer between control functions is handled by an electronic switch which automatically selects the correct crossover point. You merely set the desired limits on the corresponding vibration meter, shown close-up in the photo below. No thumps or other low frequency transients mar this smooth transfer.



This kind of flexibility, precision control and ease of operation begins with thoughtful consideration of basic operating requirements. And whatever your needs in high-power electronics—for vibration testing, acoustics or sonar—you'll find you can rely on Ling Electronics for the thoughtful design that leads to practical advances.

LING
ELECTRONICS
HIGH-POWER ELECTRONICS FOR VIBRATION TESTING • ACOUSTICS • SONAR

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'cocktail party effect . . .'

New Sound Technique For Voice from Space

SANTA BARBARA, CALIF.—Astrometrics, Inc., has developed an entirely new sound reproducing system for voice transmission from space based on a principle observable at any cocktail party.

The system, called the "articulator," is designed to increase the intelligibility of an astronaut's voice under conditions of a high ambient noise level at the listening end, the transmitting end or in the transmission link itself.

It makes use of the fact that human ears are directional devices relying on both amplitude and arrival time differences for information. Sound emanating from in front and to the right of a listener will arrive at his right ear first, thus allowing the brain to decide where the source is. If two or more sounds are being generated at different locations, the listener has the ability to "tune up" the sound he wants and "tune down" the other.

This is what Astrometrics calls the "cocktail party" effect and it forms the basis for the Articulator, designed to make transmission from an astronaut more intelligible.

"This capability of the listener to tune in on one of the conversations and tune down all other conversations and noises in the room is dependent on his ability to locate the source of the sound he is after," company president W. M. Turner notes. "There's both a physiological and a mental mechanism at work here."

Yet a tape recording taken in the same room will produce substantially unintelligible and confused sounds with only a few highlights coming through, Turner points out. This is attributed in large part to the fact that the tape-recorded sound emanates, in effect, from only one source.

• **Three frequencies used**—By feeding all desired and undesired signals from a single channel line into a phase shifter which has the characteristic of presenting two outputs with a constant phase difference relationship at all frequencies, (i.e., all frequencies from 20 to 20,000 cps are 90° apart at the two output terminals), a precise but different time delay from one output to the other results for every individual frequency component in the sound.

Ninety degrees represents 2.5 milliseconds difference at 100 cps, 250 microseconds at 1000 cps, and 25 microseconds at 10,000 cps. If these three frequencies are transmitted by two widely spaced speakers and the 90° phase relationship maintained, the three frequencies appear to the listener to be coming from three different locations between the two speakers.

Each voice has an attack transient containing a band of identifying frequencies. These become locating frequencies in a system of this type. If several voices, hum, and static all are

Model 100 Articulator Specifications

Input Impedance:	greater than 47 K Ohms
Input Voltage: (required for rated power output)	1 Volt RMS
Input Signal Range:	0.1 to 5 Volts RMS
Output Power:	10 Watts (each channel)
Output Impedance:	4 Ohms (each channel)
Intermodulation Distortion: Harmonic Distortion: Frequency Response:	not applicable (function of speaker and ambient parameters)
Improvement:	The average intelligence signal to noise ratio improvement is 3 db.
Power Required:	117 VAC 60 cps single phase at 1.25 amperes (nominal)
Physical Dimensions	
Amplifier and Control Unit:	5¼" H x 19" W x 13½" D
Speaker Units:	5¼" H x 19" W x 7½" D



Whether shooting for the moon or pinpointing an ICBM in the Atlantic, success or failure already has been determined before the button is pushed. Hit or miss depends upon the *reliability* of men, component parts, and support equipment.

Reliability of Hokanson missile support air conditioning has been proven in support of the Snark, Polaris, Thor, Titan, Minuteman, and Quail programs. Hokanson also has demonstrated its ingenuity by solving new and unusual air conditioning design and performance requirements.

If you have a missile air conditioning problem, let Hokanson solve it. Write today for our latest brochure.

Designers and manufacturers of the H-35 airline mobile air conditioner now used throughout the world.

Hokanson

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C. G. HOKANSON COMPANY, INC.
2140 Pontius Avenue
Los Angeles 25, California

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being transmitted over one line, then, with the Articulator, the hum will seem to be coming from one point, one voice from another point and so on.

"The listener will subconsciously locate the desired sound and tune down all others, something that would be impossible if they were all following each other out of the same box," Turner says.

It is this which the company says greatly enhances the ability of the listener to extract the intelligence from a single channel sound transmission system. He can, in effect, "tune in" mentally on the astronaut's voice.

"Prior to the space age, important information in missile programs was derived from the radar, telemetry, and on board recording devices," says company president Turner. "Voice communications played a secondary role, only important at certain points in the countdown and during an occasional emergency transmission from a chase plane pilot. However, with the advent of men in space, we have in addition to the aforementioned sources of intelligence, the astronaut himself. What he says will be of great importance, so that the human voice as a source of data will be of primary or paramount importance as opposed to unmanned missile programs."

Turner points out that recovery of the human voice under conditions of space travel is a field on which very little effort has been expended.

Development of the Articulator is aimed at improving the intelligibility of man's voice under space conditions and is an effort to increase the useful range of transmission without further encumbering the vehicle or the astronaut himself.

• **Used with telemetry**—The Articulator is added to the ground communication system between the final electrical voice output and the human receiver. The communications system up to the human receiver is immaterial to the Articulator. It can be AM, FM, single sideband, double sideband, constant level speech, narrow band FM, phase modulation or any other. It can be landline communications, it can be clipped, or it can be digitized and then reconstituted in an analog form.

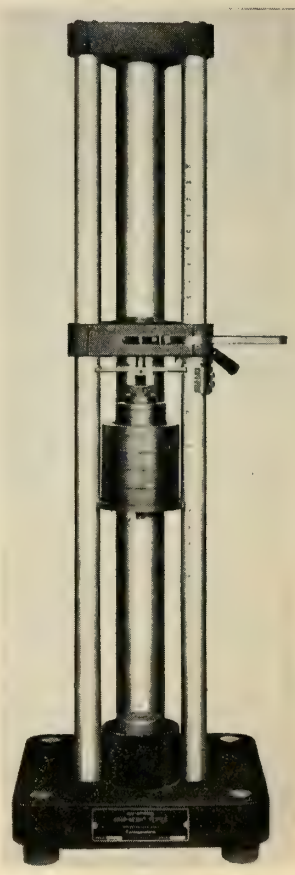
Application of the Articulator is not limited to space programs but can be used in any communications system where intelligibility is important. It could be employed, for example, in playback of telemetry data where information for the annotation of records is derived from voice signals on the tape along with the telemeter information.

There are three separate units making up the Model 100 Articulator. The

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OLIN MATHIESON* DROP-WEIGHT TESTER



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VERSATILE: Particularly suitable for impact sensitivity testing all classes of materials, both solid and liquid, including slurries and low-boiling liquids.

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RAPID: One half-hour or less for a complete determination (20-30 tests).

SIMPLE: No special mount required. Operates at bench height on any table or laboratory work space.

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BASIC BUILDING BLOCKS FROM KEARFOTT



NEW HIGH PERFORMANCE

Size 8 Motor Generator

This new Size 8 high performance servo motor-generator features high signal output and extremely low null voltage. The signal-to-noise ratio of 100:1 and linearity of 0.2% make the application of this motor generator to lightweight integrator packages most desirable. Stainless steel construction and thermal stability of this component assure its reliability and long life in the most severe environments.

ELECTRICAL CHARACTERISTICS

Motor Section	Generator Section		
	Phase 1	Phase 2	Excitation
Voltage (volts)	26	40	26
Frequency (cps)	400	400	400
Current (ma)	110	77	72
Power Input (watts)	2.3	2.3	1.3

GENERATOR SECTION OUTPUT

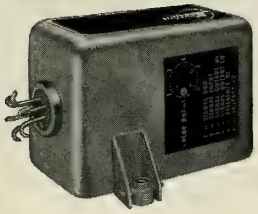
Volts at RPM (mv)	10
Volts at 1000 RPM (volts)	1.1
Output Impedance (ohms)	21 + j2500
Rated Load (ohms)	100,000

MECHANICAL CHARACTERISTICS

No Load Speed (RPM)	6500
Stall Torque (In. Oz.)	0.25
Rotor Moment of Inertia ($gm\text{-}cm^2$)	1.2
Theoretical Acceleration (Rad/Sec^2)	14,400
Weight (Oz.)	3.9

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT



QUADRATURE REJECTION CIRCUIT

Kearfott's quadrature rejection circuit is designed to operate from a preamplifier or gain controlled amplifier into a transistor servo amplifier. This small, light and rugged device rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to load and magnitude of in-phase signal. Kearfott's high-performance rejection circuit is designed to operate in an ambient temperature range of −55°C to +115°C at unlimited altitudes.

TYPICAL CHARACTERISTICS #D4816-01

Input Impedance — In phase signal component (ohms)/5000 $+R_L$ / Quadrature component (ohms)/5000 (min)

Signal Frequency (cps)/400

Max. Signal Input (volts RMS)/6

Bandwidth (cps)/6

Quadrature Rejection Ratio:

Rejection Ratio (min)/50:1/ 35:1/35:1

Signal Input/0.15 to 4/4 to 6/ 0.005 to 0.15

Meets environmental requirements of MIL-E-5272.

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

TWO AXIS ACCELER-OMETERS



Highly precise and accurate, Kearfott two-axis accelerometers are pendulous devices which sense airframe acceleration forces acting on them in aircraft and missile guidance systems, navigational computers and wherever acceleration must be measured precisely and translated into electrical output signals.

The pendulum is anchored to a housing by means of a unique Hooke's joint type spring suspension. Whenever there is relative motion between pendulum and housing due to acceleration, an AC excited, air-core differential transformer type pickoff produces a voltage which is a servo error signal that is fed into an AC to DC amplifier. Feedback signal in form of a DC current transmitted to a restoring coil produces a force that exactly balances force of any accelerations acting on pendulous mass.

TYPICAL CHARACTERISTICS

Range of Measurement: ± 25g (can be adjusted upward within amplifier limits.)

Scale Factor (Output): 5.0000 MA/g of applied acceleration.

Operating Temperature: Performance is optimized within any 20°F range between +50°F and +160°F.

Linearity (Output): Within ± 0.005% of the applied acceleration.

Threshold: Less than 2×10^{-7}g.

Zero Stability: ± .00005g day to day; less than ± .00002g over any continuous time interval.

Vibration: Up to ± 5g peak from 20 to 2000 CPS.

Storage Temperature: −60°F to +170°F.

Scale Factor Variation: ± 0.01% randomness.

Write for complete data.

KEARFOTT DIVISION
Little Falls, New Jersey

GENERAL PRECISION, INC.
Other Divisions: GPL, Librascope, Link

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SPACE STATION
POLARIS FBM
PROJECT ARGUS



DISCOVERER SATELLITE

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

ADVANCED PROJECTS AT LOCKHEED

Now in its advanced development status, the Navy-Lockheed POLARIS Fleet Ballistic Missile is scheduled to be fully operational and aboard its specially designed submarines late this year. Full-scale test vehicles have been successfully flown on a regular schedule of firings for months with only two failures, a remarkable achievement in view of the totally different environmental problems involved in its underwater launch. With nearly three-quarters of the earth's surface being water, practically no target in the world is outside the POLARIS' range of over 1200 nautical miles. The Division is systems manager for the POLARIS under the direction of the Special Projects Office of the Navy.

The Air Force-Lockheed AGENA satellite is a versatile space vehicle capable of numerous assignments. In its present DISCOVERER program configuration, it is 19 feet long, 5 feet in diameter with an orbital weight of approximately 1700 pounds. Payload of several hundred pounds includes telemetry, instrumentation, guidance and attitude control systems, reentry vehicle and recovery capsule. The AGENA has accomplished several significant space "firsts." It was first to be placed on the difficult polar orbit; first to be placed on a precise, predicted, and nearly circular orbit; first to change its attitude on orbit, with a turn of 180 degrees and a downward tilt of 60 degrees; first to eject a capsule; and first to prove advanced space systems such as ground-space communications, instrumentation, attitude and guidance and life-sustaining devices. The AGENA can be modified for a variety of space missions such as navigation; geophysical investigations; lunar probes; long-range communications; and space probes.

In addition to the DISCOVERER program, the Division is developing advanced AGENA satellites for the MIDAS program (Missile Defense Alarm System) and the SAMOS strategic warning system. Lockheed is system manager and prime contractor for these projects under the direction of the Air Force Ballistic Missile Division (ARDC).

An orbiting research facility to serve as an advanced base for space exploration, has been proposed in practical detail by Lockheed's research and development staff. The station would carry a 10-man crew. Prefabricated compartments for the rim of the wheel, the spokes, and the three hubs would be launched separately by ballistic missiles and assembled in space by means of the specially-designed, Lockheed Astrotug.

The Air Force-Lockheed X-17 solid-propellant ballistic missile has pioneered many new techniques, and the valuable experience gained from this program facilitated development of other, inter-service projects, including the Navy POLARIS FBM. The Navy's Project Argus radiation explosion featured the X-17 as the vehicle. Developed for the Air Force, the Lockheed KINGFISHER is designed to simulate enemy attacks to test our nation's anti-bomber and anti-guided-missile defenses. The Air Force X-7 is a unique, recoverable ramjet-engine test vehicle designed to test new developments in advanced components for other missiles.

The successful completion of projects such as these requires a bold and imaginative approach to entirely new environments. Lockheed's programs reach far into the future. It is a rewarding future which scientists and engineers of outstanding talent and inquiring mind are invited to share. Write: Research and Development Staff, Dept. G-29A, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

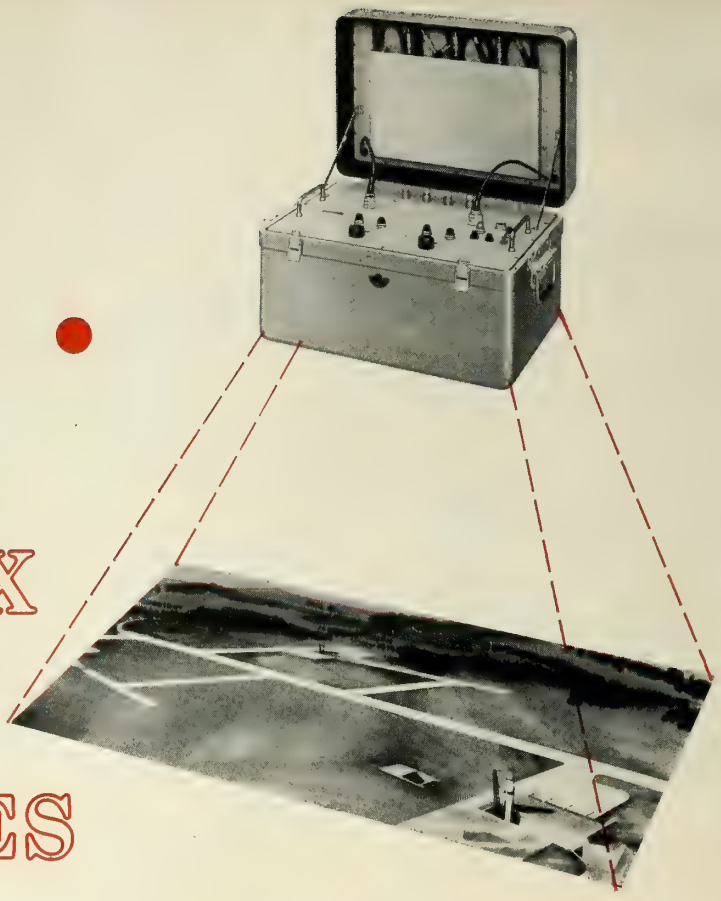
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Dry (instrument) air

OPERATING INPUTS REQ'D.
Air Pressure: 20 to 30 PSIG
Vacuum Source: 0 to 2.0 inches of mercury (absolute)

OUTPUT PRESSURE RANGES
Static Pressure (P_s): 2 to 70 inches of mercury (absolute)
Pitot Pressure (P_t): Automatically determined by P_s and P_s/P_t settings
P_s/P_t Ratio Range: 0.580 to 0.940
Other Static and Ratio ranges available.
Differential Pressure Range: 0 to 30 inches of mercury.

POWER REQUIREMENTS
110 volts, 400 CPS—275 watts

OVERALL DIMEN. (Approx.)
Height: 14.5 inches
Width: 24 inches
Depth: 16 inches

AMBIENT TEMPERATURE
Range: —54°C (—65°F) to +55°C (+130°F)
Weight: Approx. 80 pounds

GCC 0-3

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main chassis contains the controls, a 90° phase shifter, two separate audio servosound amplifiers and a DC power supply. The other two units are identical speaker enclosures with the exception of the location of barrier terminal strips on the rear section.

In use the two speaker enclosures are placed at the same height on the same plane with a center to center distance in the range of 6 to 20 ft. Cables 10 ft. in length are provided for connection of the speaker enclosures to the main chassis.

Astrometrics has determined, using series of random-number and other tests on listening groups under a variety of ambient listening conditions, that the average intelligence improvement under conditions of noise in the transmission link is 3 db. An improvement of this magnitude would, in the case of a moving aircraft, result in a range increase of 1.4 to 1.

The improvement in intelligibility under conditions of ambient room interference is said to be much more spectacular. Astrometrics explains the improvement this way:

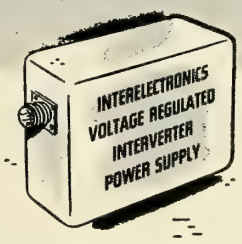
Consider the case where a voice is emanating from a single speaker in a room with an interfering voice at a higher amplitude than the desired reproduced voice. If the amplitude peaks of the interfering voice are sufficiently high to override the desired voice, a listener can no longer keep his physical and mental machinery "tuned to" or "locked on" the desired voice and is thereby distracted by the interfering voice. In the case of the Articulator's two outputs with 90° phase difference, if the interfering voice peaks are coincident and override the peaks of the voice emanating from one speaker, it necessarily follows that they cannot interfere with all of the peaks coming from the other speaker—since the sounds from the other speaker arrive at a different time. All of the intelligence-containing components of the voice arrive at different times, so that even if the interfering voice were to be coincident with some frequencies, it cannot coincide with others because there is an arbitrary and varying difference in time delay between the two speakers.

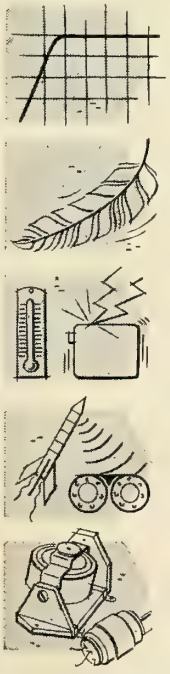
• **Negative feedback**—If a rapid-speaking, interfering voice, such as a radio commercial, is turned on at a volume greatly exceeding that of a desired single channel signal reproduction, the desired signal is virtually unintelligible. The recovery ratio is approximately 10%. Addition of a second speaker, at no increase in volume, increases the intelligibility to 95 or 100%. Effectivity of the Articulator phase relationship is said to be even more pronounced with use of a stereophonic headset because the phase relationships are retained in their pure state and therefore are not deteriorated by room reflections.

It is coincidence that the intelligence or fidelity increasing mechanism of each of the two channels considered separately in the Articulator also is a phase function. The Articulator has a novel feedback circuit which treats the speaker itself as a transducer and reflects variations from a pure resistive load back into the amplifier in a negative feedback sense. The particular feedback arrangement employed results in essentially a "constant power" amplifier characteristic. The amplifier is neither constant voltage nor constant current, but constant power. The constant power relationship has been determined, through empirical study, to produce the highest auditory fidelity.

Harmonic distortion measurements made on speakers using this feedback versus pure voltage feedback in the conventional sense will yield a greater harmonic distortion reading. However, since the speaker is resistive only at two frequencies and is either capacitive or inductive at all other frequencies,

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Ultra-reliable in operation (over 260,000 logged hours), no moving parts, unharmed by shorting output or reversing input polarity. Wide input range (18 to 32 volts DC), high conversion efficiency (to 92%, including voltage regulation by Interelectronics patented reflex high-efficiency magnetic amplifier circuitry).

Light weight (to 6 watts/oz.), compact (to 8 watts/cu. in.), low ripple (to 0.01 mv. p-p), excellent voltage regulation (to 0.1%), precise frequency control (to 0.2% with Interelectronics extreme environment magnetostrictive standards or to 0.0001% with fork or piezoelectric standards).

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AC single and polyphase units supply sine waveform output (to 2% harmonics), will deliver up to ten times rated line current into a short circuit or actuate MIL type magnetic circuit breakers or fuses, will start gyros and motors with starting current surges up to ten times normal operating line current.

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Interelectronics—first and most experienced in the solid-state power supply field produces its own all-silicon solid-state gating elements, all high flux density magnetic components, high temperature ultra-reliable film capacitors and components, has complete facilities and know how —has designed and delivered more working KVA than any other firm!

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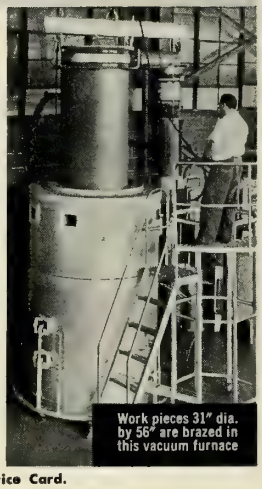
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Ask us for help in deciding how to best braze your stainless alloy assemblies. We successfully braze almost every known stainless steel, superalloy, and aluminum or titanium bearing metal.

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Ask us for a quotation on doing your stainless brazing or heat processing. Our pencils are sharp and so are the four furnace plants we operate to serve you.



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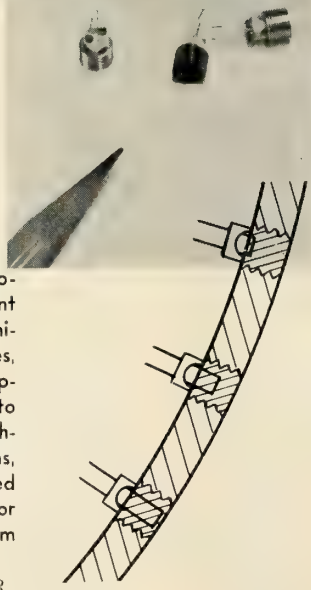
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there is a phase difference between the cone movement at all different frequencies from a given speaker.

An example of this might be a 100 cps square wave wherein the speaker has a capacitive reactance at the fundamental frequency of 100 cycles, but is resistive at 300 cycles and highly inductive at 50° cycles. Under these conditions, a microphone picking up the same square wave reproduced by the speaker would display a waveform bearing little resemblance to a square wave.

Use of the Articulator feedback circuit reflects the speaker movement in a negative feedback sense, providing a great deal of phase correction such that the square wave components are reconstituted in their proper phase relationships.

There are circuits which have been employed to yield essentially perfect phase correction up to the piston point of speakers. However, these circuits, in the past, have resulted in a prohibitive amount of complexity. Additionally, it is Astrometrics' opinion that all of the practical circuits used to obtain this result leave much to be desired in the sense of actual listening fidelity. The unique constant power circuit employed by Astrometrics reflects speaker load variations back into the amplifier and results in what has been empirically determined to be the optimum reproducing condition for any particular transducer.

Astrometrics believes there is an important delineation which should be made between the mechanism of phase delay or constant phase shift as employed in the Articulator and the time delay mechanism used in the past by the military.

In the case of the time delay, which has been found to increase intelligibility in aircraft, the principle is this: if a sound generated at the right ear is interfered with, by some ambient noise peak, that same noise sound arrives at the left ear later in time and may, by coincidence, not be interfered with at all.

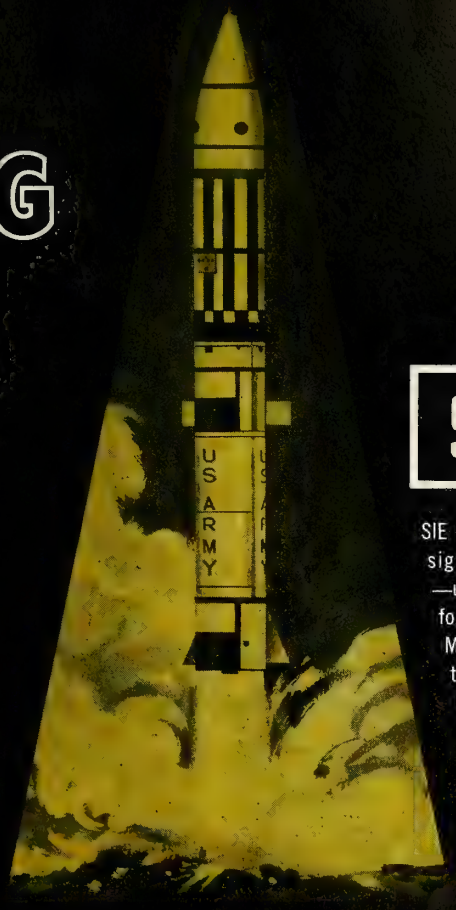
It is certain that the same peak that interfered with the sound in the right ear will not affect the left. However, in the case of the Articulator, since there is a varying time delay for all of the different frequency components of the desired signal, an interfering sound at the right ear cannot interfere with any of the components from the left ear. An additional interfering sound that might affect one component of the left ear can necessarily not interfere with all of the components since they are distributed in time.

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PERSHING

AIRBORNE TELEMETRY SIGNAL CONDITIONING SYSTEMS



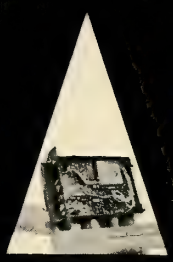
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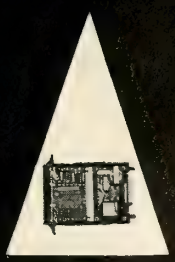
SIE provides airborne telemetry, signal conditioning systems —using solid state electronics— for the U. S. Army's new Pershing Missile, recently successfully test-fired at Cape Canaveral. SIE measurement equipment delivers unexcelled reliability under extreme airborne environmental conditions—providing the Martin Company with advanced, precise electronic missile measurements.

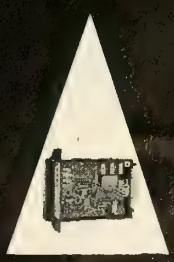
For detailed information about SIE telemetry, signal conditioning systems, please contact LIGHT MILITARY PRODUCT MANAGER.


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TPC-27
Transistorized
Power Supply


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DC Amplifier


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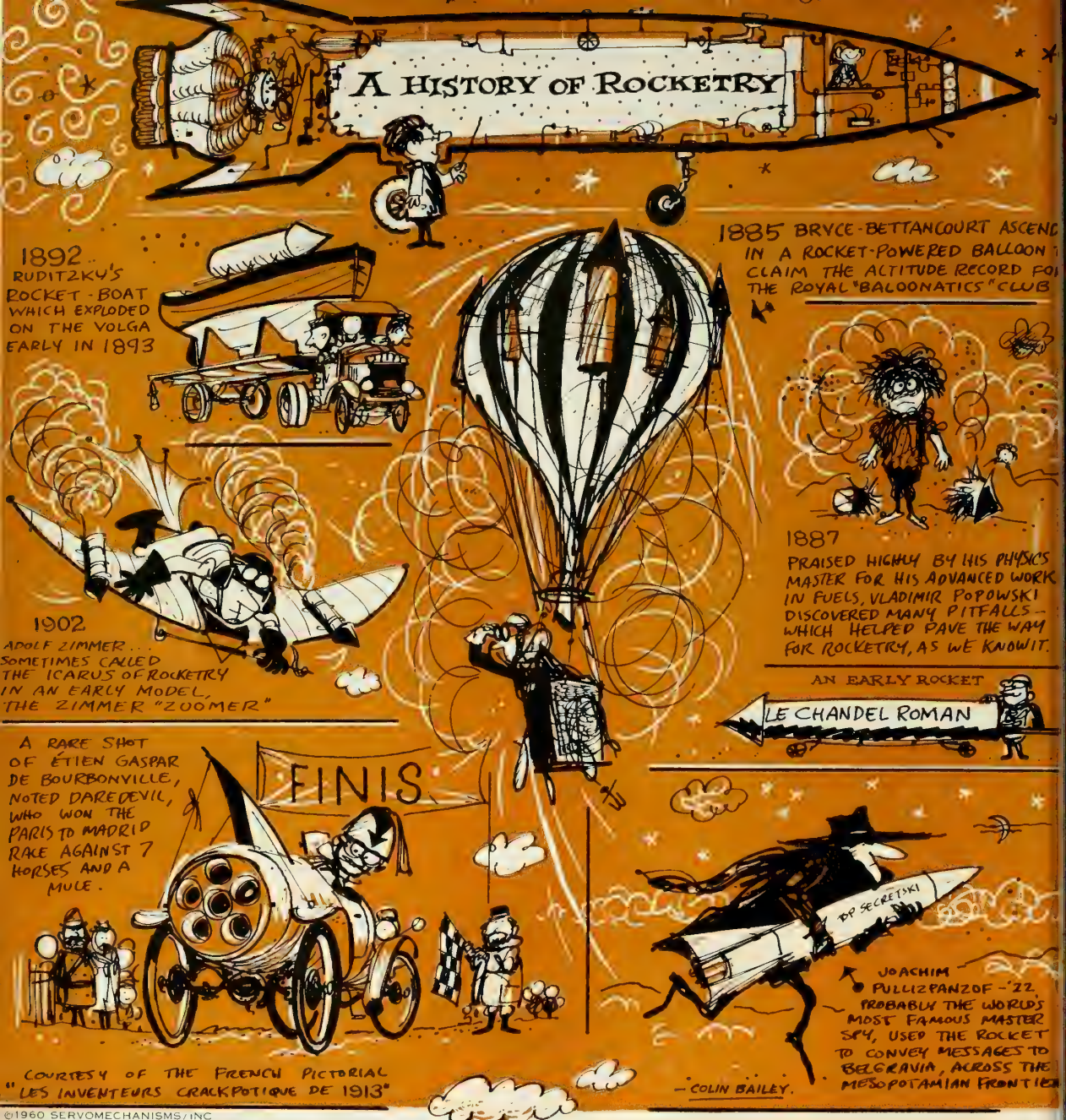

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1960

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ASW E21

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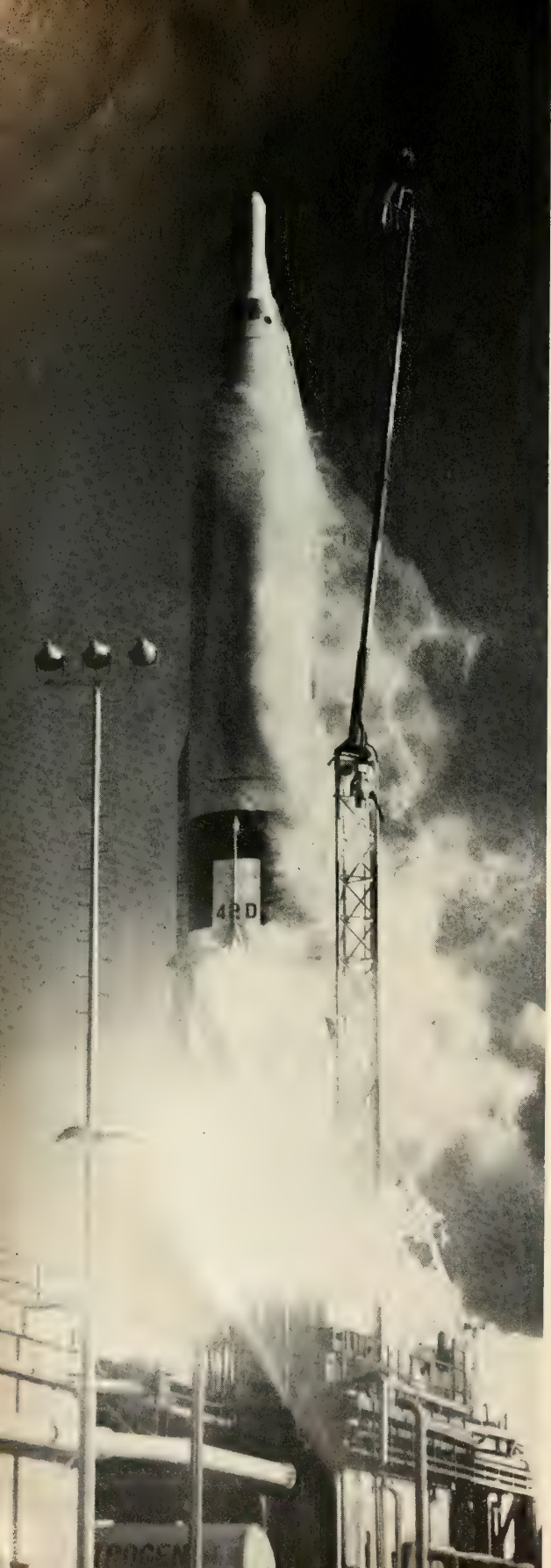
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Vanguard (sat.) E32
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STRATEGIC

U.S. strategic missiles become a major factor in the Cold War for the first time in 1960.

Several Air Force Atlas ICBM's became operational at Vandenberg AFB, Calif., in the fall of last year. But they were only a token.

By the end of 1960, one or more squadrons of Atlases are scheduled to be operational at Warren AFB, Wyo., and two Polaris submarines are scheduled to be on station somewhere in the seas off Russia.

Titan is scheduled to follow Atlas into operational

ATLAS (Air Force)

Military designation: SM-65
Type: ICBM surface-to-surface (fixed base)
Status: Operational
Prime contractor: Convair-Astronautics Division, General Dynamics Corp.
Performance: Range—more than 8000 n. miles. Speed—about 18,000 mph. Apogee—about 600 n. miles.
Frame: System contractor—Convair. Length—82.5 ft. Diameter—10 ft. Launch weight—260,000 lbs. Material (major)—stainless steel.
Guidance: System contractor: GE/Burroughs; Bosch Arma. Type—all inertial later models; radio-inertial command early models.
Booster: System contractor—Rocketdyne. Propellant—LOX and RP-1. Thrust—165,000 lbs. each of two boosters.
Sustainer: System contractor—Rocketdyne. Propellant—LOX and kerosene. Thrust—60,000 lbs.
Re-entry Vehicle: System contractor—General Electric/Avco. Warhead type—nuclear.
Ground support equipment: Launcher—Convair. Fueling—Arthur D. Little Co. Handling and service—Goodyear Aircraft. Transport vehicles—Goodyear Aircraft.
Remarks: Atlases with in-silo launch capability to be deployed beginning with squadron 8.

DEPLOYMENT

Squadrons planned: 13
Bases planned: 10
Squadron strength: 6 to 12 missiles
Initially operational: Sept. 9 1959 at Vandenberg AFB, Calif.
Total number of missiles: 129

Squadron Locations

Vandenberg AFB, Lompoc, Calif. One squadron—6 missiles, soft, non-dispersed
Warren AFB, Cheyenne, Wyo. Three squadrons—(1) 6 missiles, soft, non-dispersed; (2) 9 missiles, soft, semi-dispersed; (3) 9 missiles, semi-hard, dispersed
Offutt AFB, Omaha, Neb. One squadron—9 missiles, semi-dispersed, soft
Fairchild AFB, Spokane, Wash. One squadron—9 missiles, dispersed, semi-hard
Forbes AFB, Topeka, Kans. One squadron—9 missiles, dispersed, semi-hard
Schilling AFB, Salina, Kans. One squadron—12 missiles, dispersed, hard
Lincoln AFB, Lincoln, Neb. One squadron—12 missiles, dispersed, hard
Altus AFB, Altus, Okla. One squadron—12 missiles, dispersed, hard
Dyess AFB, Abilene, Kans. One squadron—12 missiles, dispersed, hard
Walker AFB, Roswell, N.M. One squadron—12 missiles, dispersed, hard
Plattsburgh AFB, Plattsburgh, N.Y. One squadron—12 missiles, dispersed, hard

←

An Atlas blasts off from a pad at Patrick AFB, Fla., in one of many successful shots of first operational U. S. ICBM.

MISSILES

service in mid-1961; Minuteman a year later. By 1965, the total of U.S. strategic missiles is expected to reach more than 1000—not counting air-launched Hound Dogs and Sky Bolts.

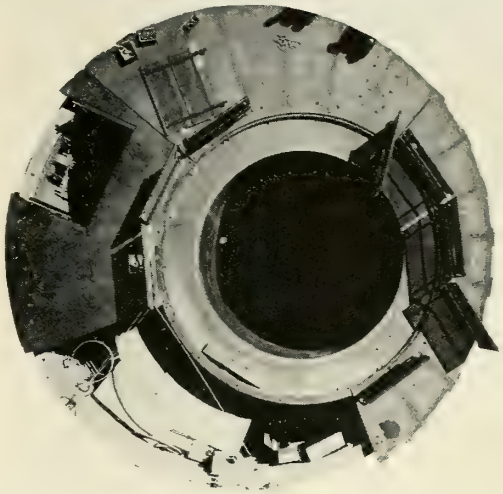
Two major trends have emerged: American strategic power is being vested mainly in mobile systems and large numbers of extremely hard, fixed bases that are widely dispersed. Which approach will be the dominant one was still to be determined at the beginning of the summer of 1960.

The Navy continued to press for the construction of a fleet of 45 Polaris-launching submarines, but the Administration maintained its position that if all tests proved to be successful 1961 would be time enough to accelerate the sub-building program. Meantime, the Air Force received authority to enlarge somewhat six Atlas squadrons and pushed ahead with its Minuteman and Sky Bolt programs.

Mobility vs. Fixed Bases remained a problem for the new Administration.

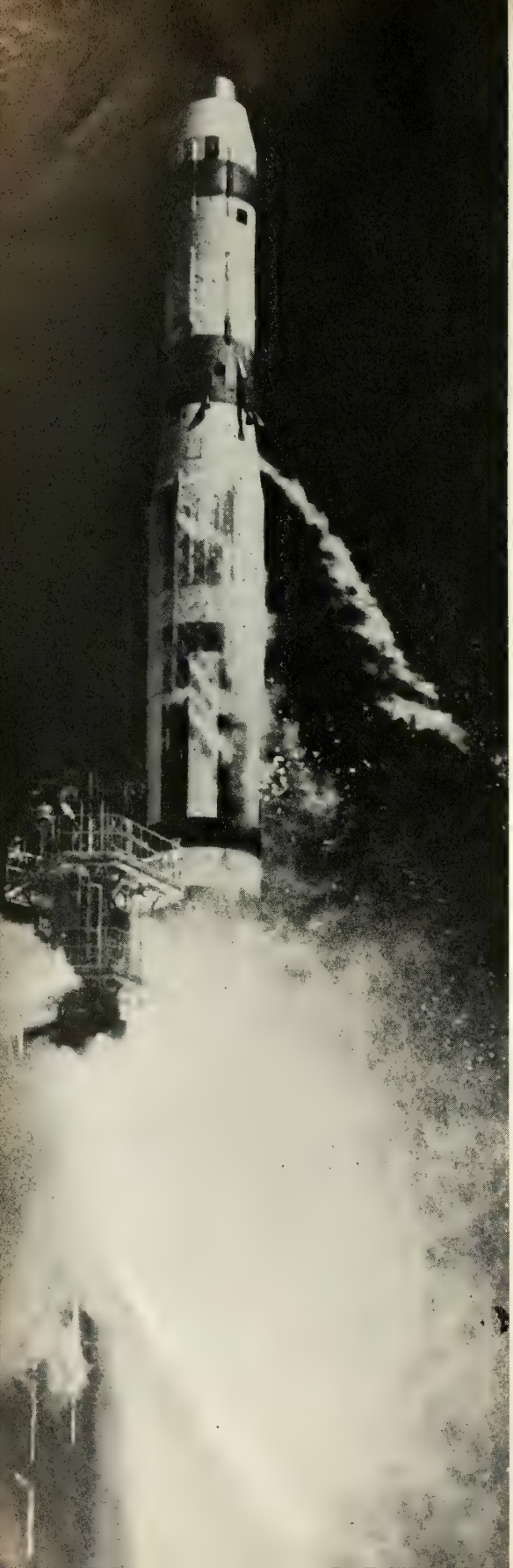
MINUTEMAN (Air Force)

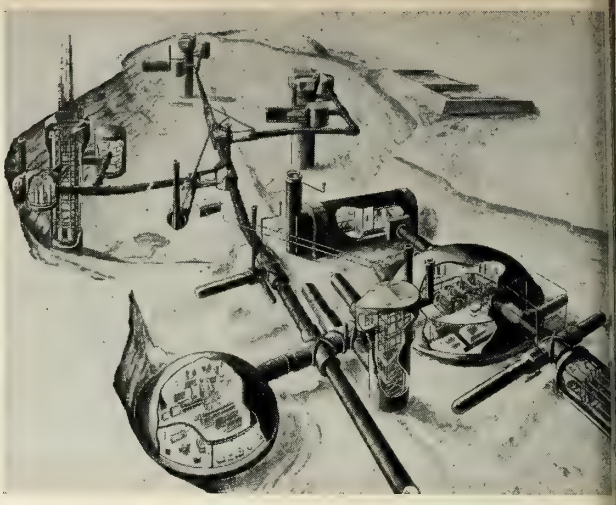
Military designation: SM-80
Type: ICBM surface-to-surface (fixed base and mobile)
Status: R&D
Major contractor: Boeing Airplane Co.
Performance: Range—5500 n. miles. Speed—more than 15,000 mph. Apogee—about 600 miles.
Deployment: Squadrons planned—about 14 (9 in fixed bases and about 5 on trains). Squadron strength—about 50 in silo-based units and 30 to 50 in train-based units. Trains per squadron—10. Initially operational—mid-1962. Total number of missiles—about 600. Squadron locations — Malmstrom AFB, Great Falls, Mont. (3 squadrons dispersed, hard, in-silo launched).
Frame: System contractor—Boeing. Length—about 60 ft. Diameter—about 6 ft. Launch weight—about 65,000 lbs. Material (major)—steel (first two stages), titanium or plastic (third stage).
Guidance: System contractor—Autonetics. Type—all inertial.
Booster: System contractor—Thiokol. Propellant — solid. Thrust—about 160,000 lbs.
Second stage: System contractor—Aerojet-General. Propellant—solid.
Third stage: System contractor—Aerojet or Hercules Powder. Propellant—solid.
Re-entry vehicle: System contractor — Avco. Warhead type—nuclear.
Ground support equipment: Launcher—Boeing. Handling and service—Boeing. Transport vehicles—Boeing.



ABOVE: Looking down the throat of a Minuteman test silo.
BELOW: Full-scale Minuteman silo test missile on Trailer.







Operational base for Titan shown in an artist's cutaway conception. There will eventually be 10 such bases, 14 squadrons.

TITAN (Air Force)

Military designation: SM-68
Type: ICBM surface-to-surface (fixed base)
Status: R&D
Prime contractor: Martin Co.
Performance: Range—more than 5500 n. miles. Speed—1700 mph. Ceiling—about 600 miles.
Frame: System contractor—Martin. Length—98 ft. Diameter (max.)—10 ft. Launch weight—220,000 lbs. Material (major)—2014K aluminum.
Guidance: System contractor—Bell Telephone Laboratories/Sperry-Rand, A. C. Spark Plug. Type—radio inertial first six squadrons; later squadrons all inertial.
Booster: System contractor—Aerojet General. Propellant—LOX and RP-1. Thrust—300,000 lbs.
Sustainer: System contractor—Aerojet General. Propellant—LOX and RP-1. Thrust—80,000 lbs.
Re-entry vehicle: System contractor — Avco. Warhead type—nuclear.
Ground support equipment: Launcher—Martin. Fueling—Air Products/Cambridge Corp. Handling and service—Martin. Transport vehicles—North American Aviation, Douglas.
Remarks: Longer range Titan II will have a storable propellant and will be launched from its underground silo. Titan II will be deployed with Squadron 7.

DEPLOYMENT

Squadrons planned: 14
Bases planned: 10
Squadron strength: 9 missiles
Initially operational: July 1961
Total number of missiles: 126

Squadron Locations

Lowry AFB, Denver, Colo. Two squadrons — semi-dispersed, hard, elevated to surface for launching.
Ellsworth AFB, Rapid City, S.D. One squadron — semi-dispersed, hard, elevated to surface for launching.
Mountain Home AFB, Mountain Home, Idaho. One squadron—semi-dispersed, hard, elevated to surface for launching
Larson AFB, Moses Lake, Wash. One squadron — semi-dispersed, hard, elevated to surface for launching
Beale AFB, Marysville, Calif. One squadron — semi-dispersed, hard, elevated to surface for launching
Davis-Monthan AFB, Tucson, Ariz. Two squadrons—dispersed, hard, in-silo launched
McConnell AFB, Wichita, Kans. Two squadrons — dispersed, hard, in-silo launched
Little Rock AFB, Little Rock, Ark. Two squadrons—dispersed, hard, in-silo launched

←

Titan takes off from its launching facility at Patrick AFB.

POLARIS (Navy)

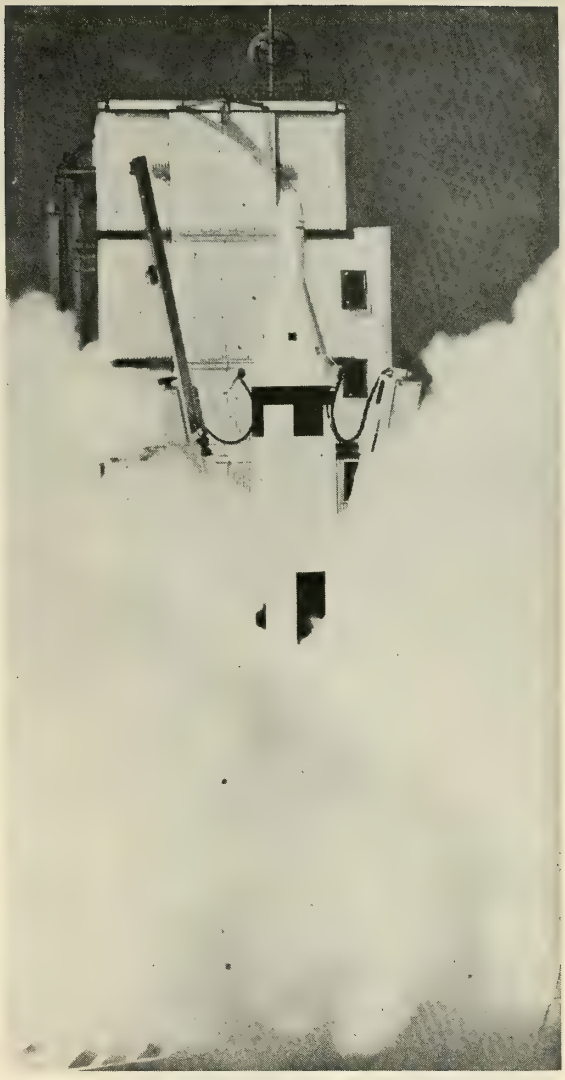
Military designation: FBM
Type: Submarine or surface ship-launched IRBM surface-to-surface (mobile)
Status: R&D
Prime contractor: Lockheed Missile Systems Division, Lockheed Aircraft Corp.
Performance: Range—1200 n. miles. Speed—about 8000 mph. Apogee—about 400 miles.
Frame: System contractor—Lockheed. Length—28 ft. Diameter—4.5 ft. Launch weight—28,000 lbs. Material (major)—steel
Guidance: System contractor—General Electric/MIT. Type—all inertial.
Booster: System contractor—Aerojet-General. Propellant—solid. Thrust—about 100,000 lbs.
Sustainer: System contractor—Aerojet-General. Propellant—solid.
Fire control: System contractor—General Electric.
Navigation: System contractor—Sperry-Gyroscope/Autonetics. Type—inertial (SINS).
Re-entry vehicle: System contractor—Lockheed. Warhead type—nuclear.
Ground support equipment: Launcher — Westinghouse. Handling and service—Westinghouse, Lockheed. Transport vehicles—Lockheed.
Remarks: Advanced 1500 n. mile and 2500 n. mile models under development. NATO nations may purchase for deployment as land-based NATO IRBM.

DEPLOYMENT

Missile-launching nuclear-powered submarines planned: about 45.
Submarines authorized part or whole: 21
Missiles per submarine: 16
Initially operational: Fall, 1960.
Total number of missiles (authorized): 336.

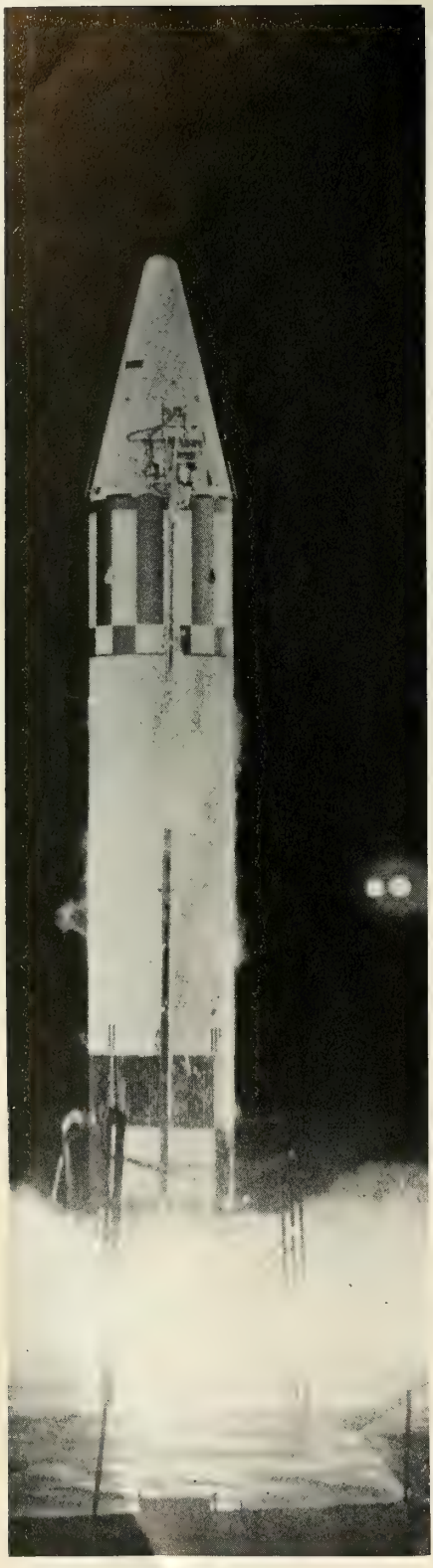
Polaris Submarines

George Washington 380 ft. 5600 tons commissioned 1960 Electric Boat
Patrick Henry 380 ft. 5600 tons commissioned 1960 Electric Boat
Theodore Roosevelt 380 ft. 5600 tons commissioned 1960 Mare Island
Robert E. Lee 380 ft. 5600 tons commissioned 1960 Newport News Ship
Abraham Lincoln 380 ft. 5600 tons commissioned 1960 Portsmouth Naval
Ethan Allen 410 ft. 6900 tons launching 1960 Electric Boat
Sam Houston 410 ft. 6900 tons launching 1961 Newport News Ship
Thomas A. Edison 410 ft.. 6900 tons launching 1961 Electric Boat
John Marshall 410 ft. 6900 tons launching 1961 Newport News Ship
Administration plans call for laying three more keels in FY 1961



ABOVE: A land based launching of a Polaris test vehicle.
BELOW: Nuclear-powered Patrick Henry, second Polaris sub.





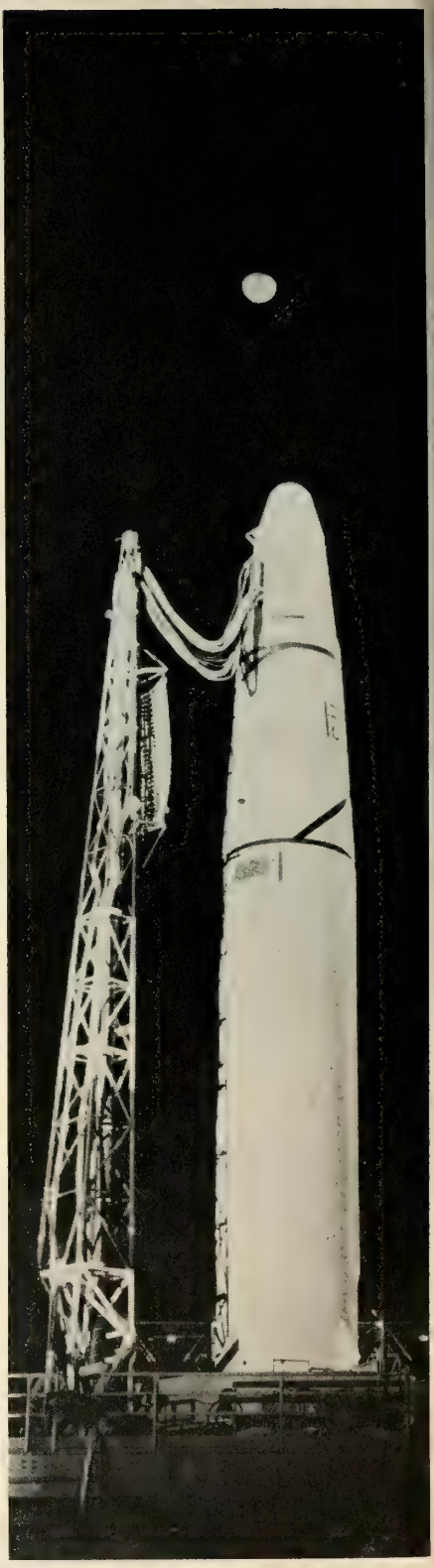
JUPITER

JUPITER
(Air Force-Army)

Military designation: SM-78
Type: IRBM surface-to-surface (fixed base or mobile)
Status: Operational
Prime contractor: Chrysler Corp.
Performance: Range—1500 n. miles. Speed—10,000 mph. Apogee—380 miles.
Deployment: Location—Italy and Turkey. Initially operational in Italy and Turkey—1960. Total squadrons planned—two in Italy; one in Turkey. Total bases—three. Squadron strength—15 missiles. Total missiles—15.
Frame:. System contractor—Chrysler. Length—58 ft. Diameter—8.75 ft. Launch weight—105,000 lbs. Material (major)—aluminum.
Guidance: System contractor—Ford Instrument. Type—all inertial.
Booster: System contractor—North American Aviation. Propellant—LOX and kerosene. Thrust—150,000 lbs.
Re-entry vehicle: System contractor—Goodyear/C.T.L. Warhead type—nuclear.
Ground support equipment: Launcher—Chrysler. Fueling—Chrysler. Handling and service—Chrysler. Transport vehicles—Chrysler.
Remarks: Jupiter was developed by the Army Ballistic Missile Agency and turned over to the Air Force for operational deployment.

THOR
(Air Force)

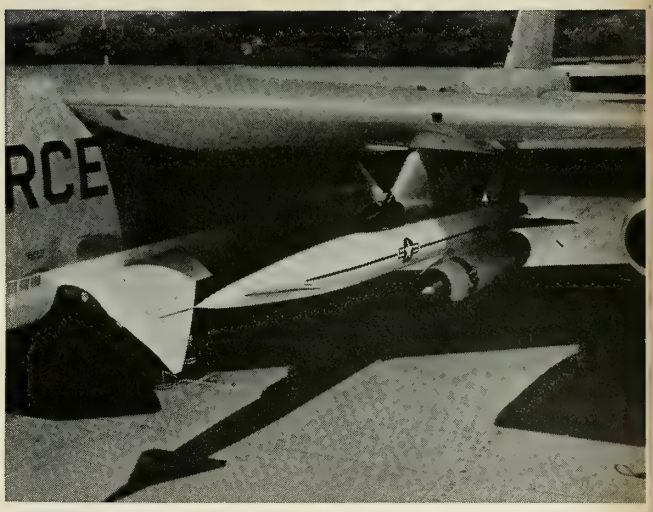
Military designation: SM-75
Type: IRBM surface-to-surface
Status: Operational
Prime contractor: Douglas Aircraft Co., Inc.
Performance: Range—1500 n. miles. Speed—10,000 mph. Apogee—about 400 miles.
Deployment: Location—Great Britain (military); Vandenberg AFB and Cape Canaveral (R&D and training). Initially operational in England—1959. Total squadrons—four. Total bases—four. Squadron strength—15 missiles. Total missiles deployed—60.
Frame: System contractor—Douglas. Length—65 ft. Diameter—8. Launch weight—110,000 lbs. Material (major)—aluminum.
Guidance: System contractor—A.C. Spark Plug. Type—all inertial.
Booster: System contractor—Rocketdyne. Propellant—LOX and JP4. Thrust—150,000 lbs.
Re-entry vehicle: System contractor—General Electric. Warhead type—nuclear.
Ground support equipment: Launcher—Food Machinery. Fueling—Daco. Transport vehicles—Fruehauf.



THOR

HOUND DOG (Air Force)

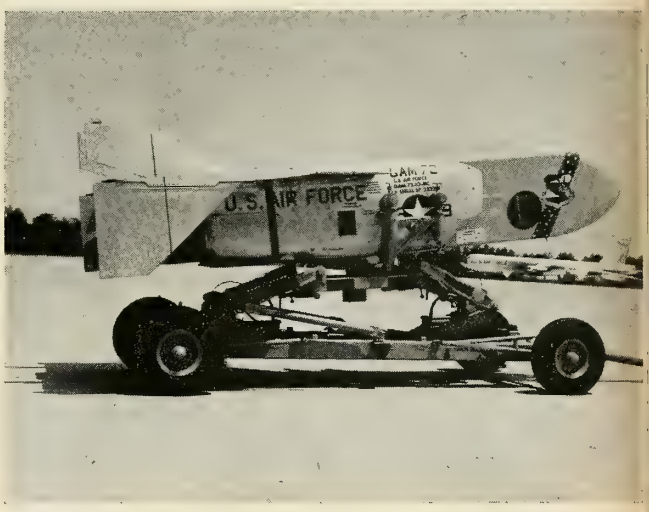
Military designation: GAM-77
Type: Air-breathing air-to-surface
Status: Operational
Prime contractor: North American Aviation, Inc.
Performance: Range—more than 500 n. miles. Speed—about Mach 2. Apogee — air-breather.
Deployment: Location—SAC B-52 bases in U.S. and overseas. Initially operational—1960. Total deployed missiles—expected to exceed 400.
Frame: System contractor—North American. Length—42.5 ft. Diameter—28 in. Wing span—12 ft. Launch weight—about 10,000 lbs.
Guidance: System contractor—Autonetics. Type—all inertial.
Powerplant: System contractor—Pratt & Whitney. Engine—J-52 turbo-jet. Thrust—7500 lbs.
Re-entry vehicle: Type warhead—nuclear.
Remarks: Hound Dog was developed as an interim weapon for use while the Air Force is developing the far superior Sky Bolt.



HOUND DOG

QUAIL (Air Force)

Military designation: GAM-72
Type: Air-launched missile ECM decoy
Status: R&D
Prime contractor: McDonnell Aircraft Co.
Performance: Range—about 200 n. miles. Speed—near sonic. Ceiling—more than 50,000 ft.
Deployment: Location—SAC air bases. Initially operational—1960.
Frame: System contractor—McDonnell. Length—13 ft. Wing span—65 in. Launch weight—about 1100 lbs. Material (major)—reinforced plastics.
Guidance: System contractor—Summers Gyro. Type—gyro autopilot.
Powerplant: System contractor—General Electric. Engine—J85-7 turbo-jet. Thrust—2000 lbs.
Payload: System contractor—Ramo-Wooldridge. Type—electronic counter measures.
Ground support equipment: System contractor—Bell Aircraft.
Remarks: Quail is designed to serve a dual role as a decoy for a strategic bomber and as a vehicle to carry ECM equipment.



QUAIL

SKY BOLT (Air Force)

Military designation: GAM-87A
Type: air-to-surface ballistic missile (ALBM)
Status: R&D
Prime contractor: Douglas Aircraft Co.
Performance: Range—1000 n. miles. Speed—hypersonic.
Deployment: Location — SAC and TAC air bases. Also RAF bases in England. (Sky Bolts to be launched from variety of aircraft besides bombers—particularly tankers and transports.) Initially operational—about 1964.
Frame: System contractor—Douglas.
Guidance: System contractor—Nortronics. Type—stellar-inertial.
Booster: System contractor—Aerojet. Propellant—solid.
Sustainer: System contractor—Aerojet. Propellant—solid.
Re-entry vehicle: System contractor — General Electric. Warhead type—nuclear.



SKY BOLT

SLAM (Air Force)

Type: Intercontinental nuclear-powered missile
Status: Study
Prime contractor: No contractor announced
Performance: Range—global. Speed—supersonic. Ceiling—low altitude.
Sustainer: System contractor—R&D being conducted by the Atomic Energy Commission, N.A.A. International and Marquardt (Project Pluto). Engine—nuclear-powered ramjet.
Payload: Warhead type—nuclear.
Remarks: Convair, North American and Chance Vought are principal competitors in studies submitted to the Air Force.



REGULUS I



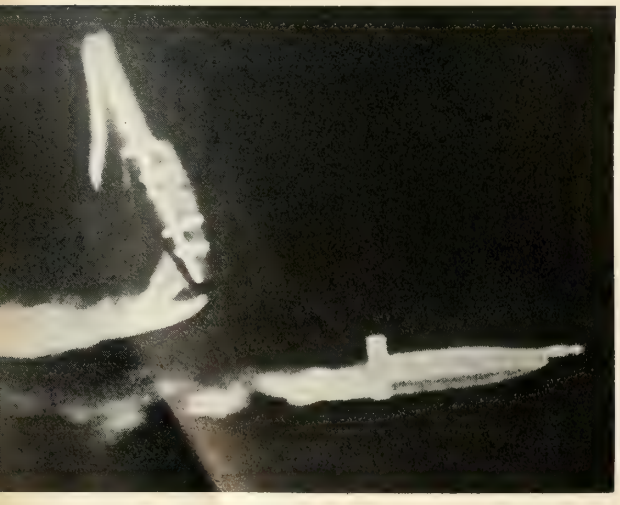
REGULUS II

REGULUS I (Navy)

Military designation: SSM-N-8
Type: Air-breathing surface-to-surface (seaborne)
Status: Operational
Prime contractor: Chance Vought Aircraft, Inc.
Performance: Range—500 n. miles. Speed—about 600 mph. Ceiling—about 40,000 ft.
Deployment: Location—aboard five submarines (Growler Barbero, Grayback, Tunny and nuclear-powered Halibut) and two cruisers (Los Angeles and Helena). Initially operational—1954.
Frame: System contractor—Chance Vought. Length—34 ft. Diameter—4.5 ft. Wingspan—21 ft. Launch weight—14,000 lbs. Material (major)—aluminum.
Guidance: System contractor—Sperry. Type—radio command.
Booster: System contractor—Aerojet. Propellant—solid. Number—two. Thrust—33,000 lbs. each.
Sustainer: System contractor—Allison. Engine—J33-18 turbo-jet. Thrust—4600 lbs.
Payload: Warhead type—nuclear.
Ground support equipment: Launcher—Fruehauf. Fueling—Chance Vought. Handling and service—Chance Vought. Transport vehicles—Fruehauf.
Remarks: Last of more than 500 Regulus I's were delivered in 1958. Production terminated. Warhead considered large.

REGULUS II (Navy)

Military designation: SM-N-9A
Type: Air-breathing surface-to-surface (seaborne)
Status: Operational as target drone.
Prime contractor: Chance Vought Aircraft, Inc.
Performance: Range—more than 800 n. miles. Speed—more than Mach 2. Ceiling—more than 65,000 ft.
Deployment: Location—PMR, Point Mugu, Calif., and Eglin Test Range, Fla. Initially operational: March, 1959. Total squadrons planned: Two.
Frame: System contractor—Chance Vought. Length—59.5 ft. Diameter: 50 in. Wingspan—20 ft. Launch weight—up to 30,000 lbs. Material (major) aluminum.
Guidance: System contractor—Bell. Type—radio command.
Booster: System contractor—Aerojet and Rocketdyne. Propellant—solid. Thrust—115,000 and 130,000 lbs.
Sustainer: System contractor—General Electric. Engine—J-79-3 turbo-jet. Thrust—more than 10,000 lbs.
Payload: Warhead type for military version—nuclear.
Ground support equipment: Launcher—Fruehauf. Fueling—Chance Vought. Handling and service—Chance Vought. Transport vehicles—Fruehauf.
Remarks: The Navy cancelled the Regulus II weapon system in December, 1958, on grounds that the missile had become obsolescent. The missile was in production.



SNARK

SNARK (Air Force)

Military designation: SM-62
Type: Air-breathing intercontinental guided missile
Status: Operational
Prime contractor: Northrop Corp.
Performance: Range—5500 n. miles. Speed—Mach 0.94. Ceiling—more than 50,000 ft.
Deployment: Location—702nd Strategic Missile Wing, Presque Isle, Maine. Initially operational—1959. Total squadrons planned—one. Total bases planned—one. Squadron strength—about 15.
Frame: System contractor—Northrop. Length—67.2 ft. Diameter—five ft. Wing span—42 ft. Launch weight—59,936 lbs. Material (major)—aluminum.
Guidance: System contractor—Northrop. Type—stellar-inertial.
Booster: System contractor—Allegany Ballistic Lab. Type—solid. Number—two. Thrust—33,000 lbs. each.
Sustainer: System contractor—Pratt & Whitney. Engine—J-57 turbojet. Thrust—10,500 lbs.
Payload: Warhead type—nuclear.
Ground support equipment: Launcher—Northrop. Fueling—Northrop. Handling and service—Northrop. Transport vehicles—Northrop.
Remarks: Capable of carrying very large warhead.

TACTICAL MISSILES

The development of advanced tactical missiles with ranges from several miles to 1000 miles is expected to call on the best talent of the Missile/Space Industry in the 1960's.

New tactical missiles already are revolutionizing military thinking.

The individual soldier of the very near future will have tremendous power in his hands with the deployment of nuclear-tipped Davy Crocketts. Highly mobile Little Johns and Sergeants will give the infantryman artillery support that will be far more powerful and effective than anything ever seen on a battlefield.

At the same time, the stand-off air-to-surface missile is expected to extend the life of military planes into the late 1960's. Such missiles as Corvus and Bullpup will enable aircraft to strike at heavily-defended targets that it would be nearly certain death to attack.

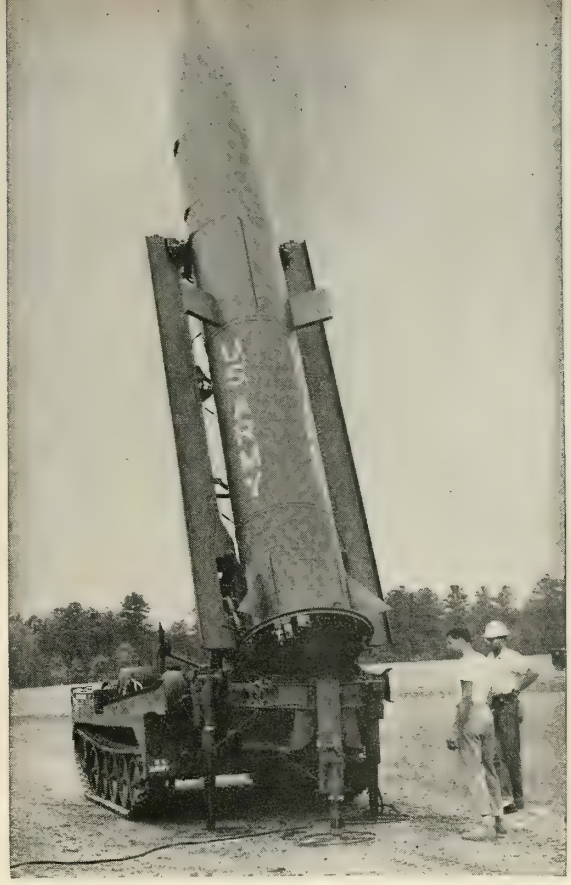
SURFACE-TO-SURFACE

PERSHING (Army)

Type: Surface-to-surface
Status: R&D
Prime contractor: The Martin Co.
Performance: Range—350 n. miles. Speed—supersonic.
Deployment: Location—to replace Redstone. Initially operational: about late 1961.
Frame: System contractor—Martin. Length—about 32 ft. Diameter—40 in.
Guidance: System contractor—Bendix. Type—inertial.
Booster: System contractor—Thiokol. Propellant—solid.
Sustainer: System contractor—Thiokol. Propellant—solid.
Payload: Warhead type—nuclear.
Ground support equipment: Transporter-erector-launcher—Thompson-Ramo Wooldridge. Handling and services—Vehicles—Food Machinery.
Remarks: Range could be greatly increased if desired. First R&D launching Feb. 25, 1960 from Cape Canaveral, Fla.

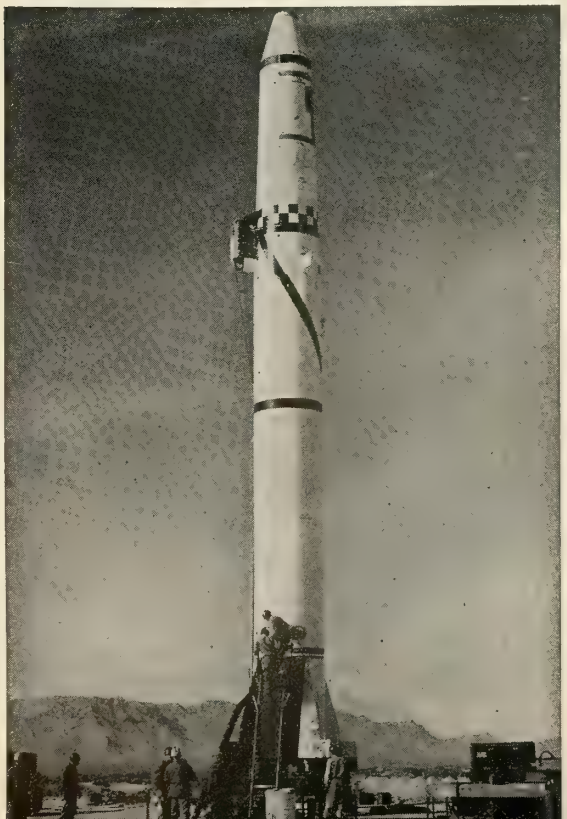
REDSTONE (Army)

Military designation: SXXM-A14
Type: Surface-to-surface
Status: Operational
Prime contractor: Chrysler Corp.
Performance: Range—200 n. miles. Speed—3800 mph. Apogee—55 miles.
Deployment: Location—U.S. troops in Germany. Initially operational—1958.
Frame: System contractor—Reynolds Metals. Length—70 ft. Diameter—5.5 ft. Launch weight—62,000 lbs. Material (major)—aluminum.
Guidance: System contractor—Ford Instrument. Type—inertial.
Booster: System contractor—North American Aviation. Propellant—Thrust—78,000 lbs.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—Chrysler. Fueling—Chrysler. Handling and service—Chrysler. Transport vehicles—Chrysler.
Remarks: To be replaced by Pershing. Redstones are to be used in the Mercury program by NASA for early equipment test flights.



PERSHING

REDSTONE

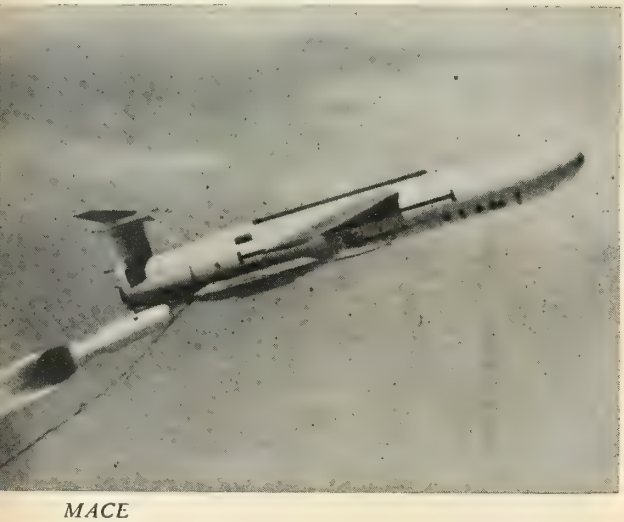




MATADOR

MATADOR (Air Force)

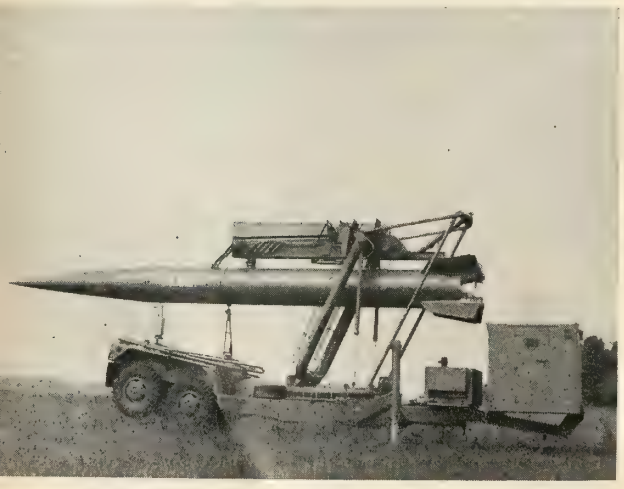
Military designation: TM-61C
Type: Air-breathing surface-to-surface
Status: Operational
Prime contractor: The Martin Co.
Performance: Range—500 n. miles. Speed—about 650 mph. Ceiling—more than 40,000 ft.
Deployment: Location — U.S. troops in West Germany, Far East. Also in hands of NATO allies. Initially operational: October, 1951. Total divisions—three. Divisional strength—about 50.
Frame: System contractor—Martin. Length—39.6 ft. Diameter—54 in. Wingspan—28.7 ft. Launch weight—12,500 lbs. Material (major)—aluminum and magnesium.
Guidance: System contractor—Air Force. Type—radar control
Booster: System contractor—Thiokol. Propellant — solid (JATO). Thrust—57,000 lbs.
Sustainer: System contractor—Allison. Engine—J-33-37 turbo jet. Thrust—4200 lbs.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—Martin. Fueling—Martin. Handling and service—Martin. Transport vehicles—Martin.
Remarks: Relatively mobile Matadors are being replaced by more advanced Maces. Matadors in West Germany are being turned over to German troops.



MACE

MACE (Air Force)

Military designation: TM-76A and TM-76B
Type: Air-breathing surface-to-surface
Status: TM-76A operational. TM-76B flight-testing.
Prime contractor: The Martin Co.
Performance: Range—(A) more than 650 n. miles. (B) more than 1200 n. miles. Speed—(A) more than 650 mph. (B) same but supersonic in terminal dive. Ceiling—more than 40,000 ft.
Deployment: Location—(A) U.S. troops in West Germany. Initially operational—(A) 1960. Total divisions—at least two. Divisional strength—about 50.
Frame: System contractor—Martin. Length—44 ft. Diameter—54 in. Wingspan—22.9 ft. Launch weight—15,500 lbs. Material (major)—aluminum and magnesium
Guidance: System contractor—(A) Goodyear. (B) A.C. Spark Plug. Type: (A) ATRAN map-matching. (B) inertial.
Booster: System contractor—Thiokol. Propellant — solid (JATO). Thrust—100,000 lbs.
Sustainer: System contractor—Allison. Engine — J-33-41. Thrust—5200 lbs.
Ground support equipment: Launcher—(A) Goodyear. (B) Martin. Fueling—Martin. Handling and service—(A) Goodyear, Martin, Four Wheel Drive Auto Co. (B) Martin, A.C. Spark Plug. Transport vehicles—(A) Four Wheel Drive. (B) Martin.



SERGEANT

SERGEANT (Army)

Military designation: SSM-A26
Type: Surface-to-surface
Status: Nearly operational
Prime contractor: Sperry Utah Engineering Lab.
Performance: Range—75 miles. Speed—supersonic.
Deployment: Location—to replace Corporal. Initially operational—1960.
Frame: System contractor—Sperry. Length—36 ft. Diameter—31 in. Launch weight—10,000 lbs. Material (major) — steel and aluminum.
Guidance: System contractor—Sperry. Type—inertial.
Booster: System contractor—Sperry. Propellant—solid. Thrust—about 55,000 lbs.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—AMF. Fueling—Thiokol. Handling and service—Sperry. Transport vehicles—Fruehauf.

CORPORAL (Army)

Military designation: M-2
Type: Surface-to-surface
Status: Operational
Prime contractor: Firestone Tire & Rubber Co./Gilfillan Bros.
Performance: Range—75 miles. Speed—Mach 3.
Deployment: Location — U.S. troops in Europe. Battalion strength—two launchers; two batteries (one firing, the other service). Initially operational—late 1953.
Frame: System contractor—Firestone. Length—45 ft. Diameter—30 in. Launch weight—11,000 lbs. Material (major)—steel.
Guidance: System contractor—Gilfillan. Type—preset and command.
Booster: System contractor—Ryan. Propellant—nitric acid and aniline.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—Firestone. Fueling—Firestone. Handling and service—Firestone.
Remarks: To be replaced by the solid-propelled Sergeant.



CORPORAL



HONEST JOHN

HONEST JOHN (Army)

Military designation: M-31
Type: Surface-to-surface
Status: Operational
Prime contractor: Douglas Aircraft Co./Emerson Electric
Performance: Range—12 miles. Speed—Mach 1.7.
Deployment: Location — U.S. forces in continental United States, Europe and the Far East. Also in the hands of U.S. NATO allies. Initially operational—late 1953. Battalion strength—four launchers.
Frame: System contractor—Douglas/Emerson. Length—27 ft. Diameter—30 in. Launch weight—5800 lbs. Material (major) steel.
Guidance: Type—free-flight ballistic missile.
Booster: System contractor—Hercules Powder. Propellant—solid.
Spin rockets: System contractor—Thiokol. Propellant—solid.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—Rock Island Arsenal.
Remarks: Douglas is producing an Improved Honest John made of aluminum with a solid booster manufactured by Allegany Ballistic Lab. The improved version has a range of more than 12 miles, weighs 1000 lbs. less and is three inches shorter.

LITTLE JOHN (Army)

Military designation: M-51
Type: Surface-to-surface
Status: Operational
Prime contractor: Emerson Electric Co.
Performance: Range—10 miles. Speed—supersonic.
Deployment: Location—missile in hands of training units in the United States. Initially operation—1960. Battalion strength—four launchers.
Frame: System contractor—Emerson Electric. Length—14 ft. 5 in. Diameter—12.5 in. Launch weight—760 lbs. Material (major)—steel and aluminum.
Guidance: Type—free-flight ballistic missile.
Booster: System contractor—Army Ordnance Missile Command/Hercules Powder. Propellant—solid.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—Rock Island Arsenal.
Remarks: A highly mobile and easily airlifted missile.



LITTLE JOHN IV

LACROSSE (Army)

Military designation: M4E2
Type: Surface-to-surface
Status: Operational
Prime contractor: The Martin Co.
Performance: Range—20 miles. Speed—transonic.
Deployment: Location—Two U.S. battalions in West Germany; five more in training in the United States. Initially operational—1959. Total battalions—seven. Battalion strength—four mobile launchers.
Frame: System contractor—Martin. Length—19 ft. Diameter—20.5 in. Launch weight—2300 lbs.
Guidance: System contractor—Martin. Type—command.
Booster: System contractor—Thiokol. Propellant—solid.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher—Martin. Handling and service—Martin.



LACROSSE

DAVY CROCKETT (Army)

Military designation: XM-388
Type: Surface-to-surface
Status: Nearly operational
Prime contractor: Rock Island Ill. Arsenal
Performance: Launched from either two tube-shaped launchers (XM-28 and XM-29) of varying size for different ranges. Range is relatively short.
Deployment: Location—U.S. troops overseas and in continental United States; also NATO allies. Initially operational: about 1961.
Booster: Propellant—solid.
Payload: Warhead type—nuclear. (frational yield).
Remarks: Smaller launcher can be carried by two men. Crockett is inserted into its launcher in the same fashion as a rifle grenade. The warhead is larger than the tube.



DAVY CROCKETT

SHILLELAGH (Army)

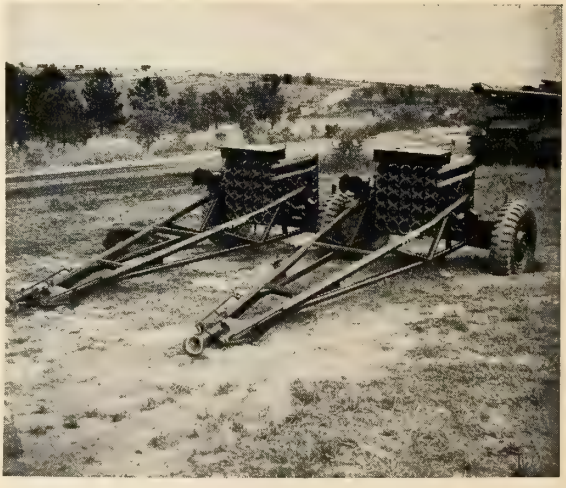
Type: Surface-to-surface
Status: R&D
Prime contractor: Ford Aeronutronics Div.
Performance: Designed to provide heavy firepower for close-in support of troops.
Deployment: Location—to be deployed with U.S. combat troops. Initially operational—mid-1960's.
Fire control: System contractor—Raytheon
Payload: Warhead type—nuclear.
Remarks: There will be hand-carried and vehicle mounted versions.

MISSILE A (Army)

Type: Surface-to-surface
Status: R&D
Prime contractor: None announced
Performance: Range—about 10-20 miles.
Frame: Launch weight—under 500 lbs.
Remarks: The Army Rocket and Guided Missile Agency at Huntsville, Ala., is acting as systems manager for a series of components that have been under development.

M-55 (Army)

Type: Surface-to-surface
Status: Operational
Prime contractor: Norris Thermador Co.
Performance: Range—relatively short. Launched from 45-tube T-145 launcher.
Deployment: Location—U.S. combat troops in the United States and overseas. Initially operational: 1960.
Frame: Diameter—115 mm.
Guidance: Type—free-flight.
Booster: Propellant—solid.
Payload: Warhead type—chemical agents.
Remarks: The Army in FY '61 is planning to buy more than 100,000 M-55's with an undisclosed number of launchers.

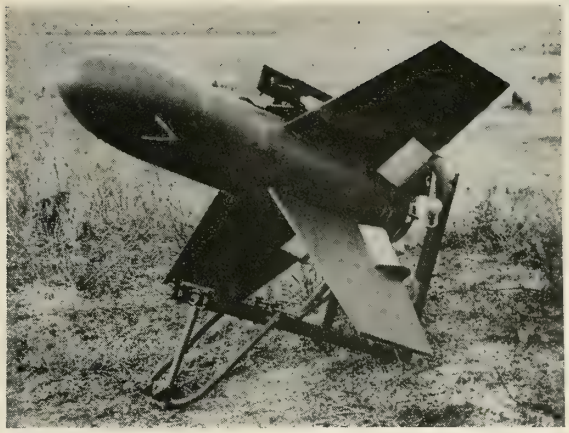


ARMY MULTIPLE ROCKET LAUNCHERS

ANTI-TANK

SS-10 (Army)

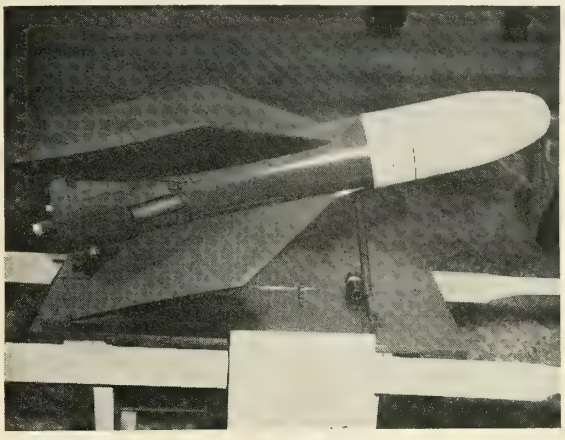
Type: Anti-tank
Status: Operational
Prime contractor: Nord Aviation, Paris, France; General Electric Co. (U.S. licensee)
Performance: Range—5250 ft. (effective). Speed—180 mph.
Deployment: Location—U.S. Army combat units (launched from jeeps, helicopters and other mobile vehicles). Also see Foreign Missiles section
Frame: System contractor—Nord (GE secondary source). Length—34 in. Diameter—six in. Wingspan—30 in. Launch weight—33 lbs.
Guidance: System contractor—Nord. Type—wire.
Booster: System contractor—Nord. Propellant—solid.
Payload: System contractor—Strim. Warhead type—armor-piercing HE.
Remarks: Initial U.S. Army procurement began in April, 1959. SS-10 can be carried and launched by one man.



SS-10

SS-11 (Army)

Type: Anti-tank
Status: Operational
Prime contractor: Nord Aviation, Paris, France
Performance: Range—1650-11,500 ft. (effective). Speed—more than 400 mph.
Deployment: Location—under evaluation by Army units. Also see Foreign Missiles section.
Frame: System contractor—Nord. Length—46 in. Diameter—six in. Wingspan—20 in. Launch weight—62 lbs.
Guidance: System contractor—Nord. Type—wire.
Booster: System contractor—Nord. Propellant—solid.
Payload: System contractor—Strim. Warhead type—armor-piercing HE.



SS-11

COBRA (Marines)

Type: Anti-tank
Status: Operational
Prime contractor: Boelkow Entwicklungen, Munich, Germany, and Daystrom, Inc.
Performance: Range—5940 ft. (max.); 5280 ft. (effective). Speed—191 mph.
Deployment: Location—Marine evaluation units.
Deployment: Location—1st Marine Division, Camp Pendleton, Calif., and Marine Corps Landing Force Development Center, Quantico, Va., to conduct evaluation in 1960. Also see Foreign Missiles section
Frame: System contractor—Boelkow (Europe); not determined for U.S. Length—30.7 in. Diameter—3.9 in. Height—13.6 in. Wingspan—19 in. Launch weight—20.2 lbs. Material (major)—plastic
Guidance: System contractor—Boelkow (Europe); Daystrom (U.S.) Type—wire.
Booster: System contractor—Oerlikon (Europe). Not determined for U.S. Propellant—solid.
Payload: Warhead type—armor-piercing HE (5.5 lbs.)
Remarks: Missile can be launched and guided by one man.



COBRA



BULLPUPS ON NAVY FJ FURY

AIR-TO-SURFACE

BULLPUP (Navy and Air Force)

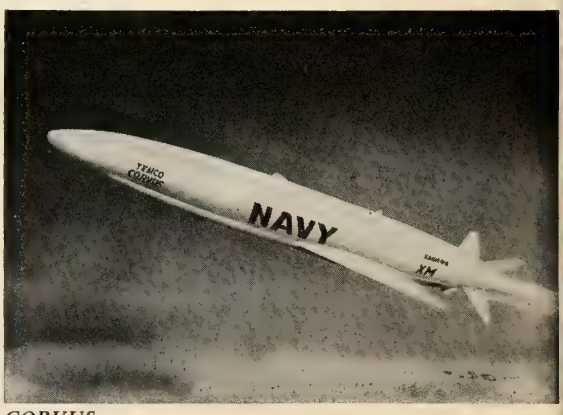
Military designation: ASM-N-7 and GAM-83A
Type: Air-to-surface
Status: Operational
Prime contractor: The Martin Co.
Performance: Range—three to six n. miles. Speed—supersonic.
Deployment: Location—U.S. carriers, Marine Corps units and the Tactical Air Command. Initially operational—April, 1959, aboard the Carrier Lexington.
Frame: System contractor—Martin. Length—11 ft. Diameter—about one ft. Launch weight—571 lbs. Material (major)—aluminum.
Guidance: System contractor—Martin. Type—command (visual reference).
Booster: System contractor—Allegany Ballistics Lab and Thiokol. Type—solid and packaged liquid (Guardian).
Payload: Warhead type—HE (250-1000 lb.) or nuclear.
Remarks: The Air Force originally planned a radically different version of Bullpup called White Lance, but switched to buying only slightly modified Bullpups. Bullpups are usually carried by tactical jet aircraft, but Marines also have fired a Bullpup from a helicopter.

CORVUS (Navy)

Military designation: XASM-N-8
Type: Air-to-surface
Status: Pre-operational testing
Prime contractor: Temco Aircraft Corp.
Performance: Range—more than 100 n. miles. Speed—supersonic.
Deployment: Location—designed for carrier-based aircraft. Initially operational—1960-61.
Frame: System contractor—Temco.
Guidance: System contractor—Maxson and Texas Instrument. Type—radar homing.
Booster: System contractor—Thiokol. Propellant—packaged liquid (Patriot).
Payload: Warhead type—HE or nuclear.
Remarks: First guided test flight March 15, 1960, from an A3D jet over PMR sea test area. Most information about Corvus classified, but missile is reported to be designed to penetrate highly defended areas by homing on electronic equipment such as radar.

ADVANCED TACTICAL MISSILES

Project	Contractors	Description	Status
ARM (Air Force)	No contracts announced	Air-to-surface anti-radar missile	R&D
COBRA (Navy)	No contracts announced	Anti-ship, anti-radar missile	R&D
CLAYMORE (Army)	No contracts announced	Anti-personnel missile	R&D
GPSSM (Army)	No contracts announced	General purpose surface-to-surface missile	Study
LOBBER (Army)	No contracts announced	Surface-to-surface cargo carrier; 10-15 m. range; also can drop napalm	Study
RAVEN (Navy)	No contracts announced	Air-to-surface; about 500 m. range	Study
WAGTAIL (Air Force)	Minneapolis-Honeywell-prime	Air-to-surface; solid propellant; designed to hug terrain	R&D
WILLOW (Army)	Chrysler, prime	No details available	



CORVUS

Air/Space Defense

A revolution in air defense missiles is coming quickly.

Such surface-to-air missiles as Nike-Hercules and Bo-arc, along with air-to-air missiles like Sidewinder and alcon continue to be America's main weapons against tacking aircraft.

But the emphasis is switching rapidly to defense against issiles and spacecraft.

So far, Nike-Zeus is the only U.S. anti-ICBM funded for ll development. But both the Army and Navy are work-g on tactical anti-missile missiles. And all three services e looking ahead beyond Zeus.

America must defend itself not only against incoming issiles but also against satellites and spacecraft.

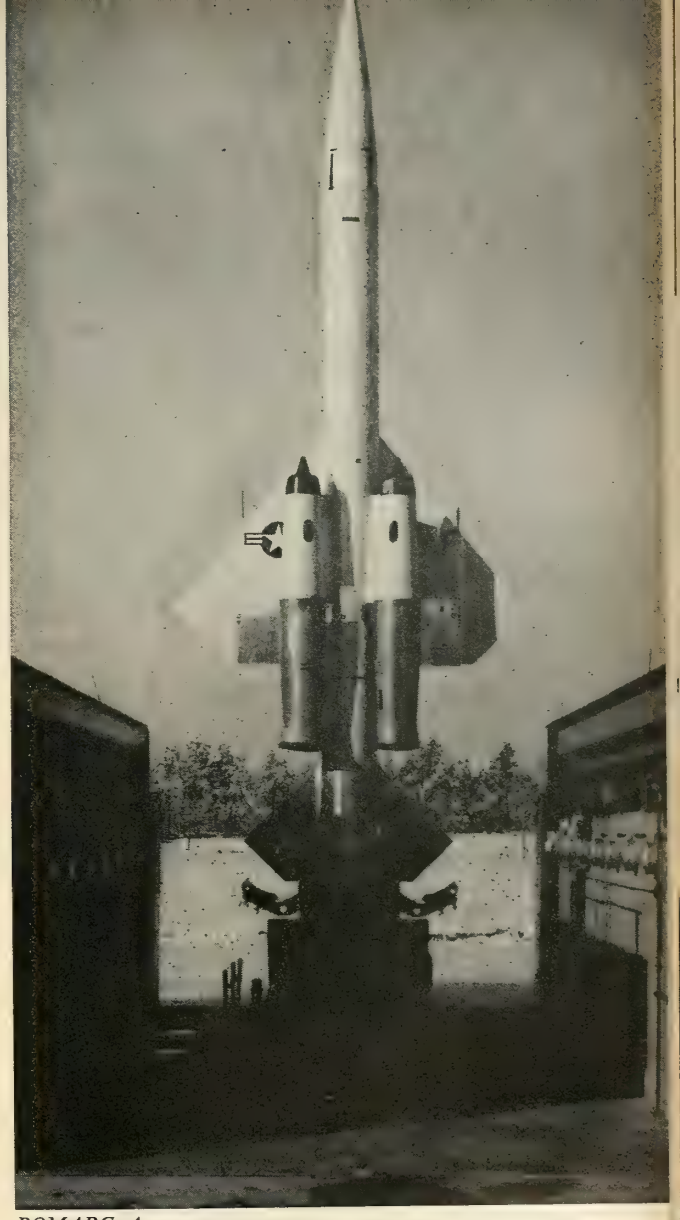
ANTI-AIRCRAFT

OMARC A (Air Force)

ilitary designation: IM-99A
ype: Air-breathing surface-to-air
atus: Operational
ime: Boeing Airplane Co.
erformance: Range—250 n. miles. Speed — supersonic. Ceiling—more than 68,000 ft.
eployment: Location—McGuire AFB, N.J.; Suffolk County AFB, N.Y.; Otis AFB, Mass.; Dow AFB, Maine; and Langley AFB, Va. Initially operational—1959. Total bases planned—five. Total squadrons planned—five. Squadron strength—average about 40 missiles.
rame: System contractor—Boeing. Length—47 ft. Diameter —35 in. Wingspan—18 ft. Launch weight—15,000 lbs. Material (major)—stainless steel.
Guidance: System contractor—IBM and Westinghouse. Type: command and homing radar. (IBM SAGE guides missile to vicinity of target when homing radar assumes command.)
Booster: System contractor—Aerojet. Propellant—liquid.
Sustainer: System contractor—Marquardt. Engine—(2) RJ-43 ramjets.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher-erector—Food Machinery.

BOMARC B (Air Force)

lilitary designation: IM-99B
ype: Air-breathing surface-to-air
tatus: R&D/production
erformance: Range—400 n. miles. Speed — supersonic. Ceiling—more than 70,000 ft.
eployment: Location — continental United States (Duluth, Minn.; Niagara Falls, N.Y.; Kincheloe AFB, Mich.) and Canada. Initially operational: Total squadrons — (U.S.) three: (Canada) two. Total bases planned—five. Squadron strength—average about 40 missiles.
rame: System contractor—Boeing. Length—45 ft. Diameter —35 in. Wingspan—18 ft. Launch weight—16,000 lbs. Material (major)—stainless steel.
Guidance: System contractor—IBM and Westinghouse. Type —command and radar homing. (IBM SAGE guides missile to vicinity of target when homing radar takes command.)
Booster: System contractor—Thiokol. Propellant—solid.
Sustainer: System contractor—Marquardt. Engine—(2) RJ-43 advanced ramjets.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launcher-erector—Food Machinery.
Remarks: Original number of squadrons planned was sharply cut.



BOMARC A

BOMARC A'S AT McGUIRE AFB, N. J.



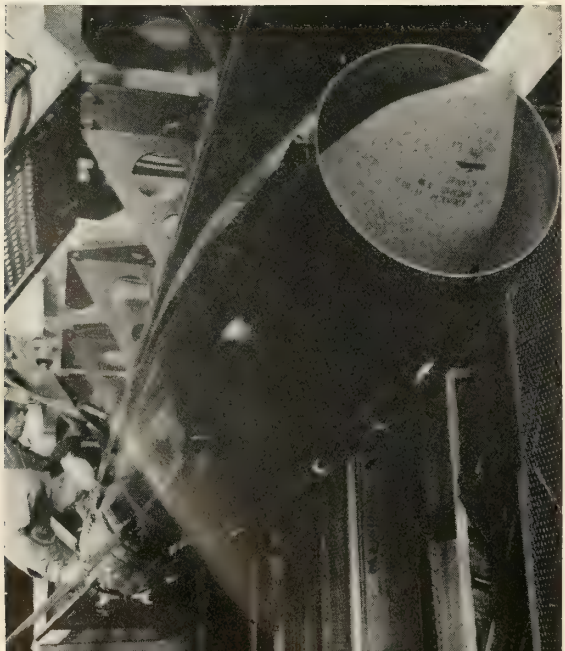


NIKE-AJAX



NIKE-HERCULES

TALOS



NIKE-AJAX (Army)

Military designation: SAM-A-7
Type: Surface-to-air
Status: Operational
Prime contractor: Western Electric Co.
Performance: Range—25 miles. Speed—Mach 2.5. Ceiling—60,000 ft.
Deployment: Location—United States, Western Europe, Far East. Initially operational—1953. Total battalions—about 40. Battalion strength—4 batteries. Battery strength—9 launchers. Total launchers—nearly 1500.
Frame: System contractor—Douglas. Length—31 ft. Diameter—12 in. Wingspan—52 in. Launch weight—2300 lbs. Material (major)—aluminum and steel.
Guidance: System contractor—Western Electric. Type—command.
Booster: System contractor—Thiokol. Propellant—solid.
Sustainer: System contractor—Thiokol. Propellant—liquid.
Payload: Warhead type—HE.
Ground support equipment: Launchers — Consolidated Western Steel. Transport vehicles—Fruehauf.
Remarks: Nike-Ajax is being replaced by the far more advanced Nike-Hercules.

NIKE-HERCULES (Army)

Military designation: SAM-A-25
Type: Surface-to-air (anti-missile capability)
Status: Operational
Prime contractor: Western Electric Co.
Performance: Range—more than 75 n. miles. Speed—Mach 3 plus. Ceiling—more than 150,000 ft.
Deployment: Location—United States, Western Europe, Far East. Initially operational—mid-1958. Total battalions—about 20. Battalion strength—4 batteries. Battery strength—9 launchers. Total launchers—more than 700.
Frame: System contractor—Douglas. Length—39 ft. Diameter—31.5 in. Wingspan—90 in. Launch weight—10,000 lbs. Material (major)—aluminum and steel.
Guidance: System contractor—Western Electric. Type—command.
Booster: System contractor—Hercules Powder. Propellant—solid.
Sustainer: System contractor—Thiokol. Propellant—solid.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launchers — Consolidated Western Steel. Transport vehicles: Fruehauf.
Remarks: New General Electric radars give Nike-Hercules the capability of intercepting incoming tactical missiles. The Army plans to install improved system in Europe and other appropriate areas. The Army also is expected to build mobile Nike-Hercules anti-missile batteries for deployment in the field.

TALOS (Navy)

Military designation: SAM-N-6
Type: Surface-to-air and surface-to-surface (Seagoing)
Status: Operational
Prime contractor: Bendix Aviation Corp. System engineer—Vitro Corp.
Performance: Range—more than 65 n. miles. Speed—about Mach 2.5. Ceiling—extremely high altitude.
Deployment: Location—aboard the Missile Cruiser Galveston. To be deployed aboard at least six more cruisers including the nuclear-powered Cruiser Long Beach. Initially operational—1959.
Frame: System contractor—McDonnell. Length—about 30 ft. Diameter—about 30 in. Launch weight—7000 lbs. (booster alone weighs 4000 lbs.) Material (major)—steel.
Guidance: System contractor—Bendix/Sperry. Type—beam riding.
Booster: System contractor—Allegany Ballistics Lab. Type—solid.
Payload: Warhead type—nuclear or HE.
Ground support equipment: Launchers—Naval Weapons Plant.
Remarks: Improvements in the Talos system have led to work on an anti-missile system called Typhon.



TERRIER



ADVANCED TERRIER

TERRIER (Navy)

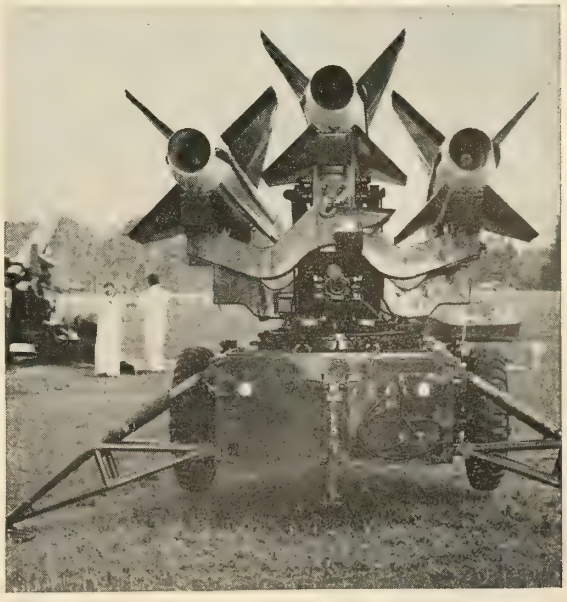
Military designation: SAM-N-7
Type: Surface-to-air (seagoing)
Status: Operational
Prime contractor: Convair Division, General Dynamics Corp. System engineer—Vitro Corp.
Performance: Range—about 10 n. miles. Speed—supersonic. Ceiling—more than 50,000 ft.
Deployment: Location—aboard U.S. destroyers, frigates and cruisers. Also used in a mobile version by Marines. Initially operational—1956.
Frame: System contractor—Convair. Length—29 ft. (with 15 ft. booster). Diameter—12 in. Launch weight—2500 lbs.
Guidance: System contractor—Reeves/FTL, Sperry. Type—radar beam rider.
Booster: System contractor—Allegany Ballistics Lab. Propellant—solid.
Sustainer: System contractor—Allegany Ballistics Lab. Propellant—solid.
Payload: Warhead type—HE.
Remarks: Terrier is being replaced by the Convair Advanced Terrier. The Advanced Terrier's performance is about 100% greater than Terrier's. The new Frigate Dewey is the first ship to be armed with Advanced Terrier.



TARTAR

TARTAR (Navy)

Military designation: Mark 15
Type: Surface-to-air (seagoing)
Status: Operational
Prime contractor: Convair Division, General Dynamics Corp. System engineer—Vitro Corp.
Performance: Range—more than 10 n. miles. Speed—supersonic. Ceiling—high-altitude.
Deployment: Location—to be installed aboard 21 destroyers and three cruisers. Initially operational—1960.
Frame: System contractor—Convair. Length—15 ft. Diameter—12 in. Launch weight—about 1500 lbs.
Guidance: System contractor—Raytheon.
Booster: System contractor—Aerojet. Propellant—solid.
Payload: Warhead type—HE.
Ground support equipment: Launcher — Puget Sound Naval Shipyard. Handling—Washington Technological Associates/Naval Weapons Plant.



HAWK

HAWK (Army)

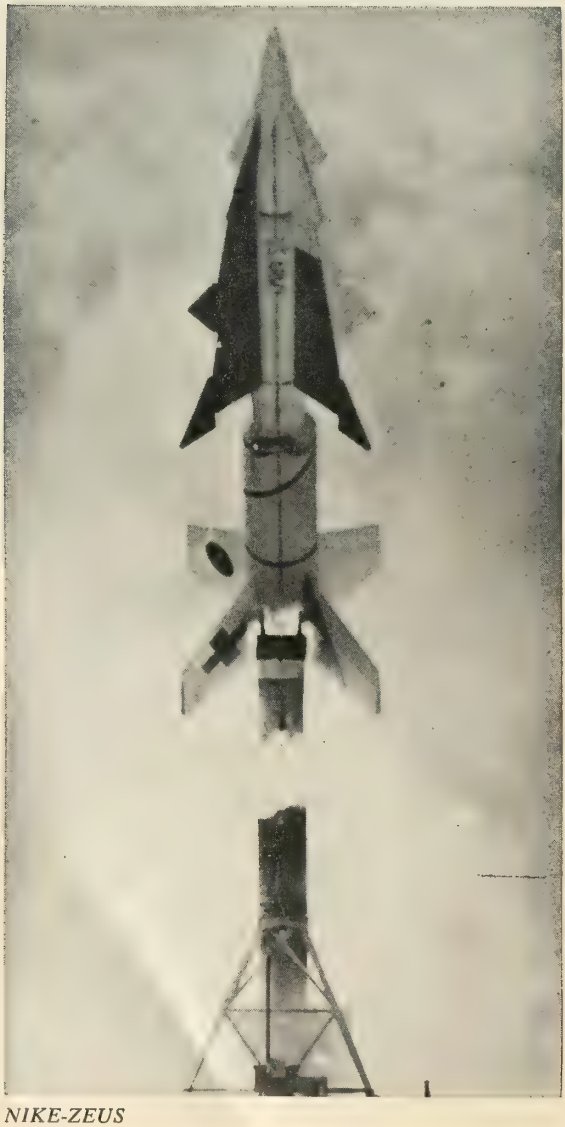
Military designation: XM3E1
Type: Surface-to-air
Status: Operational
Prime contractor: Raytheon Co.
Performance: Range—about 22 n. miles. Speed—Mach 2 plus. Ceiling—tree-top level to about 40,000 ft. (Hawk is specifically designed for use against low-flying aircraft.)
Deployment: Location — U.S. troops training with Hawks in the United States. Initially operational—1959. Battalions—two. Battalion strength—3 to 5 batteries. Battery strength—6 to 12 launchers (3 missiles per launcher). Also to be used by Marine Corps and NATO allies.
Frame: System contractor — Raytheon/Northrop, Temco. Length—17 ft. Diameter—14 in. Wingspan—48 in. Launch weight—1275 lbs. Material (major) — aluminum and steel.
Guidance: System contractor—Raytheon. Type—semi-active radar homing.
Booster: System contractor—Aerojet. Propellant—solid.
Sustainer: System contractor—Aerojet. Propellant—solid.
Payload: Warhead type—HE.
Ground support equipment: Launcher—Northrop. Handling and service—Raytheon, Northrop, Food Machinery and RCA. Transport vehicles—Food Machinery.
Remarks: Although Hawk is not an anti-missile missile, it has successfully intercepted an Honest John in a test. Hawk is highly mobile.

REDEYE (Army)

Type: Surface-to-air (shoulder-launched)
Status: Nearly operational
Prime contractor: Convair Division, General Dynamics Corp.
Performance: Designed to intercept low-flying jet aircraft. One man can operate and carry.
Deployment: Location—to be deployed with Army and Marine combat troops. Initially operational—late 1960.
Frame: System contractor—Convair. Length—4 ft. Diameter—3 in. Launch weight—20 lbs.
Guidance: System contractor—Philco/Convair. Type—Infrared.
Booster: System contractor—Atlantic Research. Propellant—solid.
Payload: Warhead type—HE.
Remarks: Redeye is shipped, carried and launched from a disposable bazooka-shaped container.



REDEYE



NIKE-ZEUS

ANTI-MISSILE

NIKE-ZEUS (Army)

Type: Surface-to-air anti-ICBM and IRBM.
Status: R&D
Prime contractor: Western Electric Co.
Performance: Range—about 200 n. miles. Speed—est. Mach 4.
Deployment: Location — continental United States (particularly around soft SAC bases). Initially operational—about 1964. Total batteries—undetermined. Battery strength—about 50 launchers.
Frame: System contractor—Douglas. Length—about 65 ft. Diameter—about 5 ft.
Guidance: System contractor—Western Electric. Type—command.
Booster: System contractor—Thiokol. Propellant—solid.
Sustainer: System contractor—Grand Central. Propellant—solid.
Payload: Warhead type—nuclear.
Ground support equipment: Launcher—Douglas. Handling and service—Douglas.
Remarks: The future of the Nike-Zeus system is in doubt. The Eisenhower Administration refused to permit the Army to begin production thereby causing deployment to slip. However plans for flight-testing the missile in the Pacific in mid-1961 against live missiles were approved.

TYPHON (Navy)

Type: Surface-to-air (anti-missile missile)
Status: R&D
Prime contractor: Westinghouse Electric Corp./Applied Physics Lab
Performance: Designed to intercept both incoming tactical missiles and missiles launched from submerged submarines seconds after launching. Range—est. 100 n. miles. Speed—supersonic.
Deployment: Location—aboard cruisers, destroyers and possibly hydrofoil destroyers.
Payload: Warhead type—nuclear or HE.
Remarks: Two types are being developed—Long Range Typhon (formerly called Super Talos) and Medium Range Typhon (formerly called Super Tartar).

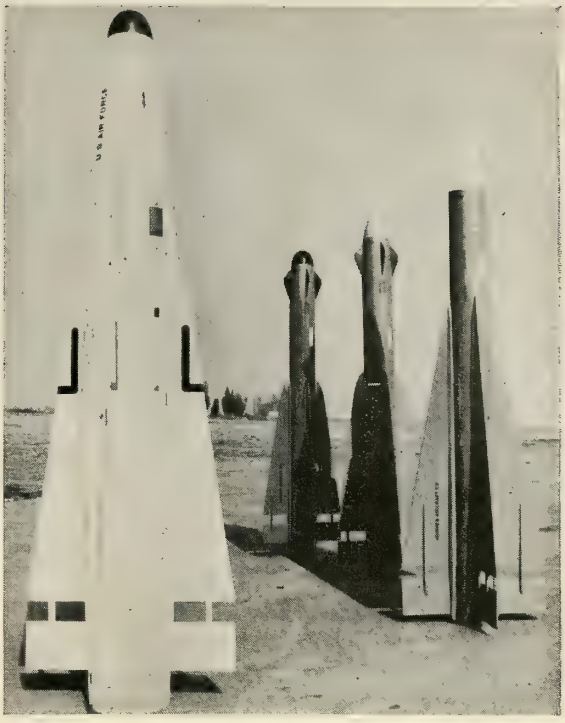
MAULER (Army)

Type: Surface-to-air (anti-missile missile)
Status: R&D
Prime contractor: Convair Division, General Dynamics Corp.
Performance: Designed to intercept incoming tactical missiles and jet aircraft.
Deployment: Location—to be put in hands of Army combat units in near forward positions.
Guidance: Type—radar.
Booster: Propellant—solid.
Remarks: Mauler will be launched from tracked vehicle manned by crew of only several men. System will be self-propelled and highly mobile and compact. Seagoing version has been proposed.

AIR-TO-AIR

FALCON (Air Force)

Military designation: GAR-1 through GAR-4, GAR-9 and GAR-11
Type: Air-to-air
Status: Operational (GAR-1 through GAR-4) and R&D (GAR-9 and GAR-11)
Prime contractor: Hughes Aircraft Co.
Performance: Range—about 5 n. miles. Speed—supersonic. (Greater ranges and speeds for GAR-3 and GAR-4, GAR-9 and GAR-11)
Deployment: Location—Air Defense Command aircraft (F-89, F-101, F-102 and F-106). Initially operational — 1957 (first versions).
Frame: System contractor—Hughes. Length—about 6.5-7 ft. (GAR-11 is more than 7 ft.). Diameter—6.4 in. GAR-11 is 7 ft. 11 in.) Wingspan—20 in. Launch weight—more than 120 lbs. (GAR-11 is more than 200 lbs.)
Guidance: System—contractor—Hughes. Type—(GAR-1D and GAR-3) radar homing; (GAR-2 and GAR-4) infrared.
Booster: System contractor—Thiokol. Propellant—solid.
Payload: Warhead type—(GAR-1 through GAR-4) HE; (GAR-11 and probably GAR-9) nuclear.
Remarks: GAR-3 and GAR-4 are known as Super Falcons. GAR-9 was originally designed for the now-cancelled F-108 Mach 3 interceptor.



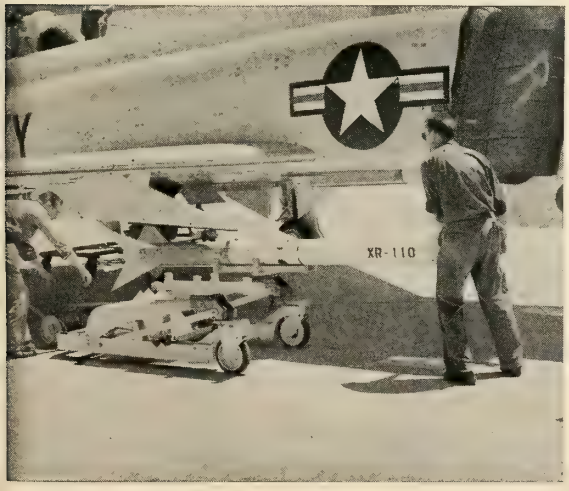
FALCONS (FROM LEFT): GAR-11, GAR-1D, GAR-2A, GAR-3

GENIE (Air Force)

Military designation: MB-1
Type: Air-to-air
Status: Operational
Prime contractor: Douglas Aircraft Co.
Performance: Range—1.5 n. miles. Speed—supersonic.
Deployment: Location—aboard Air Defense Command aircraft (F-89's, F-101's, F-106's). Initially operational—about 1958.
Frame: System contractor—Douglas. Length—eight ft. Launch weight—nearly 1000 lbs.
Guidance: Type—free flight.
Booster: System contractor—Aerojet. Propellant—solid.
Payload: Warhead type—nuclear.
Ground support equipment: Launcher—Douglas. Handling and service—Douglas. Transport vehicles—Fruehauf.



GENIE



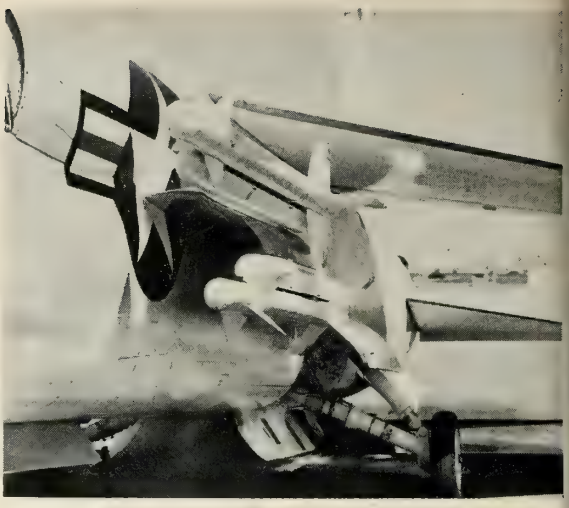
SPARROW III

SPARROW III (Navy)

Military designation: AAM-N-6A
Type: Air-to-air
Status: Operational
Prime contractor: Raytheon Co.
Performance: Range—more than 5 n. miles. Speed—more than Mach 2.
Deployment: Location—carrier-based U.S. Navy aircraft. Also with Marine units. Initially operational—August, 1958, replacing Sparrow I.
Frame: System contractor—Raytheon. Length—12 ft. Diameter—8 in. Launch weight—400 lbs. Material (major)—aluminum.
Guidance: System contractor—Raytheon. Type—radar homing.
Booster: System contractor—Aerojet. Propellant—solid (A new version of Sparrow with greater capability has Thiokol booster with packaged liquid propellant.) Thrust (solid)—7800 lbs.
Payload: Warhead type—HE.
Ground support equipment: Handling and service—Raytheon.
Remarks: Sparrow gave the Navy an all-weather missile when Sidewinder had only IR guidance.

SIDEWINDER (Navy-Air Force)

Military designation: AAM-N-7 (Navy) and GAR-8 (Air Force)
Type: Air-to-air
Status: Operational
Prime contractor: Philco Corp./ General Electric Co.
Performance: Range—about 2 n. miles. Speed—supersonic. Ceiling—more than 50,000 ft.
Deployment: Location—carried by carrier-based Naval aircraft and Air Defense Command aircraft. Also widely used by U.S. allies. Initially operational—mid-1956.
Frame: System contractor—Norris Thermador/Hunter-Douglas. Length—9 ft. Diameter—5 in. Launch weight—about 155 lbs. Material (major)—aluminum.
Guidance: System contractor—Philco/GE. Type—Infrared.
Booster: System contractor—Naval Propellant Plant. Propellant—solid.
Payload: Warhead type—HE.
Remarks: Philco is prime contractor for Sidewinder I-C, a second-generation missile with greater speed and range. I-C will have switchable IR and radar homing warheads. The Naval Ordnance Test Station at China Lake, Calif., developer of Sidewinder, also is developing I-C.



SIDEWINDER

EAGLE (Navy)

Military designation: XAAM-N-10
Type: Air-to-air
Status: R&D
Prime contractor: Bendix Corp.
Performance: Range—est. 100 n. miles. Speed—more than Mach 3.
Deployment: Location—to be launched from new low-speed, long-endurance plane called Missileer which is to be developed and deployed on carriers.
Frame: System contractor—Grumman. Length—est. 15 ft. Launch weight—about 2000 lbs.
Guidance: System contractor—Bendix. Type—radar homing.
Booster: System contractor—Aerojet. Type—solid.
Payload: Warhead type—nuclear or HE.
Remarks: Eagle introduces a new Navy concept of putting high performance into an air-launched missile that will be fired from a low-speed aircraft.

ZUNI (Navy)

Type: Air-to-surface
Status: Operational
Prime contractor: Naval Ordnance Test Station, China Lake
Performance: Range—about 5 n. miles. Speed—about 3000 ft./sec.
Deployment: Location—carrier-based aircraft. Initially operational—1957.
Frame: Length—110 in. Diameter—5 in. Launch weight—107 lbs.
Guidance: Type—free flight.
Booster: System contractor—Hunter-Douglas. Type—solid. Thrust—7000 lbs.
Payload: Warhead type—HE (also variety of other conventional warheads including flares.)
Remarks: The four-rocket launchers, which also are used for transporting and storing Zunis, can be jettisoned from plane after rockets are launched. AD-type Naval aircraft can carry up to 48 Zunis.



ZUNI

Anti-submarine

The decade of the 1960's is seeing the missile come into its own as a weapon for attacking submarines.

ASROC—the greatest step forward in the development of an ASW missile in a decade—is already operational. SUBROC is expected to be operational in less than a year.

Meantime, improvements in both systems are under consideration.

The stumbling block continues to be detection. Any improvements in detection can be quickly followed by improvements in the missiles themselves.

WEAPON ALFA (Navy)

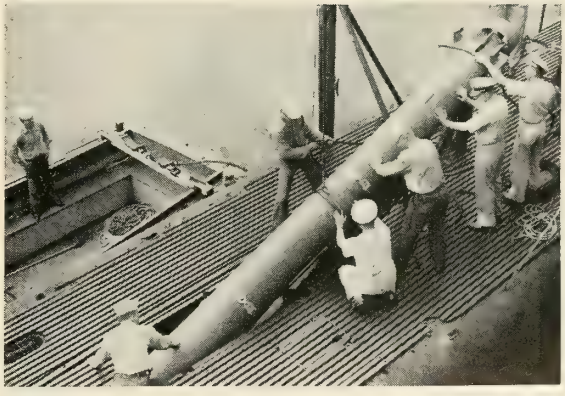
Type: ASW surface-to-underwater
Status: Operational
Prime contractor: Navy
Performance: Range—about 900 yards
Deployment: Location—aboard U.S. destroyers and cruisers. Initially operational—1952
Frame: System contractor—Avco. Length—8.5 ft. Diameter—12.75 in. Launch weight—500 lbs.
Guidance: Type—free flight
Booster: Propellant—solid
Payload: Warhead type—HE depth charge
Remarks: Alfa is launched from guns mounted in turrets



WEAPON ALFA

ASTOR (Navy)

Type: ASW rocket torpedo
Status: R&D
Prime contractor: Westinghouse Electric Corp.
Performance: Range—reported to be about 11 n. miles
Deployment: Location—aboard U.S. fleet submarines
Frame: System contractor—Westinghouse. Length—nearly 20 ft. Launch weight—more than 2000 lbs.
Guidance: Type—reported to be partly wire.
Powerplant: Type—reported to be electric and rocket-boosted. Propellant—solid
Payload: Warhead type—nuclear or HE.



ASTOR

ASROC (Navy)

Type: ASW surface-to-underwater
Status: Operational
Prime contractor: Minneapolis-Honeywell Regulator Co.
Performance: Range—about 8 n. miles. Speed—nearly Mach 1.
Deployment: Location—Destroyer Leader Norfolk and Destroyer Peary. The Navy plans to install ASROC aboard a total of 150 destroyers and cruisers within the next few years. Initially operational: 1960. Launcher capacity—eight. (Some ships will carry reloads)
Frame: System contractor—Minneapolis-Honeywell. Length—15 ft. Torpedo-warhead length—100 in. Missile diameter—1 ft. Overall diameter—2.5 ft. Launch weight—about 1000 lbs.
Fire control: System contractor—Librascope. Type—digital computer operated.
Sonar detection: System contractor—Sangamo Electric. Type—SQS-23.
Booster: Propellant—solid.
Payload: Warhead — General Electric Mark 44 acoustic homing torpedo or depth charge. Type—HE (depth charge can be nuclear)
Ground support equipment: Launcher—Universal Match



ASROC

SUBROC (Navy)

Type: ASW underwater-to-underwater
Status: R&D
Prime contractor: Goodyear Aircraft Corp.
Performance: Range—about 25 n. miles.
Deployment: Location—aboard nuclear-powered attack submarines. Scheduled to be installed first aboard the Thresher. Initially operational—1961.
Frame: System contractor—Goodyear.
Guidance: System contractor—Kearfott.
Fire control: System contractor—Librascope.
Booster: System contractor—Thiokol. Type—solid.
Payload: Warhead type—nuclear or HE.
Remarks: Subroc will be launched underwater from a conventional submarine tube, leave the water, travel through the air and re-enter the water to strike an enemy submarine

Directory of Rocket Engine

The biggest engines in America's inventory today still are propelled by the liquid combination of LOX and RP-1.

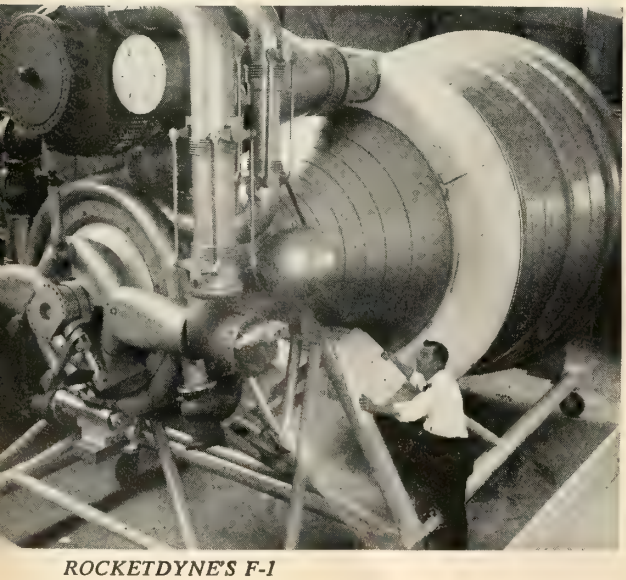
The Rocketdyne 150,000-lb.-thrust engine is the basic U.S. power plant for large liquid rockets. Developed for the Jupiter IRBM, it has been adapted for the Thor IRBM, used in pairs for the Atlas ICBM and modified for clustering into the Saturn booster. The same combination propels the F-1, the largest single engine under development, and the booster powerplant of the Titan ICBM.

However, current propulsion trends are moving toward the high-energy LOX-liquid hydrogen system, storable propellants in liquids and increased use of solids where instant readiness, mobility and low price are major factors.

LIQUID ENGINES

NOVA ENGINE (NASA)

Manufacturer: Rocketdyne
Manufacturer's number: F-1
Propellants: LOX, kerosene
Nozzle config. & exp. ratio: Modified bell, regen. cooled, more than 12:1
Nozzle material: Unsettled
Length: About 20 ft.
Width (maximum): About 12 ft.
Weight: About 18,000 lbs.
Start system: Solid propellant
Ignition: Pyrophoric, tri-ethyl aluminum
Propellant supply: Turbopumped
Average thrust: 1,500,000 lbs.
Specific impulse, sea level: about 260 sec.; average during flight: about 290 sec.
Burning time: according to tank capacity
Status: R&D. Thrust chamber test this summer; first engine test next summer; pre-flight rating test complete by summer of 1963. Cluster of several F-1's—or a single F-1 and several H-1's—will be the booster of the Nova vehicle.



ROCKETDYNE'S F-1

SATURN BOOSTER ENGINE (NASA)

Manufacturer: Rocketdyne
Manufacturer's number: H-1
Propellants: LOX, kerosene
Nozzle config. & area ratio: Bell, regen. cooled, 8:1
Nozzle material: Nickel
Length: About 8 ft.
Width (maximum): 60 in.
Engine weight: About 1400 lbs.
Start system: Solid propellant
Ignition: Pyrophoric; tri-ethyl aluminum
Propellant supply: Turbopumped
Average thrust (sea level): 165,000 lbs; later to be 188,000 lbs.
Specific impulse (sea level): 255 sec.
Burning time: According to tank capacity
Status: R&D. Earlier versions operational in Jupiter, Thor, Atlas

ATLAS BOOSTER (Air Force)

Manufacturer: Rocketdyne
Manufacturer's numbers: MA2, MA3
Propellants: LOX, kerosene
Nozzle config. & area ratio: Bell, regen. cooled, 8:1
Nozzle material: Nickel
Length: About 8 ft.
Width (maximum, one engine): 60 in.
Weight (one engine): 1418 lbs.
Start system: MA2—LOX-kerosene gas gen.; MA3—solid propellant
Ignition: MA2 — pyrotechnic; MA3—pyrophoric, tri-ethyl aluminum
Average thrust: MA2—300,000 lbs.; MA3—330,000 lbs.
Number of engines: 2 with common pumpage
Propellant consumption (total): MA2—1240 lb./sec.; MA3—classified.
Burning time: 2 min.
Status: MA2 operational. MA3—R&D.

TITAN BOOSTER (Air Force)

Manufacturer: Aerojet-General
Military numbers: LR-87-AJ-3 and -5
Propellants: -3—LOX, kerosene; -5—nitrogen tetroxide and Aerozene-50 (50-50 mix of UDMH and hydrazine)
Nozzle config. & area ratio: Bell, regen. cooled; 8:1
Nozzle material: Stainless steel
Length: About 10 ft.
Width (maximum): About 9 ft.
Engine weight: About 3700 lbs.
Start system: -3—ground-supplied and bootstrap; -5—self-contained
Ignition: -3—pyrotechnic; -5—hypergolic
Propellant supply: Turbopumped
Number of engines: 2 fed by common tankage
Average thrust (sea level): -3—300,000 lbs.; 5—more than 400,000
Burning time: 120 sec.
Status: -3 has completed qualification tests; -5 is to complete qualification in about two years.

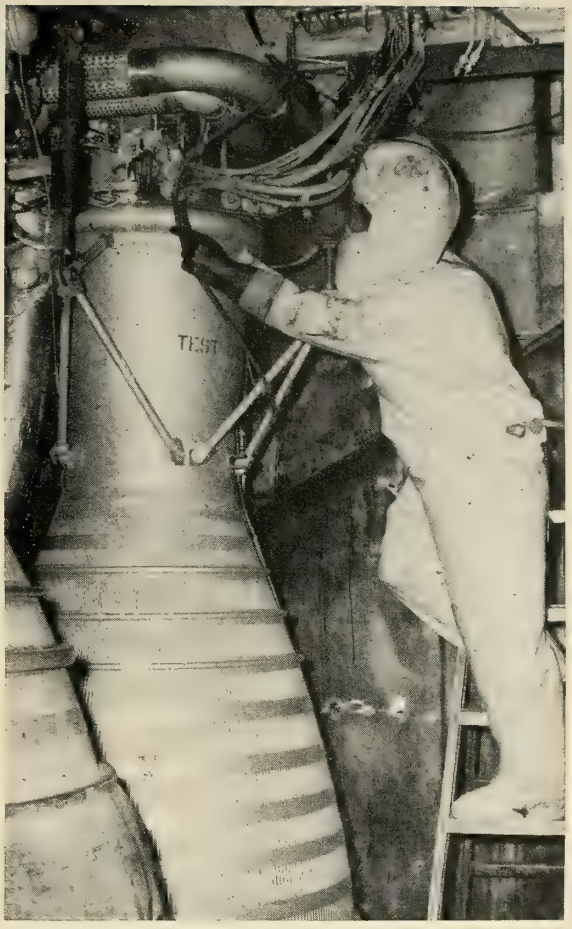
SATURN MIDSTAGE ENGINE (NASA)

Manufacturer: Rocketdyne
Manufacturer's number: J-2
Propellants: LOX, liquid hydrogen
Nozzle config. & area ratio: Bell, regen. cooled; over 30:1
Engine weight: About 2500 lbs.
Start system: LOX-hydrogen gas generator
Average thrust: 200,000 lbs.
Specific impulse (vacuum): More than 420 sec.
Burning time: More than 100 sec.
Status: NASA chose Rocketdyne in June, 1960, to conduct a three-year program leading to preflight rating test. Many engine details unsettled.

Motors

ATLAS SUSTAINER (Air Force)

Manufacturer: Rocketdyne
Manufacturer's number: S-4 (part of propulsion systems MA2 and MA3)
Propellants: LOX, kerosene
Nozzle config. & area ratio: Bell, regen. cooled, 25:1
Nozzle material: Nickel
Length: About 8 ft.
Width (maximum): About 60 in.
Engine weight: 984 lbs.
Start system: Same as booster
Ignition: Same as booster
Thrust: 57,000 sea level, 80,000 vacuum
Burning time: About 270 sec.
Status: Operational in MA2; R&D in MA3.



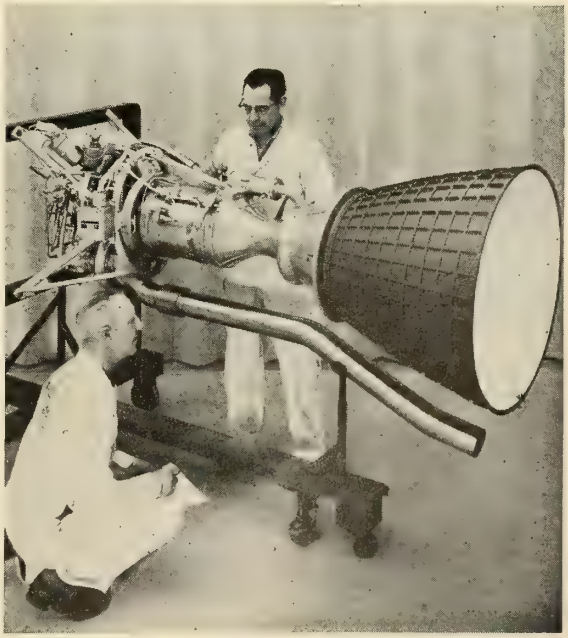
ATLAS SUSTAINER

TITAN SUSTAINER (Air Force)

Manufacturer: Aerojet-General
Military numbers: LR-91-AJ-3 and -5
Propellants: -3—LOX, kerosene; -5—nitrogen tetroxide and Aerozene-50
Nozzle config. & area ratio: Bell, partly regeneratively cooled, 25:1
Nozzle material: Stainless steel
Length: About 7 ft.
Width (maximum): About 4 ft.
Engine weight: About 1300 lbs.
Start system: Self-contained
Ignition: -3—pyrotechnic; -5—hypergolic
Propellant supply: Turbopumped
Average thrust (vacuum), lbs.: -3—80,000; -5—slightly higher
Burning time, sec: 150
Status: -3 is completing qualification tests; -5 is to complete qual. tests in about two years.

CENTAUR ENGINE (NASA)

Manufacturer: Pratt & Whitney
Military number: LR-115
Propellants: LOX, liquid hydrogen
Nozzle config. & area ratio: Bell, regen. cooled, over 30:1
Nozzle material: Stainless steel
Start system: Bootstrap hydrogen expansion pump
Ignition: Electric
Average thrust: 15,000 lbs.; almost 20,000 lbs. in later version
Specific impulse: 30% higher than LOX-kerosene; number not given
Burning time: About 5 min. in Centaur
Status: R&D; to be flown in Centaur in 1961; to be used in Saturn upper stages beginning in 1963.



BELL'S AGENA ENGINE

AGENA ENGINE (Air Force and NASA)

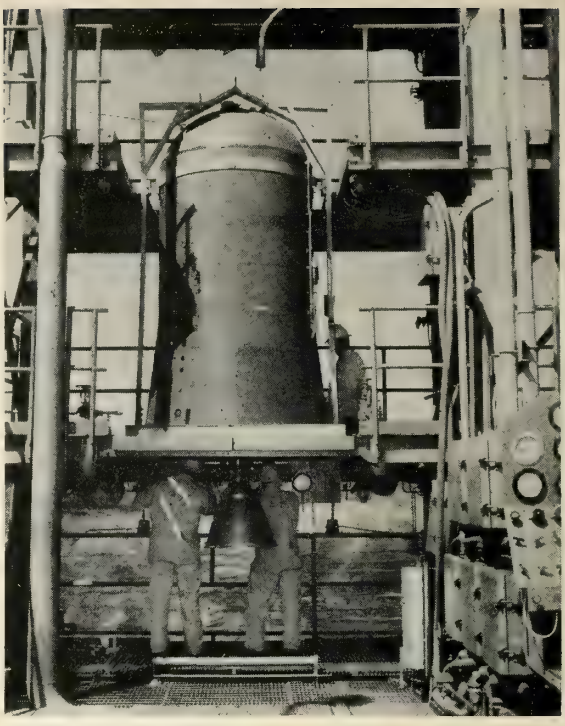
Manufacturer: Bell Aircraft
Military numbers: XLR-81-BA-5, -7 and -9
Propellants: IRFNA, UDMH
Start system: -5 single start, -7 and -9 restartable in space
Ignition: Hypergolic
Propellant feed: Turbopumped
Average thrust: 15,500 except 16,000 in -9
Burning time: -5—about 120 sec.; -7 and -9—about 240 sec.
Propellant weight: -5—8500 lbs.; -7 and -9—17,000 lbs.
Status: -5 operational in Agena A; -7 coming into operation in early Agena B; -9 in production for later Agena B.

VANGUARD-VEGA ENGINE (NASA)

Manufacturer: General Electric
Military numbers: X405; X405H
Propellants: LOX, kerosene
Nozzle config. & area ratio: 405—single-CD single-pass double shell, 5.5:1; 405H—tube bundle, 25:1
Nozzle material: Steel
Length: 405—80 in.; 405H—65 in.
Width: 405—40 in.; 405H—27.5 in.
Weight: 405—421 lbs.; 405H—458 lbs.
Propellant supply: Turbopumped
Ignition: 405 — pyrotechnic; 405H—pyrophoric tri-ethyl aluminum
Thrust, sea level: 405—28,000 lbs.; 405H—35,000 lbs.
Burning time: 405—150 sec.; 405H—250 sec.
Status: X405, the booster engine on Vanguard, has now phased out. X405H was developed for use as an upper stage, atop an Atlas, for the Vega vehicle. Although the Vega vehicle was cancelled, X405H development was continued through preflight rating test.

VARIABLE THRUST ENGINE (Air Force)

Manufacturer: Aerojet-General
Military number: LR-113-AJ-1
Propellants: Nitrogen Tetroxide, UDMH
Nozzle config. & area ratio: Conical, film-cooled, about 6:1
Nozzle material: Steel
Length: About 5 ft.
Width: About 2½ ft.
Weight (maximum): About 1000 lbs.
Ignition: Hypergolic
Propellant supply: Pressure-fed
Thrust (sea level): 50,000-150,000 lbs.
Burning time (full thrust): About 10 sec.
Status: Qualified for sled use.



ABLESTAR ENGINE

GAMMA ENGINE (British)

Manufacturer: Bristol Siddeley
Manufacturer's number: A. S. Gamma Mk. 201
Propellants: 85-7% hydrogen peroxide, kerosene
Nozzle configuration: Bell, regen. cooled
Length: 90 in.
Width (maximum): 36 in.
Engine weight: 700 lbs.
Ignition: Catalytic decomposition & hypergolic
Propellant feed: Turbopumped
Number of chambers: 4
Total thrust: Sea level—16,000-16,800; Vacuum—19,000
Status: Operational in the Black Knight Re-entry research vehicle.

NUCLEAR

ROVER NUCLEAR ENGINE (AEC and NASA)

Manufacturer: Los Alamos Scientific Lab.
Propellant: Liquid hydrogen
Nozzle config.: Bell, regen. cooled
Total weight: 39,000 lbs.
Reactor power: 1,000 megawatts thermal
Thrust (sea level): 52,000 lbs.
Propulsion time: More than 5 minutes.
Status: R&D. Tests of non-flying Kiwi engines began last summer. NASA says will be ready for orbital flight test by 1965. AEC says system could be proved sooner with ground-launched test.

ABLE SERIES ENGINES

The Aerojet-General Able series of engines originated with the second stage of Vanguard and was adapted for the Thor-Able. The Able still has two flights with the Atlas-Able scheduled this year before it phases out in favor of Delta in NASA vehicles and Ablestar in some military satellites.

ENGINE	AJ10-101 (ABLE)	AJ10-110 (DELTA)	AJ10-104 (ABLESTAR)
Propellants	IRFNA, UDMH	WIFNA, UDMH	IRFNA, UDMH
Nozzle configuration & area ratio	Bell, tube bundle, 20:1	Bell, tube bundle, 20:1	Bell, tube bundle to 20:1; Uncooled extension to 40:1
Nozzle material	Aluminum	Stainless steel	Aluminum to 20:1; titanium extension
Length, in. (including tanks)	About 190	About 190	About 207
Width (maximum), in.	About 32	About 32	About 55
Start system	Self-contained, wet	Self-contained, wet	Wet or dry, restartable
Ignition	Hypergolic	Hypergolic	Hypergolic
Propellant supply	Helium pressure feed	Helium pressure feed	Helium pressure feed
Average thrust (vac.) lbs.	About 7800	About 7800	About 8000
Burning time, sec.	About 120	About 120	About 300

SOLID MOTORS

Solid propulsion has made large strides in the last year, particularly in the development of rocket hardware. The Polaris Fleet Ballistic Missile and the Scout satellite launcher are nearly operational and the Minuteman ICBM has progressed to the point where even larger solid motors are being considered.

ALGOL (NASA)

Manufacturer: Aerojet-General
Propellant: Polyurethane composite
Nozzle config. & exp. ratio: Cone, 4.7:1
Nozzle material: Steel
Length: 358 in.
Width (maximum): 40 in.
Weight (maximum): 22,640 lbs.
Weight unloaded: 3360 lbs.
Ignition: Squib
Average thrust (sea level): 104,500 lbs.
Burning time (web): 36 sec.
Total impulse (integrated, sea level to altitude): 4,080,000 lb.-sec.
Case material: Steel
Status: An early Polaris test vehicle, Algol was adapted for use as Scout booster. Engine development is complete.

CASTOR MOTOR (NASA)

Manufacturer: Thiokol
Propellant: Polybutadiene acrylic acid composite
Nozzle config. & exp. ratio: Cone, 16:1
Nozzle material: Steel
Length: 244 in.
Width: 31 in.
Total weight: 8870 lbs.
Weight unloaded: 1430 lbs.
Ignition: Squib
Total impulse (vac.): 1,940,000 lb.-sec.
Burning time (web): 27 sec.
Average thrust: Vacuum—63,050 lbs.; sea level—55,000 lbs.
Case material: Steel
Status: Operational. Castor, a modification of the motor in the Sergeant missile, is used as second stage of Scout and as a component in Little Joe and several sounding-type vehicles.

ANTARES MOTOR (NASA)

Manufacturer: Hercules-ABL
Military number: X254
Nozzle config. & area ratio: Cone, 25:1
Propellant: Double-base
Length: 115 in.
Width (maximum): 30 in.
Weight (maximum): 2300 lbs.
Weight unloaded: 180 lbs.
Ignition: Squib
Average thrust (web, vacuum): 14,500 lbs.
Burning time (web): 37 sec.
Total impulse: 534,000 lb.-sec.
Specific impulse (vacuum): 256 sec.
Case material: Fiber glass and resin
Status: Developed specially for use as Scout third stage; development complete.

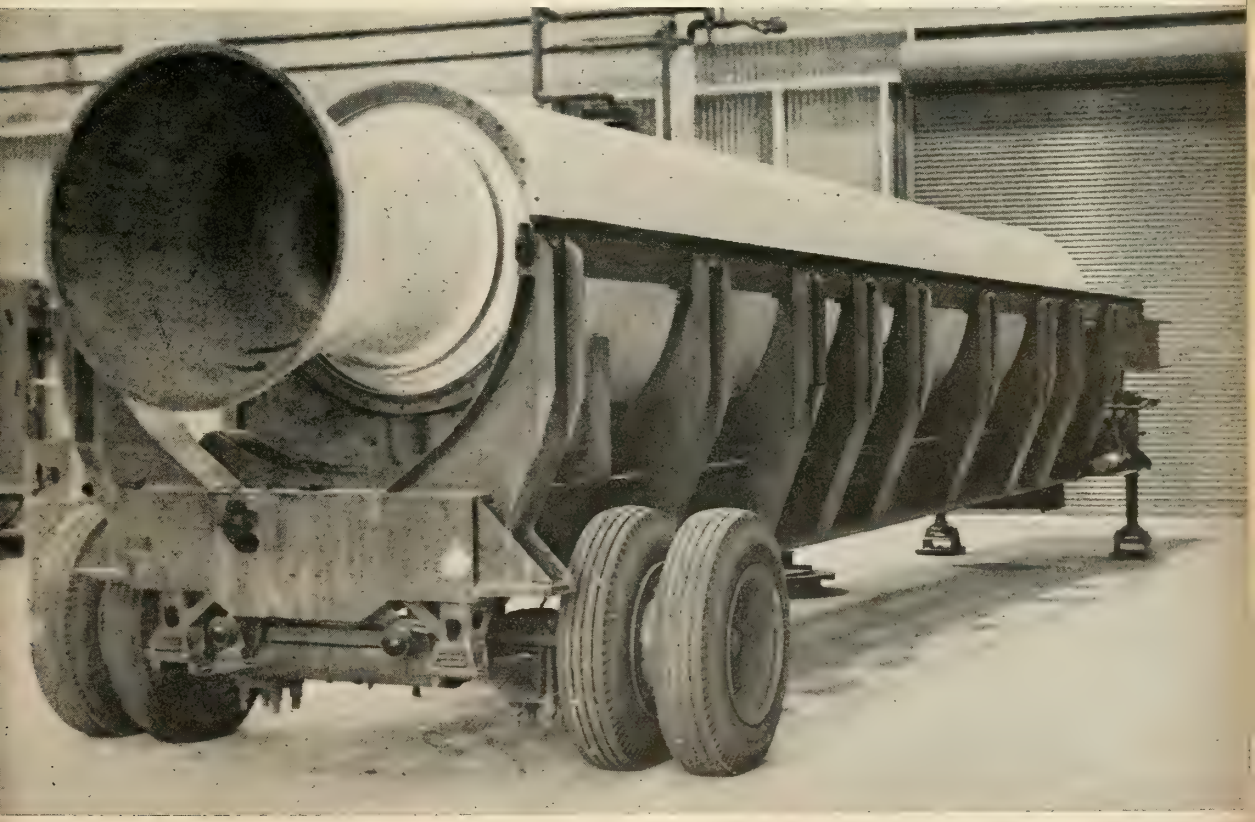
NIKE (Army)

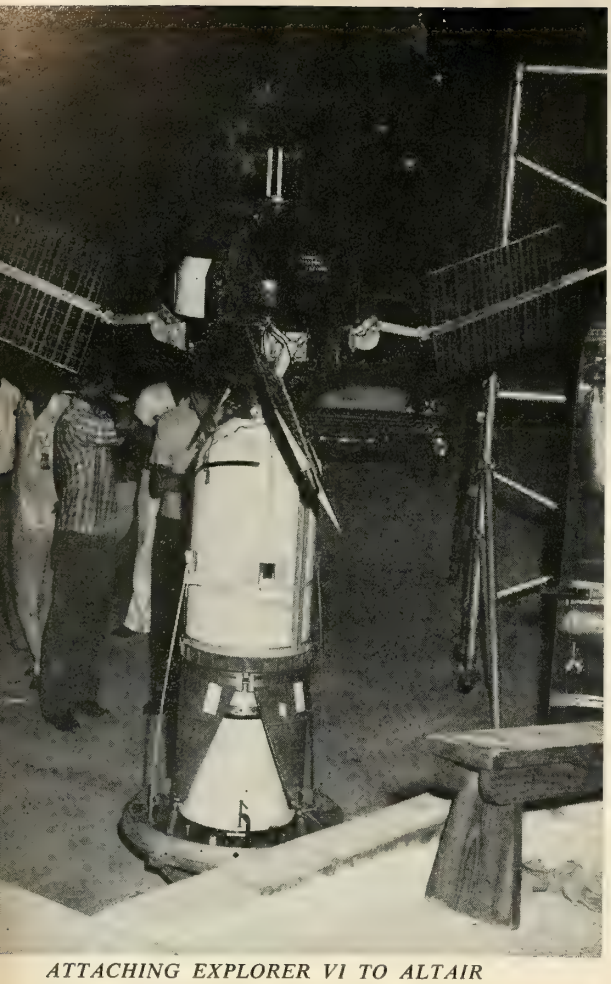
Manufacturer: Hercules-ABL
Propellant: Double-base
Length: 150 in.
Diameter: 16 in.
Total weight: 1170 lbs.
Ignition: Squib
Average thrust: 50,000 lbs.
Case material: Steel
Status: Developed originally for the Nike-Ajax, this rocket is used in a cluster of four to boost Nike-Hercules. It is also widely used in sounding rockets and for sled propulsion.

LANCE MOTOR

Manufacturer: Grand Central
Manufacturer's number: GCR-S-394A
Propellant: Polysulfide composite
Nozzle config.: Straight
Nozzle material: Steel, graphite
Length: 185 in.
Diameter: 15.1 in.
Total weight: 1682 lbs.
Weight unloaded: 490 lbs.
Ignition: Pyrotechnic
Total impulse (sea level, (70°F): 258,000 lb.-sec.
Average thrust (web, sea level): 38,800 lbs.
Burning time: Web—6.65 sec.; total—8 sec.
Case material: Steel, 150,000 psi min. yield
Grain design: 5 pt. star burning
Status: In production.

AEROJET'S ALGOL





ATTACHING EXPLORER VI TO ALTAIR



ROCKETDYNE'S MEGABOOM

ALTAIR MOTOR (Navy and NASA)

Manufacturer: Hercules-ABL
Military number: X248
Propellant: Double-base
Nozzle config. & exp. ratio: Cone, 25:1
Nozzle material: Plastic
Length: 58 in.
Width (maximum): 18 in.
Weight (maximum): 514 lbs.
Weight unloaded: 52 lbs.
Ignition: Squib
Average thrust (web, vacuum): 3060 lbs.
Burning time (web): 38 sec.
Total impulse (vacuum): 116,500 lb.-sec.
Specific impulse (vacuum): 256 sec.
Case material: Fiber glass and resin
Status: Operational

METEOR MOTOR (NASA)

Manufacturer: Grand Central
Manufacturer's number: GCR-350
Propellant: Polysulfide composite
Nozzle config.: Straight DeLaval
Nozzle material: Steel, graphite
Length: 57.4 in.
Diameter: 18 in.
Total weight: 431 lbs.
Weight unloaded: 49.5 lbs.
Ignition: Gas generator
Total impulse (vacuum, 60°F): 90,800 lb.-sec.
Average thrust (web, vacuum): 2776 lbs.
Burning time: Web—28 sec.; total—37 sec.
Case material: Stainless steel, 135,000 psi min. yield
Grain design: 5 pt. star burning
Status: Used in early versions of Vanguard

RECRUIT MOTOR (NASA)

Manufacturer: Thiokol
Propellant: Polysulfide composite
Nozzle material: Steel
Length: 107 in.
Diameter: 9¼ in.
Total weight: 350 lbs.
Ignition: Squib
Burning time: 1.5 sec.
Average thrust: About 35,000 lbs.
Case material: Steel
Status: Operational; developed for use in X-17 research vehicle, Recruit has been used widely in sounding and test vehicles.

ASP MOTOR

Manufacturer: Cooper Development
Manufacturer's number: RM 1100
Propellant: Polysulfide composite
Nozzle config. & exp. ratio: Cone, 6.41:1
Nozzle material: Steel, graphite
Length: 106.9 in.
Diameter: 6.5 in.
Total weight: 192 lbs.
Weight unloaded: 42 lbs.
Ignition: Jellyroll
Average thrust (sea level, 80°F): 5982 lbs.
Burning time: Web—4.4 sec.; total—5.9 sec.
Total impulse (sea level): 31,706 lb.-sec.
Specific impulse: 215 sec.
Case material: Steel, proof to 1900 psia
Grain design: Tapered internal cylinder
Status: Operational

CAJUN (NASA)

Manufacturer: Thiokol
Propellant: Polysulfide composite
Nozzle configuration: Varies with mission
Nozzle material: Aluminum, graphite
Length: Mod I—108 in.; Mod II—107 in.; Mod III—104 in.
Width: 6¾ in.
Weight (maximum): Mod I—172 lbs.; Mod. II—171 lbs.; Mod III—166 lbs.
Ignition: Squib
Average thrust: 8100 lbs.
Burning time: 2.8 sec.
Case material: Aluminum
Grain design: Internal star
Status: Operational. Mod I used for high-altitude research, beginning with the International Geophysical Year; Mod II for rocket sled propulsion; Mod III in target missile systems.

SALUKI (British)

Manufacturer: Imperial Chemical
Length: Body—126.9 in.; overall—150.9 in.
Diameter: 24 in.
Case material: Steel
Status: Under development for the Ministry of Aviation, Saluki is apparently the largest British solid motor. Other details are unavailable.

RAVEN MOTOR (British)

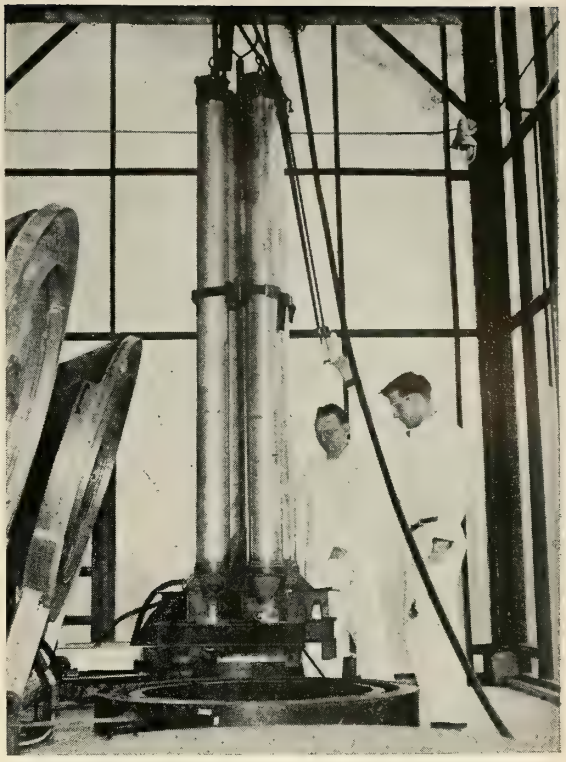
Manufacturer: Wescott R. P. E.
Propellant: Case-bondable composite
Length: 184 in.
Diameter: 17.4 in.
Total weight: 2200 lbs.
Weight unloaded: 400 lbs.
Average thrust: 12,000 lbs.
Burning time: 30 sec.
Specific impulse: 177 sec.
Case material: Steel
Status: Operational in Skylark sounding rocket.

BULLDOG MOTOR (British)

Manufacturer: Imperial Chemical
Nozzle material: Steel
Length: High-thrust model—127.6 in.; Low-thrust model—125.9 in.
Diameter: 17.5 in.
Ignition: Electrical
Average thrust: High model—46,700 lbs.; Low model—25,500 lbs.
Burning time: High thrust—2.5 sec. Low thrust—6.9 sec.
Case material: Steel
Status: R&D for the Ministry of Aviation

CUCKOO MOTOR (British)

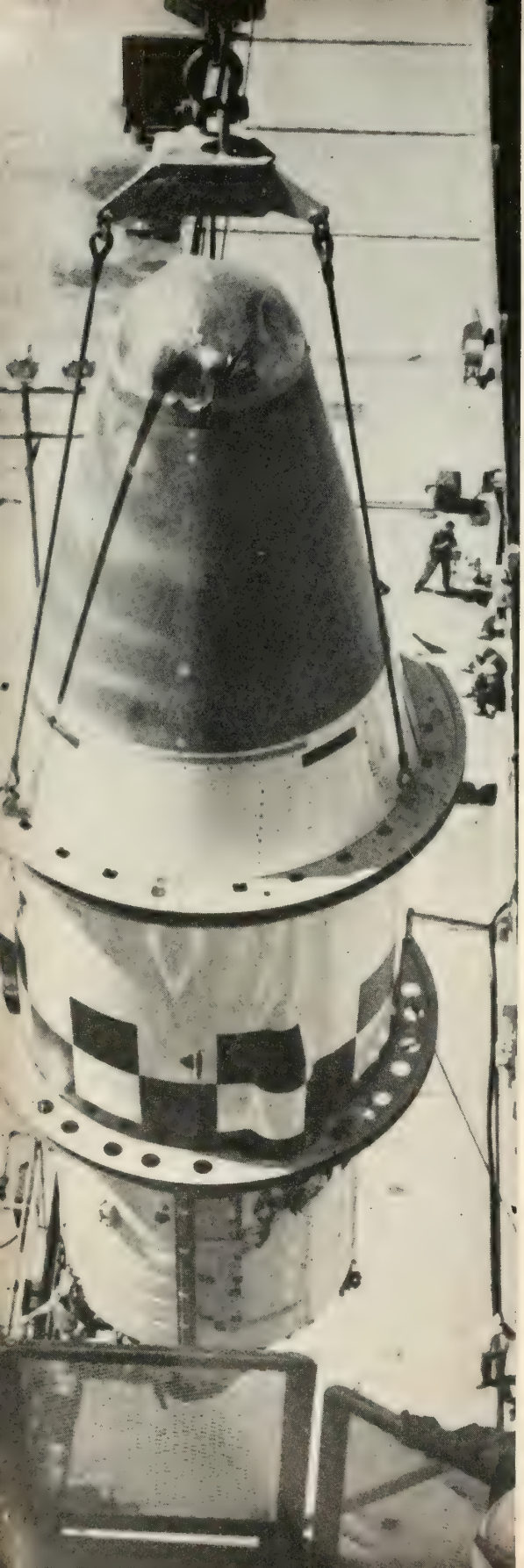
Manufacturer: Westcott R. P. E.
Propellant: Case-bondable composite
Burning time: About 4 sec.
Total impulse: 81,000 lb.-sec.
Status: Becoming operational as booster for Raven in Skylark sounding rocket.



THIOKOL APACHE MOTORS ABOVE CURING PIT

SOME OTHER SOLID MOTORS

Name	Manufacturer	Propellant	Total Wt. (lbs.)	Average Thrust (lbs.)	Burning Time (sec.)	Application
MEGABOOM	Rocketdyne	Butyl rubber	9460	100,000	10	Sled
APACHE	Thiokol	Polysulfide	223	N.A.	N.A.	Sounding (lifts 35 lbs. to 40 miles)
RECRUIT	Thiokol	Polysulfide		35,000	1.5	Sounding
JAVELIN	Grand Cent.	Polysulfide	351.1	18,000	3.2	Sled, missile
SABER	Grand Cent.	Nitrile	213	10,000	3.3	Sled, drone, sounding
ARCON	Atlantic Res.	Polyvin. Chlor.	213.1	945	33.0	Sounding
VIPER	Grand Cent.	Polysulfide	190.4	5070-7700	4.25-6	Sled, sounding
SWORD	Grand Cent.	Polysulfide	95.1	3020	4.75	TITAN separation
ARCAS	Atlantic Res.	Polyvin. Chlor.	64.5	350	28.4	Sounding
DART	Grand Cent.	Butyl rubber	42.0	100	44	Dual-range thrust; Start 640 lbs. 1.8 sec.
SKYDART	Grand Cent.	Butyl rubber	46.0	116	37	Dual-range thrust; Start 620 lbs. 1.9 sec.
ARROW	Grand Cent.	Polysulfide	17.8-24.4	1790-2400	1.1-2.1	Sled, drone, sounding
MARC 8	Atlantic Res.	Polyvin. Chlor.	17.4-17.7	860	1.48	THOR retro, MERCURY escape
TE-316	Thiokol	Polysulfide	N.A.	1000	N.A.	MERCURY orbital brake
MARC 7	Atlantic Res.	Polyvin. Chlor.	4.8-5	410	1.1	ATLAS retro, MERCURY separation, EXPLORER VI orbital control
MARC 6	Atlantic Res.	Polyvin. Chlor.	3.35-3.55	214	1.0	THOR-ABLE vernier, satellite orbital control
MARC 5	Atlantic Res.	Polyvin. Chlor.	1.3-1.37	121	0.51	Spin stabilization, de-spin ATLAS-ABLE, EXPLORER, DISCOVERER
MARC 4	Atlantic Res.	Polyvin. Chlor.	.62-.64	46	1.05	Retro, spin VANGUARD, PIONEER, SCOUT, DELTA, DISCOVERER
FANG	Grand Cent.	Polysulfide	1.0	37	1.3	Nose cone spin, component stabilizer
MARC 3	Atlantic Res.	Polyvin. Chlor.	.085	5	0.3	TIROS spin stabilization



Space Vehicles

America's two major bids for a large role in space exploration are NASA's huge Saturn booster and the Air Force's Dyna-Soar space bomber.

But Saturn's first operational flight is still several years away at best; Dyna-Soar on its present schedule several times that.

Meantime, Russia and the United States continue to race to put the first man in orbit with the odds of success still heavily in favor of Russia.

In the field of military space satellites, the United States appears to be doing better. But some congressmen have charged that these programs, too, are not being pushed to the limit.

Lack of financial support continues to be the problem.

SATELLITES/SPACECRAFT

MIDAS (Air Force)

Type: Early-warning satellite
Status: R&D
Prime contractor: Lockheed Aircraft Co.
Performance: Orbit—about 300 n. miles; polar.
Deployment: Initially operational—about 1963. Number satellites—more than a half-dozen.
Frame: System contractor—Lockheed. Height—22 ft. Diameter—5 ft. Weight—about 5000 lbs. (operational weight about 3000 lbs.)
Instrumentation: Type—IR scanner designed to detect exhaust flames of a long-range ballistic missile seconds after it is launched; data link telemetry; tape-fed programer
Booster: System contractor: Convair. Type—Atlas ICBM. Propellant—liquid.
Sustainer: System contractor—Lockheed. Type—Agena. Propellant—liquid.
Remarks: Midas II successfully launched May 24, 1960, into 300/319 mile orbit, but an equipment failure made testing of the IR scanner impossible. The launching of Midas I failed because of a breakdown in the second stage. Estimated life of Midas II—40 months.

DYNA-SOAR (Air Force)

Type: Boost-glide space bomber
Status: R&D
Prime contractor: Boeing Airplane Co.
Performance: Range—global. Speed—ultimately orbital.
Deployment: Initially operational—late 1960's.
Frame: System contractor—Boeing. Configuration—glider.
Booster: System contractor—Martin. Type—modified Titan ICBM. Propellant—liquid.
Remarks: The program is divided into phases beginning with the dropping and launching of unmanned gliders. The first manned gliders will be boosted down the Atlantic Missile Range.

LEFT: MIDAS

and Satellites



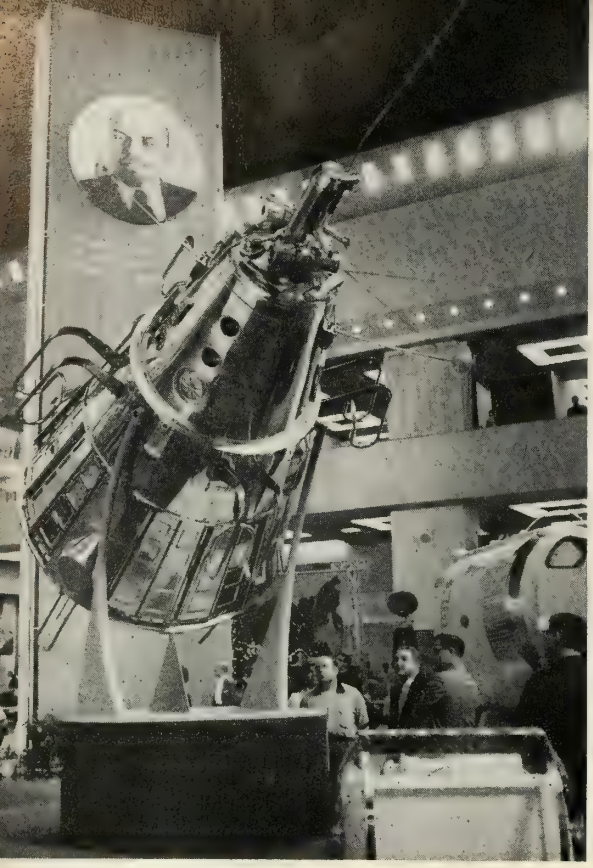
X-15

X-15 (Air Force-Navy-NASA)

Type: Manned R&D rocket plane
Status: R&D
Prime contractor: North American Aviation, Inc.
Performance: Range—400 n. miles. Speed—3600 mph. Ceiling—50-100 miles.
Frame: System contractor—North American. Length—50 ft. Launch weight—31,275 lbs. Landing weight—12,971 lbs. Capacity—18,304 lbs. Wingspan—22 ft.
Booster: System contractor—Thiokol. Propellant—LOX and liquid ammonia. Thrust—50,000 lbs. Type—XLR99.
Power units: System contractor—General Electric.
Remarks: The X-15 program is aimed at exploration of the atmosphere at the fringes of space.

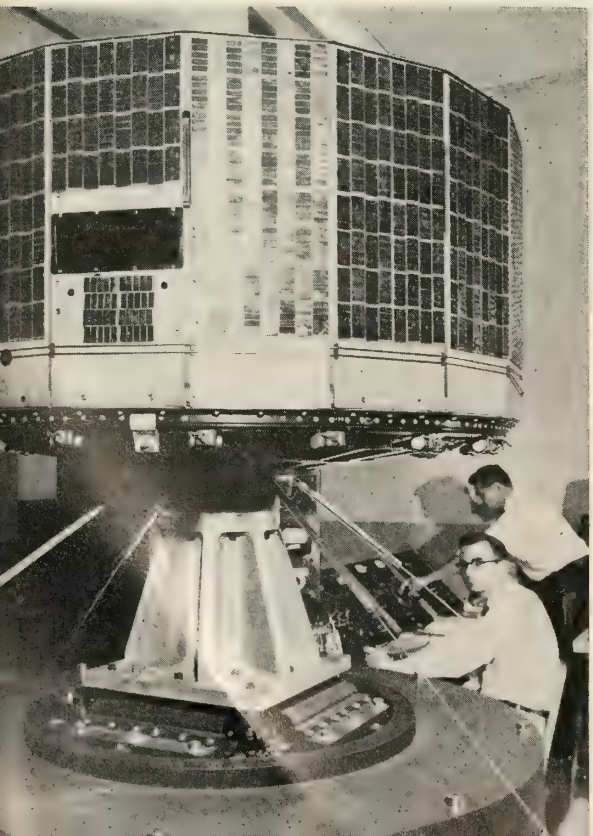
SAMOS (Air Force)

Type: Reconnaissance satellite
Status: R&D
Prime contractor: Lockheed Aircraft Co.
Performance: Orbit — Polar, several hundred miles.
Deployment: Initially operational—late 1963. Number of satellites—less than 6.
Instrumentation: System contractor—Lockheed.
Booster: System contractor—Convair. Type—Atlas. Propellant—liquid.
Sustainer: System contractor—Lockheed. Type—Agena. Propellant—liquid.
Remarks: Samos will provide a continuous reconnaissance of the world.



SPUTNIK III REPLICA

TIROS CHECKOUT



SPUTNIKS I to III (Russia)

Type: Data-collecting experimental satellites.
Status: No longer in orbit.
Performance: Orbits—(SI) 142/588; life 10/4/57 to 1/4/58. (SII) 140/1038; life 11/3/57 to 4/14/58. (SIII) 135/1167; life 5/15/58 to 3/15/60.
Frame: Diameter—(SI) 22.8 in. (SII) undisclosed. (SIII) 11 ft. 9 in. long, 5 ft. 8 in. wide at base. Launch weight—(SI) 184 lbs. (SII) 1120 lbs. (SIII) 2925 lbs.
Payload: (SI) transmitters, measuring instrumentation. (SII) transmitters, measuring instrumentation, dog "Laika." (SIII) transmitters, measuring instrumentation.
Boosters: In all three cases the Soviets used large military rockets. Thrust—about 600,000 lbs.
Power units: (SI) chemical batteries. (SII) chemical batteries. (SIII) chemical batteries and solar cells.

COURIER (Army-ARPA)

Type: Delayed-repeater communications satellite
Status: Operational 1960
Prime contractor: Army Signal Research and Development Laboratories.
Performance: Orbit—about 650 n. miles. Operational life—about 1 year.
Frame: System contractor—Philco Corp. Diameter—about 50 in. Launch weight—about 475 lbs.
Instrumentation: System contractor — Philco. Type — microwave receivers, VHF transmitters.
Booster: System contractor—Douglas. Type—Thor.
Sustainer: System contractor—Aerojet. Type—Able-Star.
Power units: Type—solar cells (about 20,000); nickel-cadmium batteries.
Remarks: Courier will be the nation's first active satellite communications system. Follow-on systems under development by ARPA and the Army and Air Force are generally lumped under the project name—Advent. These include polar-orbiting and 24-hour instantaneous repeater satellites.

TIROS (NASA)

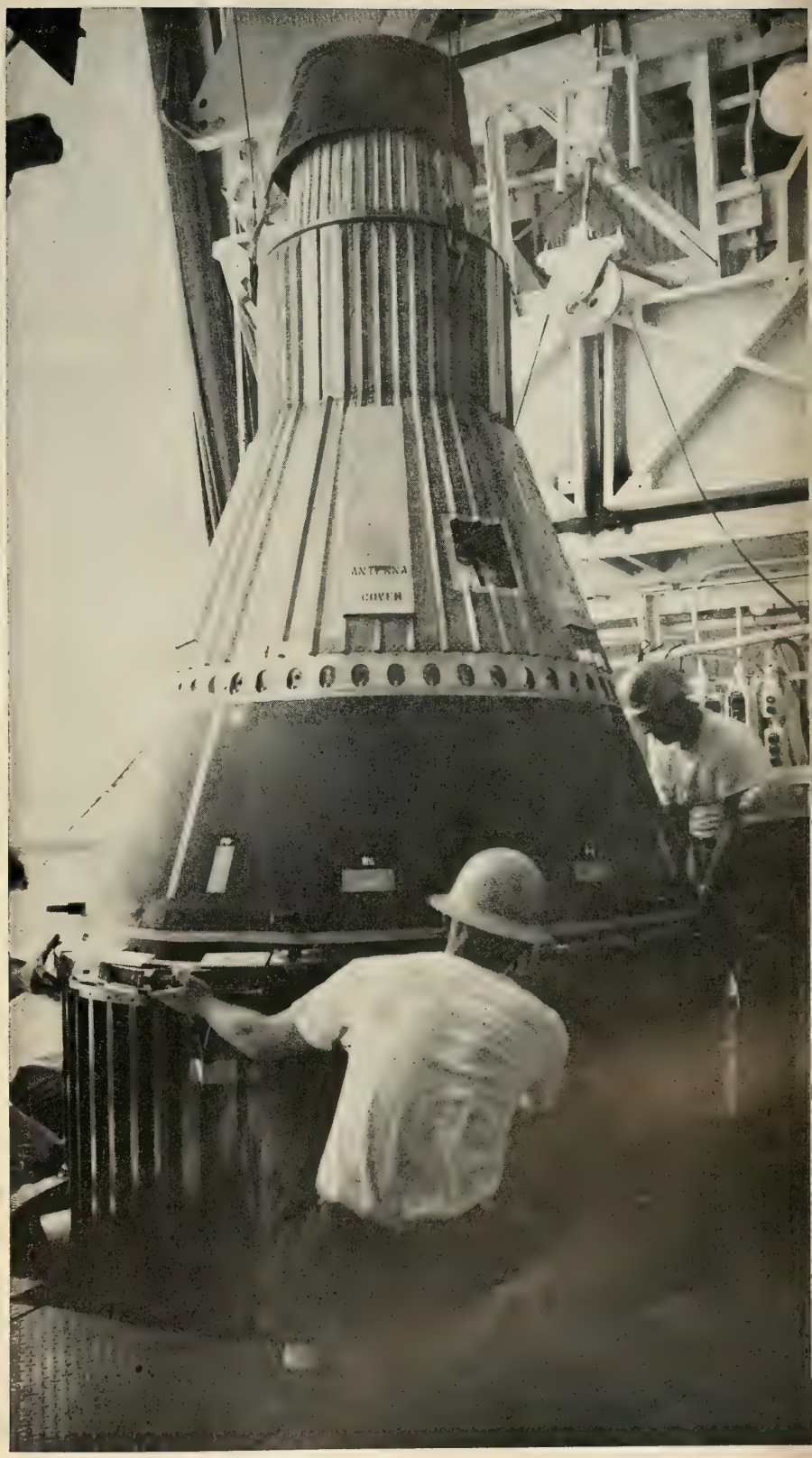
Type: Weather observation satellite
Status: R&D
Prime contractor: RCA
Performance: Photographs cloud cover and transmits on ground command.
Frame: System contractor—RCA. Diameter — 42 in. Height—19 in. Weight—270 lbs.
Instrumentation: System contractor—RCA. Types—Narrow and wide-angle camera, magnetic drag measurement.
Power units: System contractor—Hoffman Electronics. Type—solar cells.
Remarks: Tiros I transmitted 22,952 pictures during 78-day life. A second shot is planned for the fourth quarter of 1960. An advanced Nimbus weather satellite is scheduled for the fourth quarter of 1961.

MERCURY (NASA)

Type: Manned earth-orbiting capsule
Status: R&D
Prime contractor: McDonnell Aircraft Co.
Performance: Orbit—about 120 miles. Initially operational—1961.
Frame: System contractor—McDonnell. Length—9.5 ft. Diameter—6.5 ft. Weight—about 2000 lbs.
Instrumentation: System contractor—McDonnell. Types and functions — physio-psychological; attitude; navigation.
Boosters: System contractors—Convair/Redstone. Type — Atlas and Redstone. Propellant—liquid.
Power Units: System contractor —McDonnell. Type—battery. Life—mission plus 12 hours. Output—(6) 1500 watt/hour batteries.
Remarks: Initial flights call for boosting first unmanned, then manned capsules down the Atlantic Missile Range.

ECHO (NASA)

Type: Inflated balloon passive communications satellite
Status: R&D
Prime contractor: NASA
Performance: Reflect radio signals off surface of 100-ft. sphere.
Frame: Plastic film—G. T. Schjeldahl Co. Gas container—Kaiser Fleetwings Inc.
Instrumentation: None. Telemetry beacon in third stage rocket.
Power units: Mercury batteries.
Boosters: Thor-Delta.
Remarks: First attempt to launch sphere in 1000-mile circular orbit failed May 13.



MERCURY INSPECTION



VANGUARD

VANGUARD (NASA)

Type: Data-collecting experimental satellite

Status: Phased out

Prime contractor: NRL

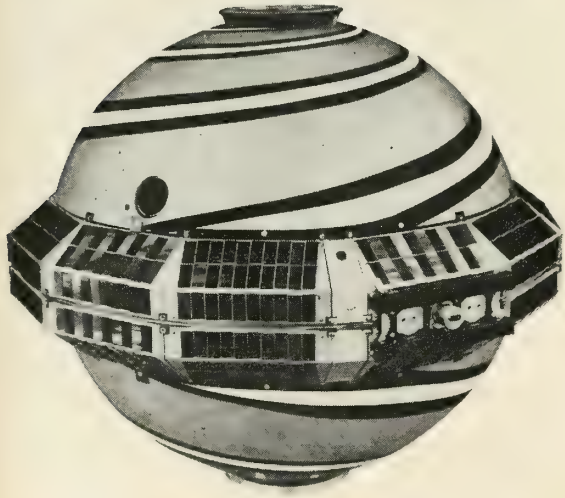
Performance: Report on space environment

Frame: System contractor—NRL. Dimensions—Sphere 6 in. or 20 in. diameter.

Instrumentation: NRL. Types—measurement of temperatures, geodetic measurements.

Power units: Mercury batteries and solar converters

Remarks: Vanguard I, still transmitting, has provided important data on the shape of the earth.



TRANSIT

TRANSIT (Navy-ARPA)

Type: Navigation satellite.

Status: R&D

Prime contractor: Applied Physics Laboratory.

Performance: Orbit—about 500 n. miles. (2 polar, 2 equatorial.)

Deployment: Initially operational about 1962. Number of satellites—four.

Frame: System contractor—APL. Configuration—36 in. sphere. Weight—(Transit-1B) 265 lbs.; (Transit IIA) 223 lbs. (Operational weight about 50 lbs.)

Instrumentation: System contractor — APL. Type — two ultra-stable oscillators, IR scanner, electronic clock.

Booster: System contractor—Douglas. Type—Thor. Propellant—liquid.

Sustainer: System contractor—Aerojet. Type—Able-Star. Propellant—liquid.

Power Units: Solar cells and storage batteries.

Remarks: Transit IIA was successfully launched into a 563/460 mile orbit June 22, 1960. It carried a piggy-back satellite—NRL I—into orbit with it and released it, thereby becoming the first two-in-one satellite. Transit will enable surface ships and submarines —particularly Polaris submarines—to fix their position by better than a quarter of a mile.



DISCOVERER

DISCOVERER (Air Force)

Type: Experimental military satellite series

Status: R&D

Prime contractor: Lockheed Aircraft Co.

Performance: Orbit—ellipitical and varied. (polar)

Frame: System contractor—Lockheed. Length—19.2 ft. Diameter—5 ft. Weight—about 1700 lbs.

Re-entry vehicle: System contractor — General Electric. Type—capsule. Length—27 in. Diameter—33 in. Weight—about 300 lbs.

Instrumentation: IR horizon scanner, telemetry, other instrumentation varied.

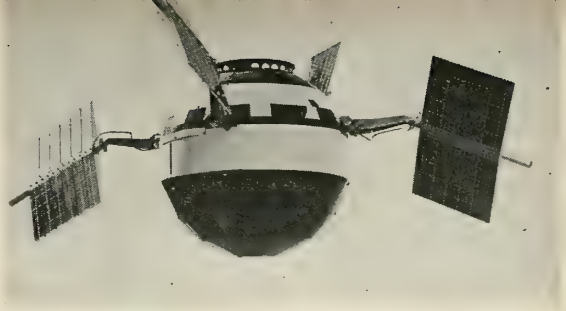
Booster: System contractor—Douglas. Type—Thor. Propellant—liquid.

Sustainer: System contractor—Lockheed. Type—Agena. Propellant—liquid.

Remarks: The Discoverer program beginning early in 1959 has launched a series of R&D satellites into orbit aimed at stabilization of a satellite in space and recovery of a capsule from orbit. While other objectives have been achieved, the Air Force failed to recover a capsule through the first dozen tries. The program calls for eventual recovery of mice and monkeys in the capsule, which would be either air-snatched by planes or picked up by ship. Discoverer is closely tied to the Samos and Midas programs.

PADDLEWHEEL (NASA)

Type: Data-collecting experimental satellite
Status: Operational
Prime contractor: STL
Performance: Report on space environment.
Frame: System contractor—STL. Dimensions variable. Weight —94 to 372 lbs.
Instrumentation: Various scientific groups. Types—Measurement of radiation, magnetism, radio background, aspect; photo scanning.
Power units: System contractor —Hoffman Electronics. Type —solar cells (on paddlewheel vanes).
Remarks: The Explorer VI satellite and the Pioneer V space probe were paddlewheel payloads. Another will be carried on the forthcoming Atlas-Able moon probe.



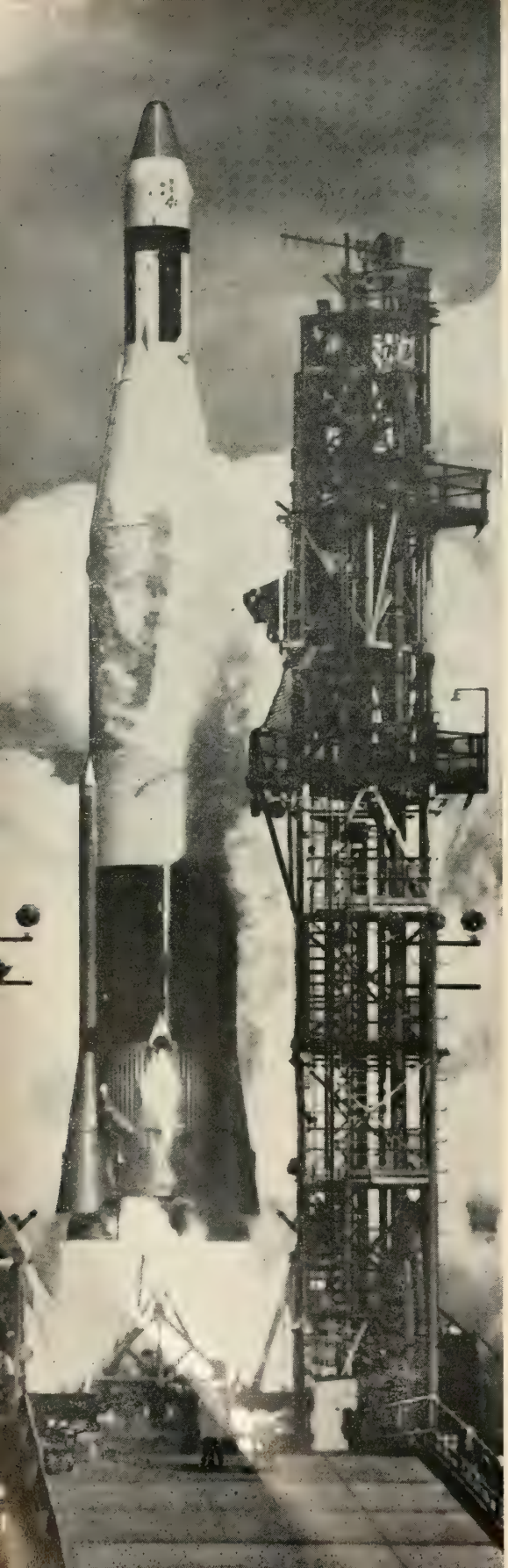
PADDLEWHEEL

DEEP SPACE PROBES

Name and Country	Weight (lbs.)	Launch Vehicle	Launch Date	Trajectory and Purpose	Remarks
LUNIK I (MECHTA), RUSSIA	3245	N.A.	1/ 2/59	Escape earth in direction of moon	Believed in 15 mo. solar orbit; passed within 5000 miles of moon
PIONEER IV, U.S.	13.4	JUNO II	3/ 3/59	Escape earth in direction of moon	In solar orbit of about 12 mo.; passed within 35,000 miles of moon
LUNIK II, RUSSIA	780 (incl. final stage)	N.A.	9/12/59	Lunar impact; radiation and magnetism measurements	Achieved impact
LUNIK III, RUSSIA	About 614	N.A.	10/ 4/59	Earth-moon orbit, apogee 291,000 mi., perigee 30,000 mi., very long lifetime	Took first picture of far side of moon
PIONEER V, U.S.	94.8	THOR-ABLE	3/11/60	Solar orbit between earth and Venus orbits; long-range radio communications; radiation, space environment measurements	Transmitted data more than 20 million miles; 5-watt transmitter weakening but still in operation

SATELLITES IN ORBIT

Name and Country	Weight (lbs.)	Launch Vehicle	Launch Date	Est. Life	Current Apogee & Perigee (mi.)	Purpose	Remarks
EXPLORER I, U.S.	30.8	JUPITER C	1/31/58	3-5 yrs.	1198.5; 216.8	Radiation measurement	Discovered Van Allen belt
VANGUARD I, U.S.	3.25	VANGUARD	3/17/58	200-1000 yrs.	2462.9; 405.7	Test VANGUARD concept	Solar battery-powered radio still operating
VANGUARD II, U.S.	20.7	VANGUARD	2/17/59	50 yrs.	2050.4; 345.8	Test weather-scan concept	
EXPLORER VI, U.S.	142	THOR-ABLE	8/ 7/59	1 yr.	26,357; 156 (at last report)	Radiation, space environment measurements	First "paddlewheel" satellite
VANGUARD III, U.S.	About 100	VANGUARD	9/18/59	30-40 yrs.	2321; 320.8	Radiation, space environment measurements	Ended VANGUARD program
EXPLORER VII, U.S.	91.5	JUNO II	10/13/59	20 yrs.	672.7; 343.7	Radiation, space environment measurements	Still transmitting some data
DISCOVERER V CAPSULE, U.S.	Under 300	THOR-AGENA	8/13/59	Several months	1074; 134	Carry satellite, which came down 9/28	Believed destroyed, later discovered & thought Russian
TIROS I, U.S.	270	THOR-ABLE	4/1/60	50-100 yrs.	468.3; 428.9	Picture-taking weather satellite	Transmitted 22,952 cloud-cover photos in 78-day instrument lifetime
TRANSIT IB, U.S.	265	THOR-ABLESTAR	4/13/60	16 mo.	454.6; 229	First R&D Navigational satellite	ABLESTAR achieved first known restart in space
SPUTNIK IV, Russia	10,008	N. A.	5/15/60	Fairly brief	409; 181	Test support systems cabin for manned flight; attempted return from orbit	Original apogee 229, perigee 188; poor retro orientation spoiled return attempt
MIDAS II, U.S.	5000	ATLAS-AGENA A	5/24/60	40 mo.	319.6; 300.1	IR scanning for early warning of missile launchings	Telemetry failed 5/26; AGENA B restarted in space
TRANSIT II-A, U.S.	223	THOR-ABLESTAR	6/22/60	50 yrs.	650.4; 389.1	Second R&D navigational satellite	Carried "piggyback" for first twin satellite launching
GREB, U.S.	40	THOR-ABLESTAR	6/22/60	50 yrs.	650.4; 389.1	Radiation measurements	Passenger aboard TRANSIT II-A



SPACE VEHICLES

ATLAS-AGENA (Air Force and NASA)

Type: Launch vehicle

Status: Operational with Agena A. R&D with Agena B.

Prime contractor: None

Performance: (Payload in 300-mile orbit): Agena A—3600. Agena B 5300. Agena B will accelerate 800 lbs. to escape velocity.

Frame: Manufacturers—Convair, Lockheed. Length overall—99-101 ft. Diameter—10 ft. Gross weight—Agena A 265,000 lbs., Agena B 275,000 lbs. Major material—steel.

Propulsion: All liquid.

Guidance: (Only Agena B) Minneapolis-Honeywell. Type: All-inertial.

Stages: 1. Modified Atlas ICBM. 2. Agena. Engine—Bell XLR-81.

Remarks: Atlas-Agena A first flown successfully May 24, 1960, to launch Midas II. Atlas-Agena B to begin service in 1961.

ATLAS-ABLE (NASA)

Type: Early deep space launch vehicle.

Status: Two shots this year, then phase-out.

Prime contractor: None.

Performance: Escape velocity—800 lbs.

Frame: Length—112 ft. Diameter—10 ft. Gross weight—255,000 lbs.

Propulsion: 2 liquid stages, 1 solid.

Guidance: Only in booster stage.

Stages: 1. Modified Atlas ICBM. 2. Able. 3. Hercules-ABL Altair.

Remarks: First two shots failed in 1959. Shortage of Atlas vehicles delayed backup shot until this summer or fall.

SCOUT (NASA)

Type: Launch vehicle for small satellites.

Status: R&D.

Prime contractor: NASA Langley Research Center.

Performance: 300-mile orbit—about 200 lbs.

Frame: Manufacturer—Chance Vought. Length overall—72 ft. Diameter—40 in. Gross weight—36,100 lbs. Major materials—steel and plastic.

Propulsion: All solid. .

Stages: 1. Aerojet Algol. 2. Thiokol Castor. 3. Hercules-ABL Antares. 4. Hercules-ABL Altair.

Guidance: Minneapolis-Honeywell. Type—semi-inertial.

Remarks: Flight tests of full vehicle began this month; to be operational this year. After next year will replace all liquid-propelled vehicles for orbiting small payloads. Air Force has similar vehicle called Hyper-Environmental Test System 609A.

LEFT: ATLAS-AGENA



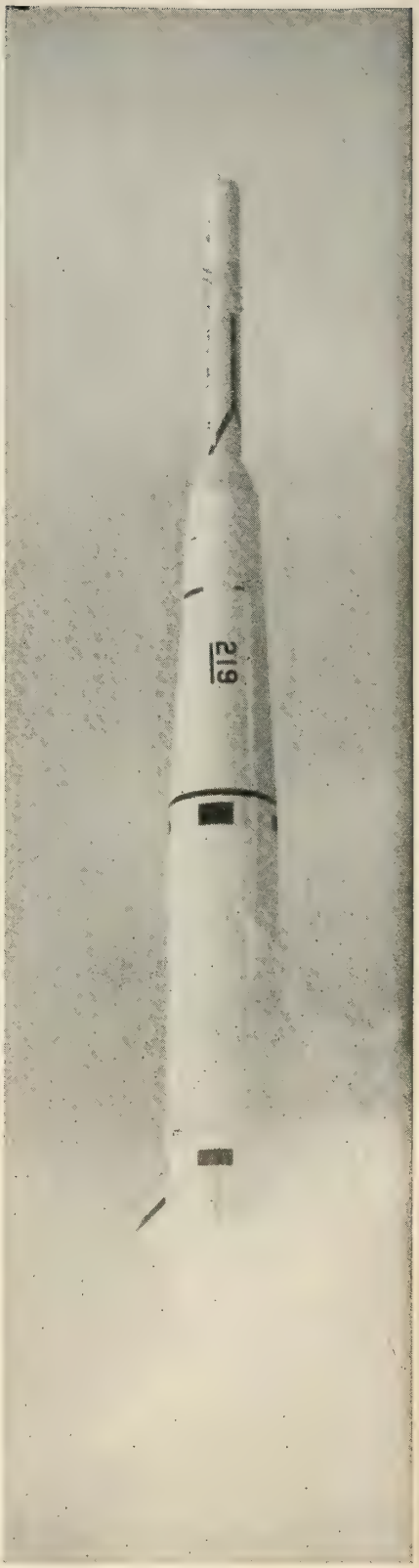
THOR-ABLESTAR

THOR-ABLE, THOR-ABLESTAR, THOR-DELTA (Air Force, NASA)

Type: Launch vehicle
Status: Thor-Able now phased out. Thor-Ablestar operational. Thor-Delta becoming operational.
Prime contractor: Douglas, except Aerojet-General for Ablestar vehicle stage.
Performance (payload in 300-mile orbit: Able—200 lbs. Ablestar—800 lbs. Delta—480 lbs.
Frame: Length overall—Able & Delta 92 ft., Ablestar 90 ft. Diameter—8 ft. Gross weight—Able 105,000 lbs., Ablestar 110,000 lbs. Delta 112,000 lbs. Major material—aluminum.
Propulsion: Able & Delta 2 liquid stages and one solid. Ablestar 2 liquid.
Guidance: (only Delta) Bell Telephone. Type: radio command.
Stages: 1. Modified Thor IRBM. 2. Able, Ablestar or Delta. 3. (Able and Delta only) Hercules-ABL Altair.
Remarks: The original Thor-Able, which made use of upper stages developed for Vanguard, was used successfully in some of this country's earliest launches. Thor-Ablestar, with a restartable, scaled-up Able, is used in the Navy's Transit program and will be used for the Army's Courier satellites. Delta, which coasts for 15 minutes before ignition of the guided third stage, is used for the Echo 100-ft. balloon satellite and a variety of other NASA programs.

CENTAUR (NASA)

Type: Multipurpose launch vehicle.
Status: R&D.
Prime contractor: Convair.
Performance: 300-mile orbit—8500 lbs. Escape velocity—1450 lbs.
Frame: Length overall—105 ft. Diameter—10 ft. Gross weight—291,000 lbs. Major material—steel, aluminum.
Stages: 1. Modified Atlas ICBM. 2. Centaur. Manufacturer—Convair; engines—Pratt & Whitney LR-115 (2).
Guidance: Minneapolis-Honeywell. Type—all-inertial.
Remarks: First flight 1961. Will provide for the first time U.S. lift capacity equal to Sputnik I and will be most powerful U.S. vehicle until Saturn is available.



THOR-ABLE IV



SATURN SPACE VEHICLE'S SUPER BOOSTER

SATURN C-1 (NASA)

Type: Multipurpose launch vehicle for very heavy payloads.

Status: R&D.

Prime contractor: NASA Marshall Center.

Performance: 300-mile orbit—22-25,000 lbs. Escape velocity —9000 lbs.

Frame: Length overall (without payload)—150 ft. Diameter—22 ft. Gross weight—1,000,000 lbs. Major material—aluminum.

Propulsion: All liquid.

Guidance: NASA Marshall center. Type—all-inertial.

Stages: 1. Saturn booster. Manufacturer—NASA Marshall Center; engines—Rocketdyne H-1 (8).

2. S-4. Manufacturer-Douglas; engines—Pratt & Whitney LR-115 (4)

3. S-5. Manufacturer-Convair; engines—Pratt & Whitney LR-115 (2)

Remarks: First flight 1961 with dummy upper stages. First three-stage vehicle flight 1963. Operational 1964. Next vehicle, Saturn C-2, will have stage made of 4 Rocketdyne J-2 engines inserted between first and second stages of C-1. A third Saturn may be an all-chemical vehicle with another J-2 stage inserted just above the J-2 stage in the C-2, or it may be a chemical-nuclear vehicle.

The Saturn program, begun under ARPA and the Army and transferred to NASA this year, is the civilian space agency's "main chance" space vehicle in the international space race. The Saturn vehicle in its later forms will be capable of sending a manned spacecraft around the moon. It also will be capable of putting into orbit around the earth multi-ton segments of a space station for assembly there.

THOR-AGENA (Air Force and NASA)

Type: Launch vehicle
Status: Operational with Agena A. R&D with Agena B.
Prime contractor: None
Performance: Agena A—300 lbs. in 300-mile orbit. Agena B—1600 lbs. in 300-mile orbit.
Frame: Manufacturers—Douglas, Lockheed. Length overall—Agena A 78.6 ft., Agena B 81 ft. Diameter—8 ft. Gross weight—Agena A 118,500 lbs., Agena B about 123,000 lbs. Major material—aluminum
Propulsion: All liquid.
Guidance: (Only Agena B) Minneapolis-Honeywell. Type: All-inertial.
Stages: 1. Modified Thor IRBM. 2. Agena. Engine—Bell XLR-81.
Remarks: Thor-Agena A in use in Discoverer program. Thor-Agena B, with restartable upper stage, will be used by both Air Force and NASA beginning in 1961.

JUNO II (NASA)

Type: Early launch vehicle.
Status: Operational.
Prime contractor: NASA Marshall Center.
Performance: 300-mile orbit—100 lbs. Escape velocity—13½ lbs.
Frame: Length overall—77 ft. Diameter—8¾ ft. Gross weight—122,000 lbs. Major material—aluminum.
Propulsion: 1 stage liquid, 3 solid.
Guidance: Upper stage unguided except spin.
Stages: 1. Modified Jupiter IRBM. 2. Cluster of 11 scaled-down Sergeants. 3. Cluster of 3 scaled-down Sergeants. 4. Scaled-down Sergeant.
Remarks: Launched 3 Pioneers and one Explorer. Four more shots planned this year and next.

JUPITER C (Army)

Type: Launch vehicle.
Status: Phased out.
Prime contractor: ABMA.
Performance: 300-mile orbit—30 lbs.
Propulsion: 1 liquid, 3 solid.
Guidance:: Upper stages unguided except spin.
Stages: 1. Modified Redstone missile. 2. Cluster of 11 scaled-down Sergeants. 3. Cluster of 3 scaled-down Sergeants. 4. Scaled-down Sergeant.
Remarks: Orbited Explorer 1, America's first satellite.

VANGUARD (NASA)

Type: Early launch vehicle.
Status: Phased out.
Performance: Up to 100 lbs. in 300-mile orbit.
Prime contractor: Martin.
Frame: Length—72 ft. Diameter—45 in. Gross weight—22,600 lbs.
Propulsion: 2 liquid stages, 1 solid.
Guidance: Minneapolis-Honeywell. Type—Semi-inertial.
Stages: 1. General Electric X405. 2. Aerojet-General Liquid AJ 10. 3. Hercules-ABL solid X248 (earlier versions used Grand Central Meteor).
Remarks: Orbited three satellites. Components and techniques used in many subsequent space programs.



DISCOVERER ON THOR AGENA

Foreign Missiles

Russia and the United States continue to dominate the world of missilery.

Russia's already large rockets appear to be getting larger as the Soviets push further into space. Meantime, the Soviets are reported to be improving their missile air defenses and rapidly increasing their ICBM strength and their already huge arsenal of tactical missiles.

The other nations of the world continue to lag behind in the field of big missiles. But much work is going on in almost every industrialized country in development of smaller tactical missiles and research rockets.

Next to Russia and the United States, Britain and France are farthest along. Japan also is beginning to move ahead swiftly.

Red China remains a question mark. The Red Chinese are reported to have some missiles and to be developing a nuclear bomb. But the missiles, at least for the present, apparently are of Russian origin.



SEASLUG

GREAT BRITAIN

SEASLUG (Navy)

Type: Surface-to-air
Status: Operational
Prime contractor: W. G. Armstrong Whitworth Aircraft, Ltd.
Performance: Range—long.
Deployment: Location—to be deployed aboard Navy cruisers. Initially operational—1960.
Frame: Length—19.5 ft. Diameter—1.5 ft. Wingspan—4.5 ft.
Guidance: System contractor—General Electric. Type—beam riding.
Booster: Type—solid (4).
Sustainer: Type—solid.
Payload: Warhead type—HE (nuclear later).

FIREFLASH (RAF)

Type: Air-to-air
Status: Operational (training)
Prime contractor: Fairey Aviation Ltd.
Performance: Range — several miles. Speed — more than Mach 2.
Deployment: Location — RAF squadrons use for training.
Frame: Length—7 ft. 5 in. Wing span—28.1 in. Diameter—5.5 in. Launch weight—300 lbs.
Guidance: Type—beam riding.
Booster: Type—solid. Number—two.
Payload: Type—HE.
Remarks: Fireflash has been replaced as an operational missile by the Firestreak.

BLUE STEEL (RAF)

Type: Air-to-surface (tactical)
Status: R&D
Prime contractor: A. V. Roe & Co., Ltd.
Performance: Range—about 400 miles. Speed—supersonic. Ceiling—about 60,000 ft.
Deployment: Location—to be air-launched from British V-bombers.
Frame: Length—36 ft. Wingspan—about 13 ft. Launch weight—about 15,000 lbs.
Guidance: System contractor—Elliott. Type-inertial.
Powerplant: Propellant—liquid
Booster: System contractor—de Havilland. Propellant—liquid. Thrust—16,000 lbs.
Payload: Warhead type—nuclear or HE.

BLOODHOUND I (RAF)

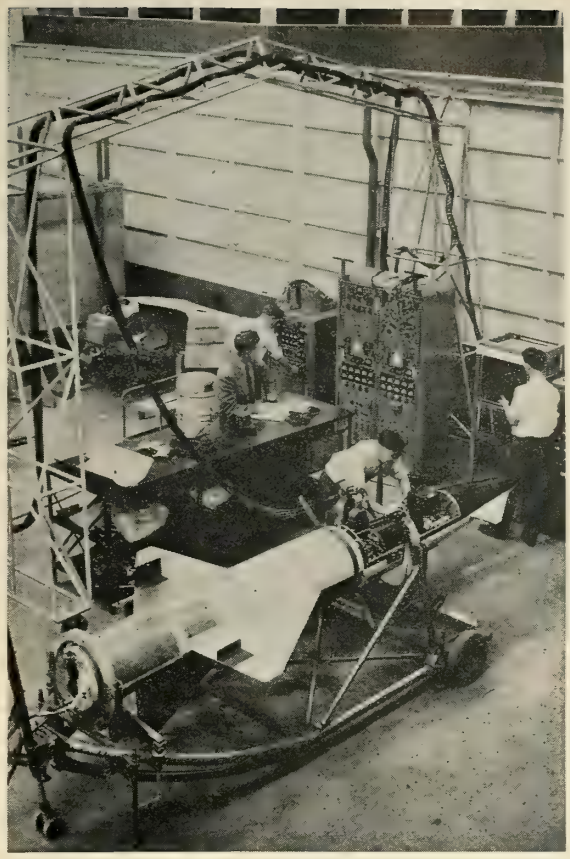
Type: Air-breathing surface-to-air
Status: Operational
Prime contractor: Bristol Aircraft Ltd.
Performance: Range—about 35 miles. Speed—Mach 2.3.
Deployment: Location—combat units in Britain and Australia. Also has been sold to Sweden.
Frame: Length—25.2 ft. Launch weight—4500 lbs.
Guidance: System contractor—Ferranti, Ltd. Type—radar homing.
Boosters: Type—solid (4)
Sustainers: System contractor—Bristol-Siddeley. Engine—Thor ramjets. Thrust—total 15,000 lbs.
Remarks: Bristol Aircraft is developing an advanced version called Bloodhound II. It will have anti-missile capability.

Pye P.V.

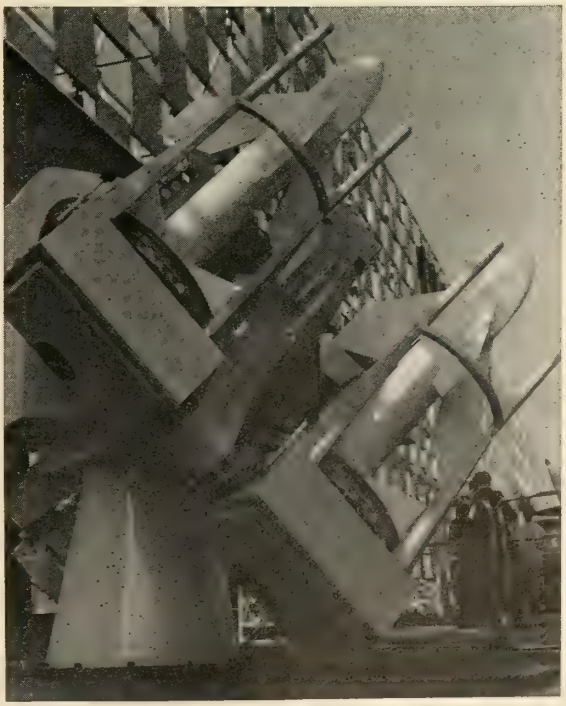
Type: Surface-to-surface (anti-tank)
Status: R&D
Prime contractor: Pye, Ltd.
Performance: Not available.
Frame: Length—5 ft. Fin span—2 ft. Launch weight—80 lbs.
Booster: Propellant—solid
Guidance: Type—wire.
Powerplant: Type—2 stage solid.
Remarks: Proposals submitted.

SEACAT (Navy)

Type: Surface-to-air
Status: Operational
Prime contractor: Short Bros. and Harland Ltd.
Performance: Range—short.
Deployment: Location—aboard Royal Naval destroyers and cruisers. Also ordered by Swedish, Australian and New Zealand navies. Initially operational—1960.
Guidance: Type—radio command.
Frame: Length—4 ft. 10 in. Wingspan—2 ft.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE.
Remarks: Four missiles on one battery.



BLUE STEEL



SEACAT

VIGILANT

Type: Surface-to-surface (anti-tank)
Status: Operational
Prime contractor: Vickers-Armstrongs, Ltd.
Performance: Range—about 1700 yards. Speed—350 mph.
Deployment: None. NATO countries considering.
Frame: Length—3 ft. Diameter—4.5 ft. Launch weight—about 26 lbs.
Guidance: Type—wire.
Booster: Propellant—solid
Remarks: Designed for use by infantrymen.

RED TOP (RAF)

Type: Air-to-air
Status: R&D
Prime contractor: De Havilland Propellers, Ltd.
Performance: Range—about 9.5 miles. Speed—supersonic.
Deployment: Location—to replace Firestreak on various aircraft.
Guidance: Type—infrared.
Booster: Type—solid.
Payload: Warhead type—HE (68 lbs.).
Remarks: Apparently designed within the same concept as the U.S. Navy's Eagle.

TIGERCAT

Type: Surface-to-air
Status: R&D
Prime contractor: Short Brothers and Harland Co., Ltd.
Performance: Designed as mobile anti-aircraft to be launched from armored carriers.
Remarks: Under consideration by British Army.

FAIREY A-T (Army)

Type: Surface-to-surface (anti-tank)
Status: Study
Prime contractor: Fairey Engineering, Ltd.
Performance: Not available.
Guidance: Type—reported to be radar.

THUNDERBIRD (Army)

Type: Surface-to-air
Status: Operational
Prime contractor: English Electric Aviation, Ltd.
Performance: Range — 25 n. miles. Speed—about Mach 2.
Deployment: Location — with British Army combat troops. Initially operational—1959.
Guidance: System contractor—Marconi Instruments. Type—radar homing.
Booster: System contractor: D. Napier. Type—solid (4).
Sustainer: System contractor: D. Napier. Type—solid.
Payload: Warhead type—HE.
Remarks: Launched from mobile carriers. Advanced Thunderbird with low-level capability and increased range under development.

BLUE WATER (Army)

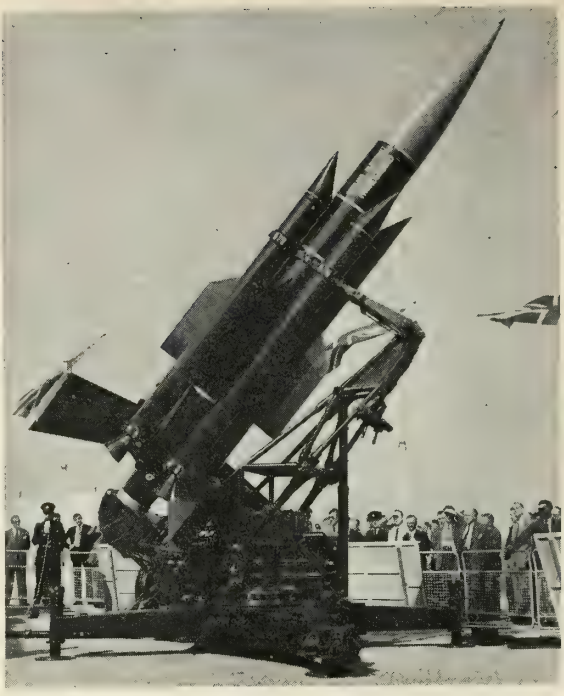
Type: Surface-to-surface (tactical)
Status: Operational
Prime contractor: English Electric Aviation Co., Ltd.
Performance: Range—about 100 miles.
Deployment: British Combat troops. Also sold to West German Army.
Booster: Type—solid.
Payload: Warhead type—nuclear or HE.
Remarks: Highly mobile.

FIRESTREAK (RAF)

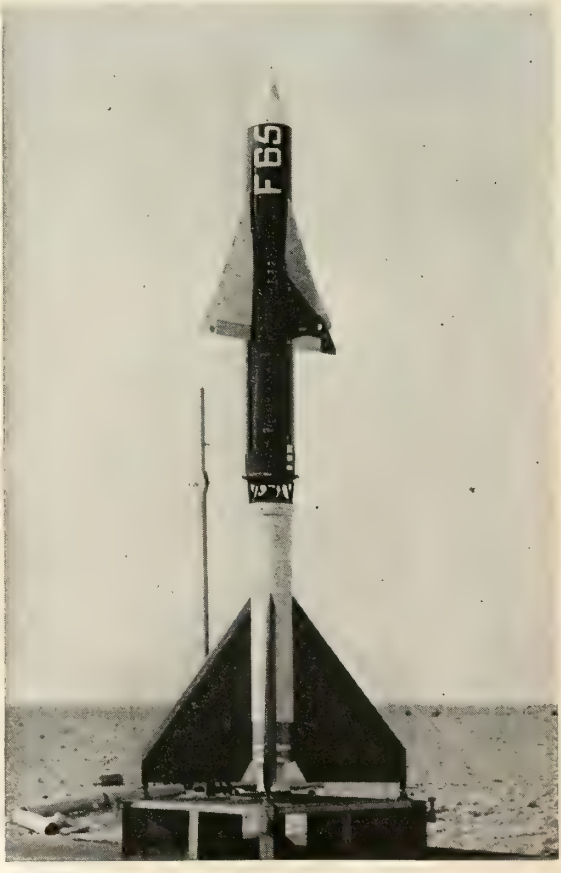
Type: Air-to-air
Status: Operational
Prime contractor: De Havilland Propellers, Ltd.
Performance: Range—about 4.5 miles. Speed—Mach 2.3.
Deployment: Location — with RAF squadrons and air units of the Royal Navy.
Frame: Length—10.5 ft. Diameter—3.5 in. Launch weight —300 lbs.
Guidance: Type—infrared.
Booster: Type—solid.
Payload: Type—HE.

BLUE STREAK (RAF)

Type: IRBM surface-to-surface
Remarks: Program cancelled 1960.



THUNDERBIRD



TRIDENT

FRANCE

TRIDENT (Army)

Military designation: SE 4400
Type: Air-breathing surface-to-air.
Status: R&D
Prime contractor: Sud-Aviation
Performance: Range—24.8 n. miles. Speed—Mach 3.3. Ceiling—164,000 ft.
Deployment: Location—to be used for French space experiments.
Frame: Length—26.5 ft. Launch weight—2640 lbs.
Guidance: Type—radar homing.
Booster: Type—solid.
Sustainer: Type—ramjet.
Payload: Warhead type—HE.

MARUCA (Navy)

Type: Surface-to-air
Status: Operational (training)
Prime contractor: Ruelle Naval Arsenal
Performance: Range—about 10 n. miles.
Deployment: Location — used aboard French Experimental Missile Ship Ile-D'Oléron (converted transport) for training.
Frame: Length—15 ft. Wingspan—5 ft.
Guidance: Type—radar command.
Booster: Type—solid (4).
Sustainer: Type—liquid (nitric acid/aniline).
Payload: Warhead type—HE.
Remarks: Development vehicle for Masurca.

ACAM 5301 (Army)

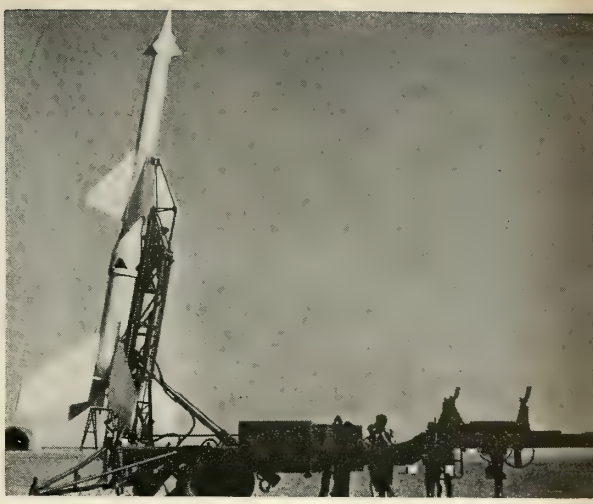
Type: Surface-to-air
Status: R&D
Prime contractor: Nord Aviation
Performance: Range—nearly 10 n. miles. Speed—about Mach 2.
Deployment: Location—to be deployed with Army combat troops, particularly for use against low-flying aircraft.
Frame: Length—14.5 ft. Wingspan—about 5 ft. Launch weight—1600 lbs.
Guidance: Type—radar.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE (nearly 90 lbs.)

MASURCA (Navy)

Type: Surface-to-air
Status: Operational
Prime contractor: Ruelle Naval Arsenal
Performance: Range—more than 20 n. miles. Speed—Mach 2.6.
Deployment: Location—to be installed aboard French warships as the French Navy's top air defense weapon. Initially operational—1960.
Frame: Length—18.5 ft. Wingspan—3 ft. Launch weight—3200 lbs.
Guidance: Type—radar beam rider.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE (220 lbs.)

R-422B2 (Army)

Type: Surface-to-air
Status: Operational
Prime contractor: MATRA
Performance: Range—about 40 n. miles. Speed—Mach 2.6.
Deployment: Location—metropolitan France. Initially operational—1960.
Frame: Length—30.5 ft. Launch weight—3500 lbs.
Guidance: Type—radar command and homing.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE (110 lbs.).
Remarks: R-422B2 is mobile. MATRA R-431, designed to intercept high-altitude supersonic bombers, is under development. R-431 will be powered by a solid booster and a Nord ramjet.



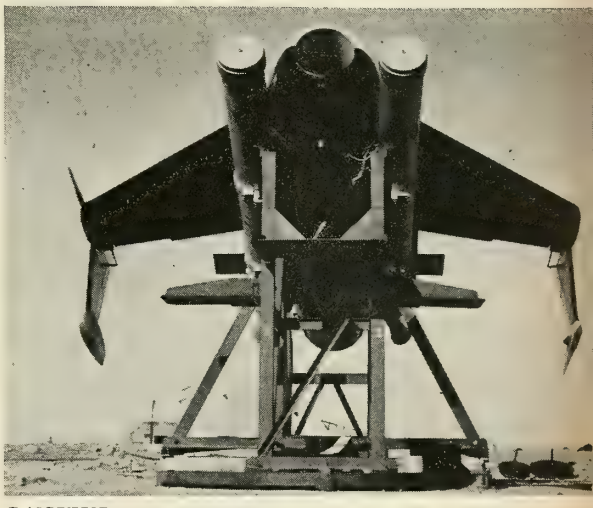
R-422B2

MALAFAC (Navy)

Type: Surface-to-surface
Status: R&D
Prime contractor: Societe Industrielle D'Aviation Latecoere
Performance: Range—about 25 n. miles.
Deployment: Location—to be installed aboard French surface warships.
Frame: Length—20.5 ft.
Guidance: Radio command.
Booster: Type—solid.
Sustainer: Type—liquid (acid/furaline).
Payload: Warhead type—HE.
Remarks: Malafac test missiles have been launched many times at sea.

CAISSEUR (Army)

Military Designation: SE4200
Type: Air-breathing surface-to-surface (tactical)
Status: Operational
Prime contractor: Sud-Aviation
Performance: Range—16 to 55 n. miles. Speed—Mach .8.
Deployment: Location—French Army combat troops. Initially operational—1950.
Frame: Length—11.5 ft. Wingspan—9 ft. 9 in. Launch weight—2075 lbs.
Guidance: Type—radar command.
Booster: Type—solid (2).
Sustainer: Engine—ramjet.
Payload: Warhead type—HE.
Remarks: Launched from mobile carrier.



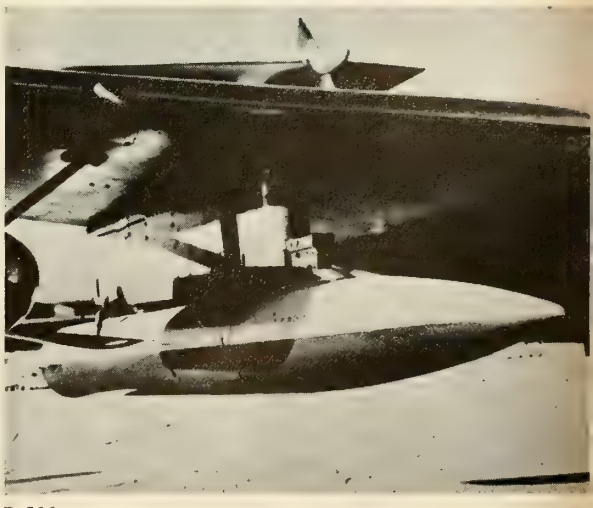
CAISSEUR

AA-20 (Air Force)

Type: Air-to-air and air-to-surface
Status: Operational
Prime contractor: Nord Aviation
Performance: Range—2.5 miles. Speed—supersonic.
Deployment: Location—in hands of Air Force and Navy units.
Frame: Length—8.5 ft. Launch weight—(a/a version) 300 lbs. (a/s version) between 295 and 375 lbs.
Guidance: Type—radio command.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE.
Remarks: Nord has an adaptation of the AA-20—the ACAM 5301—under development for the French Army. Also the follow-on AA-30 for the Air Force.

R-511 (Air Force)

Type: Air-to-air
Status: Operational
Prime contractor: MATRA
Performance: Range—about 5 miles. Speed—supersonic.
Deployment: Location—carried aboard French interceptors.
Frame: Length—10 ft. Diameter—10 in. Launch weight—about 400 lbs.
Guidance: Type—radar homing.
Booster: System contractor—Hotchkiss-Brandt. Type—solid. Thrust—3500 lbs.
Sustainer: System contractor—Hotchkiss-Brandt. Type—solid. Thrust—440 lbs.
Payload: Warhead type—HE.
Remarks: To be replaced by advanced MATRA R-530 about 1962.



R-511

SS-12 (Army)

Type: Surface-to-surface (anti-tank)
Status: R&D.
Prime contractor: Nord Aviation.
Performance: Range—more than 4 miles. Speed—Mach 1.
Deployment: Location—to be deployed with French Army combat troops. Also, can be launched from light aircraft and helicopters.
Frame: Length—about 6 ft. Wingspan—about 32 in. Launch weight—150 lbs.
Guidance: Type—wire. Also radar version.
Booster: Type—solid.
Payload: Warhead type—nuclear and HE.
Remarks: SS-12 scheduled to be in production by May 1961. SS-12 is an advanced version of the Nord SS-10 and SS-11 (See U.S. missiles) which are in the hands of a large number of NATO armies.

MASALCA (Navy)

Type: Air-breathing surface-to-air
Status: Nearly operational
Prime contractor: Societe Industrielle d'Aviation Latecoere
Performance: Range—about 65 n. miles.
Deployment: Location—aboard French cruisers. Initially operational—1960.
Frame: Launch weight—6000 lbs.
Guidance: Type—beam rider.
Booster: Type—solid.
Sustainer: Type—ramjet.
Payload: Warhead type—HE.

SSBS-1

Type: IRBM surface-to-surface
Status: R&D
Prime contractor: Societe d'Etude et de Realisation d'Engins Balistiques
Performance: Range—2300 n. miles.
Payload: Warhead type—nuclear.

MALAFON (Navy)

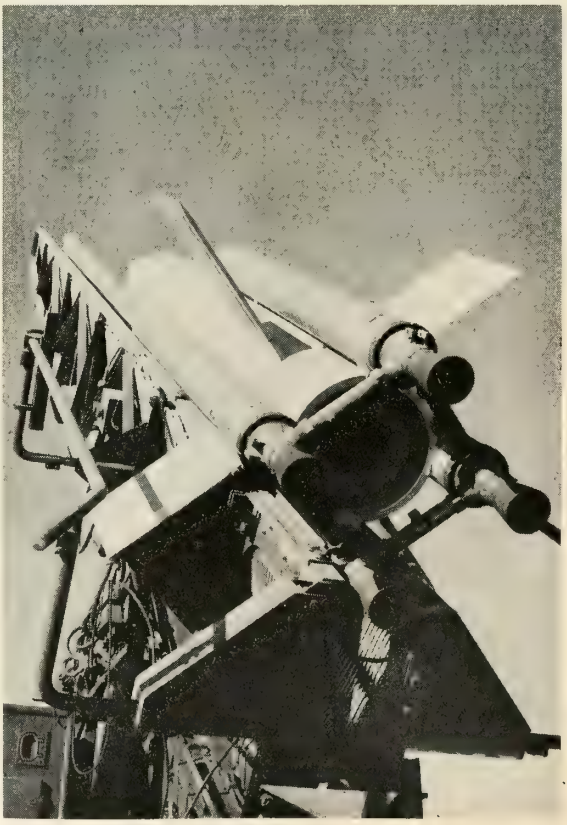
Type: Surface-to-underwater (ASW)
Status: Nearly operational
Prime contractor: Societe Industrielle d'Aviation Latecoere
Performance: Range—more than 10 n. miles.
Deployment: Location—first deployed aboard the 3750-ton ASW Command Ship La Galissoniere. Initially operational—fall 196[illegible]
Frame: Type—rocket-boosted homing torpedo similar to U.S. Navy's Asroc.
Guidance: Type—sonar and radio command.
Booster: Type—solid.
Payload: Warhead type—HE



SS-12

BB-10 (Air Force)

Type: Air-to-surface
Status: Operational
Prime contractor: Sud-Aviation
Performance: Speed—Mach 1.
Deployment: Location—deployed with French Air Force.
Frame: Length—11 ft. Wingspan—2.5 ft. Launch weight—900 lbs.
Guidance: Type—radio command. (BB-10 carries TV camera so pilot can guide the missile to its target.)
Booster: Type—solid.
Payload: Warhead type—HE.



PARCA

ENTAC (Army)

Type: Surface-to-surface (anti-tank)
Status: R&D
Prime contractor: Nord Aviation
Performance: Range—about 1 mile. Speed—about 180 mph.
Guidance: Type—wire.
Booster: Type—solid.
Payload: Warhead type—HE.
Remarks: Recently turned over to Nord by DEFA.

PARCA (Army)

Type: Surface-to-air
Status: Operational
Prime contractor: DEFA
Performance: Range—15 miles. Speed—supersonic. Ceiling—80,000 ft.
Deployment: Location—in hands of French combat troops. Used mainly for training.
Frame: Length—18 ft. Launch weight—2200 lbs.
Guidance: System contractor—C. F. Thomson. Type—radar command.
Booster: Type—solid (4).
Sustainer: Type—solid.
Payload: Warhead type—HE.
Remarks: Advanced for use against Mach 3 aircraft under development.

ITALY

HSS-R 80/100

Type: Surface-to-surface (tactical)
Status: Operational
Prime contractor: Boscarri, Meccanemica, Hispano-Suiza
Deployment: Location—Egyptian troops.
Guidance: Type—free.
Booster: Type—solid.
Payload: Warhead type—HE.
Remarks: Bombardment rockets fired in salvoes of 20.

C-7 (Air Force)

Type: Air-to-air
Status. Nearly operational
Prime contractor: Societa Italiana Sviluppo Propulsione a Reazione
Performance: Range—6 miles. Speed—Mach 1.9.
Deployment: Location—aboard Italian Air Force interceptors.
Frame: Length—6.5 ft. Wingspan—25 in. Diameter—6 in. Launch weight—155 lbs.
Guidance: Type—infrared.
Booster: System contractor—Thiokol. Type—solid.
Payload: Warhead type—HE (55 lbs.)
Remarks: Later models to have alternate radar guidance and Italian booster.

AIRONE (Army)

Type: Surface-to-surface (tactical)
Status: Operational
Prime contractor: Polverificio Giovanni Stacchini
Performance: Range—6 miles.
Guidance: Type—free.
Booster: Type—solid.

SWITZERLAND

RSD-58

Type: Surface-to-air
Status: Operational
Prime contractor: Contraves AG and Oerlikon Machine Tool Works Buhrle & Co.
Performance: Range—18.6 miles. Speed—Mach 2.5. Ceiling—65,000 ft.
Deployment: Location—Combat units in Switzerland, Italy and Japan.
Frame: Length—20 ft. Launch weight—about 900 lbs.
Guidance: System contractor—Brown, Boveri & Co. Type—beam rider.
Booster: Type—liquid.
Payload: Warhead type—HE.
Remarks: RSA-54 is an earlier model. RSC-57 is a training model.

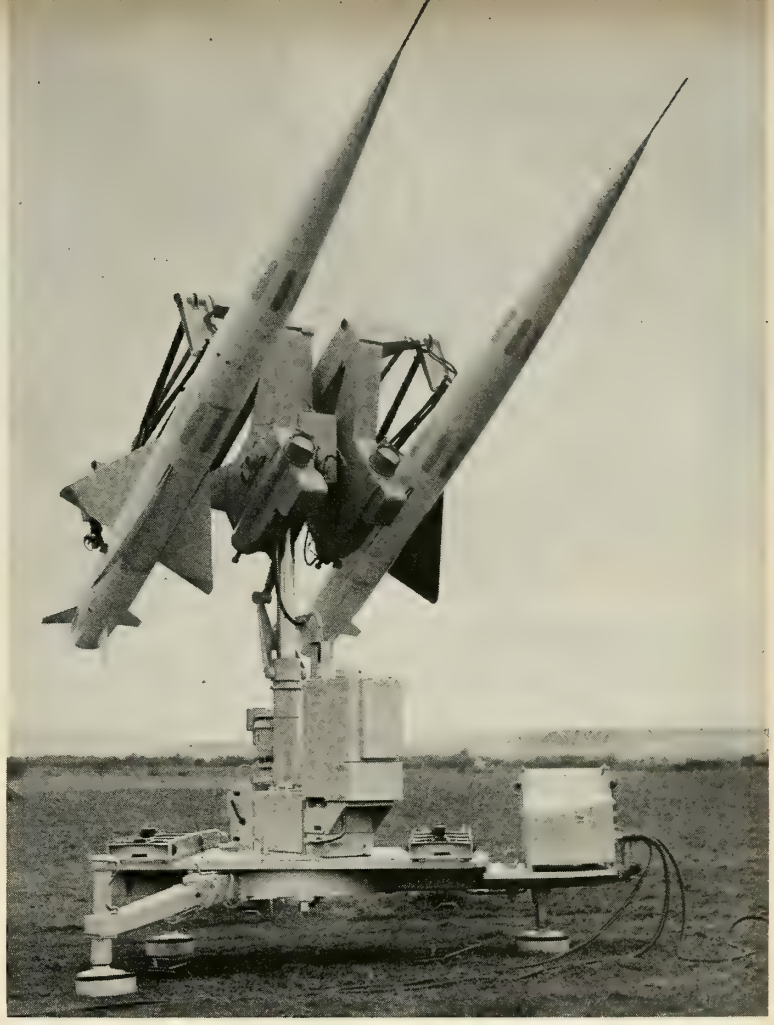
MOSQUITO (Army)

Type: Surface-to-surface (anti-tank)
Status: Operational
Prime contractor: Contraves AG and Oerlikon Machine Tool Works Buhrle & Co.
Performance: Range — about 6200 ft. Speed—200 mph.
Deployment: Location — Swiss Army units.
Frame: Length—3 ft. Launch weight—23 lbs.
Guidance: Type—wire.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE (7 lbs.).

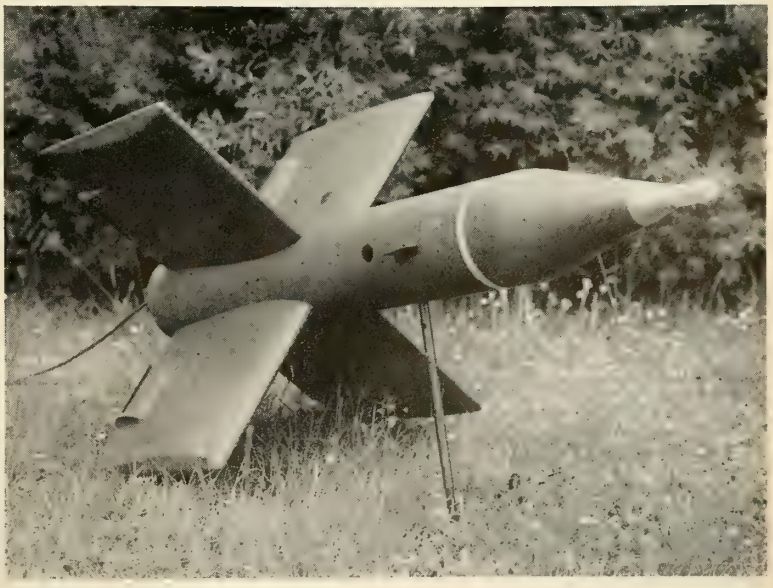
AUSTRALIA

MALKARA (Army)

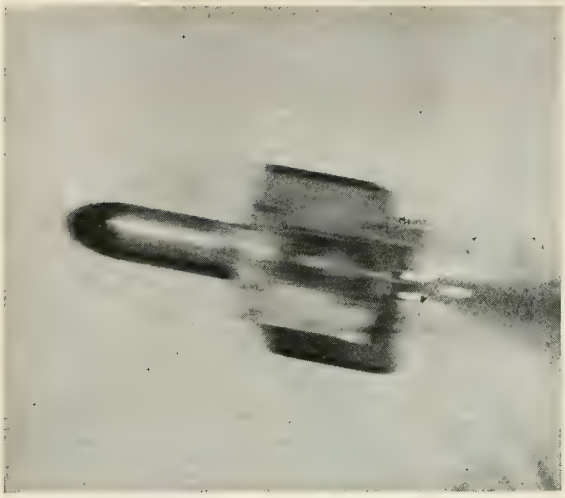
Type: Surface-to-surface (anti-tank)
Status: Operational
Prime contractor: Government Aircraft Factories
Performance: Range—about 2 miles.
Deployment: Location — British combat troops.
Frame: Length—6.5 ft. Wingspan—2.5 ft. Launch weight—206 lbs.
Guidance: Type—wire.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE (55 lbs.).



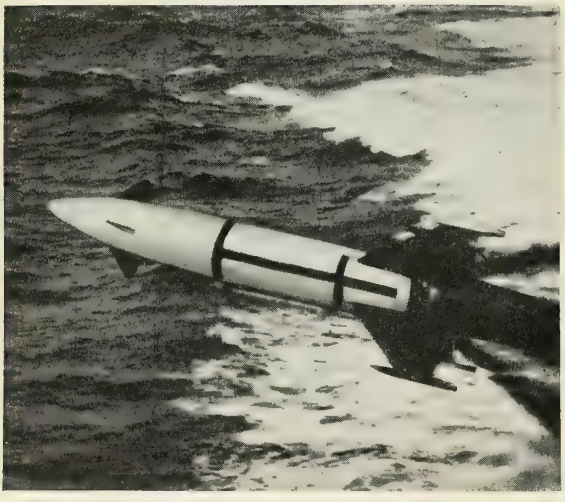
RSD-58



MOSQUITO



BANTAM



ROBOT 315



PSR-1

JAPAN

TLRM-1 (Army)

Type: Surface-to-air
Status: R&D
Prime contractor: Shin Mitshubishi, Mitshubishi Shipbuilding and Engineering Co.
Performance: Range — long. Speed—about 255 mph.
Frame: Length—10.5 ft. Launch weight—about 560 lbs.
Guidance: Type—possibly radar.

TMA-1 (Air Force)

Type: Air-to-air
Status: R&D
Prime contractor: Shin Mitsubishi and Mitsubishi Electrical.
Performance: Speed — supersonic.
Frame: Length—about 10 ft. Launch weight—more than 200 lbs.
Booster: System contractor—Fuji Precision. Type—solid.
Payload: Warhead type—HE.
Remarks: MM-1 is a test vehicle for the TMA-1.

TAAM-1D (Air Force)

Type: Air-to-air
Status: R&D
Prime contractor: Fuji Precision Machinery Co., Ltd.
Performance: Range—about 1.5 miles. Speed—Mach 1.5.
Frame: Length—8 ft. Launch weight—335 lbs.
Guidance: Type—infrared.
Payload: Warhead type—HE.

TATM-1 (Army)

Type: Surface-to-surface (anti-tank)
Status: R&D
Prime contractor: Kawasaki Kokuki Kogyu Kabushi-iki Kaisha
Frame: Length—4.5 ft. Launch weight—300 lbs.
Remarks: TATM-2 model also under development. It is 3.2 ft. long.

SWEDEN

ROBOT 315 (Navy)

Type: Surface-to-surface (tactical)
Status: Operational
Prime contractor: Swedish Guided Missile Bureau and Royal Swedish Armed Forces Research Establishment
Performance: Range—10 to 20 n. miles. Speed—Mach .9.
Deployment: Location—aboard Swedish Destroyers Halland and Smaland.
Frame: Length—24 ft. Launch weight—3000 lbs.
Guidance: Type—not available.
Booster: Type—solid (4).
Sustainer: Type—pulsejet.
Payload: Warhead type—HE.
Remarks: Torpedoboat model known as Sjorobot.

BANTAM (Army)

Type: Surface-to-surface (anti-tank)
Status: Operational
Prime contractor: A. B. Bofors
Performance: Range—6500 ft. Speed—190 mph.
Deployment: Location — with Swedish combat troops.
Frame: Length—2.5 ft. Launch weight—13 lbs.
Guidance: Type—wire.
Booster: Type—solid.
Sustainer: Type—solid.
Payload: Warhead type—HE (3.1 lbs.).
Remarks: Bantam can be fired from an infantryman's hip.

ROBOT 304 (Air Force)

Type: Air-to-surface
Status: Operational
Prime contractor: Swedish Guided Weapons Bureau and Royal Swedish Armed Forces Research Establishment.
Performance: Range—about 3 miles. Speed—Mach 1.
Deployment: Location—Swedish Air Force.
Frame: Length—14.5 ft. Launch weight—1000 lbs.
Guidance: Type—radio command.
Booster: Type—solid.
Payload: Warhead type—HE.
Remarks: Designed for use against naval targets.

ARGENTINA

PSR-1 (Army)

Type: Surface-to-surface (anti-tank)
Status: R&D
Frame: Length—3.8 ft. Launch weight—19.5 lbs.
Booster: Type—Solid (1).
Payload: Warhead type—HE.
Remarks: Can be launched by one man.

PAT-1 (Air Force)

Type: Air-to-surface
Status: R&D
Performance: Range—about 12 miles.
Frame: Length—about 11 ft. Diameter—about 1 ft. Launch weight—2310 lbs. Material (major)—steel.
Booster: Type—liquid. Propellant—oxygen and methanol.

A3H (Air Force and Navy)

Type: Air-to-surface
Status: Operational
Performance: Range—3.8 miles.
Frame: Length—about 3 ft. Diameter—about 4 in. Launch weight—48 lbs. Material (major)—steel.
Guidance: Type—free.
Booster: Type—solid.
Payload: Warhead type—HE.



SOVIET UNION

GOLEM I (Navy)

Type: Surface-to-surface
Status: Near operational
Performance: Range—400 miles; Altitude—125 miles.
Frame: Length—54 ft.; Weight 16½ tons gross; single stage.
Remarks: Developed from German World War II plans for a sea-going V-2 (A-3). Liquid-fueled, radio-inertial guided. Designed to be launched from a capsule towed by a submarine. Nuclear capability.

GOLEM II (Navy)

Type: Underwater-to-surface
Status: RD&T
Performance: Range—1200-1300 miles.
Frame: Length—nearly 60 ft.
Remarks: Advanced version of the Golem I with improvements adopted from the Army T-2. Probably radio-inertial guided, liquid fueled. Nuclear capability.

GOLEM III (Navy)

Type: Underwater-to-air, surface-to-air
Status: Operational on surface vessels
Performance: Range—10 miles.
Frame: Length—15 to 20 ft.; Diameter—20 in.
Remarks: Solid-fueled, infrared-guided. Designed to give both submarines and surface ships anti-aircraft protection.

GOLEM IV (Navy)

Type: Surface-to-air
Status: Operational on surface vessels
Performance: Range—45 miles.
Remarks: A new missile, radar-guided and solid-fueled. May also be converted to submarine use.

M-2'S IN RED SQUARE



T-5B

T-1 (Army)

Type: Surface-to-surface
Status: Operational
Performance: Range—600-775 miles
Frame: Length—50 ft.; Weight—19 tons gross; single stage
Remarks: Mobile IRBM. LOX/hyrocarbon fueled booster generates 77,000 lbs. thrust. Radio-guided. Nuclear capability.

T-2 (Army)

Type: Surface-to-surface
Status: Operational
Performance: Range—1300-1500 miles; Speed—5000 m.p.h.
Frame: Length—between 85 and 91 ft.; Weight—55 tons; two stages.
Remarks: Liquid-fueled, 80,000 lb. thrust booster. The T-2 reportedly was the first Soviet rocket used to test an H-bomb warhead. Fired from Central Russia, the warhead was exploded at 120,000 ft. near Bennet Island in the Arctic.

T-3 (Air Force)

Type: Surface-to-surface
Status: Operational
Performance: Range—5000 miles; Speed—15,000 m.p.h.; Apogee—280 miles.
Frame: Two stages.
Remarks: Liquid-fueled with booster developing 500,000 lbs. thrust. Radio-inertial-guided. HE or nuclear warhead. Russia reportedly produced 50 T-3's in 1959 and has capability to build 1200 by the end of 1963.

T-3A (Army)

Type: Surface-to-surface ICBM
Status: Operational
Performance: Range (Model A)—6000 miles; Range (Model B)—7500 miles; Speed—15,000 m.p.h.
Frame: Model A—2 stages; Model B—3 stages.
Powerplant: Liquid-fueled. Model A first stage—525,000 lbs. of thrust; Model B first stage—700,000 lbs. of thrust.
Remarks: Production of the Model A is believed to have ceased in recent months in favor of the advanced version. Original production plans reportedly called for an equal number of T-3A Model A's and T-3's. The new booster stage on the Model B is believed to be a prototype for one used in the T-4A antipodal missile. Nuclear warhead.

T-4A (Air Force)

Type: Surface-to-surface antipodal missile
Status: Advanced RDT&E
Performance: Range—10,000 miles; Apogee—186.3 miles; Speed—13,660/m.p.h.
Frame: Length—121.02 ft.; Wing span—65.6 ft.; Max. Diameter—6.88 ft.; Launch weight—115 tons.
Powerplant: First stage has 3 LOX/kerosene engines developing 360,000 lbs. thrust.
Remarks: Catapulted from rail sled. Payload—2350 to 3100 lbs. This is the Soviet counterpart of the U.S. Dyna-Soar boost-glide bomber, stemming from the German Saenger-Bredt design conceived in World War II.

T-33 (Army)

Type: Surface-to-surface ICBM
Remarks: A new missile. No other details available.

T-4 (Army)

Type: Surface-to-surface IRBM
Status: Experimental
Performance: Range—1000 miles.
Powerplant: Two stages, both liquid-fueled.
Frame: Length—53 ft.
Remarks: 1800-lb. payload may be either nuclear or HE. Some of its configurations are believed to be worked into upper stages of the T-4A.

T-5 (Army)

Type: Surface-to-surface
Status: Operational with Red Army in Eastern Europe
Performance: Range—50-100 miles.
Frame: Length—about 36 ft.; 3 stages (advanced version may have 4 stages).
Powerplant: Solid-fueled.
Remarks: Designed for firing from multiple launchers for blitz-type saturation of target. HE or small nuclear warhead.

T-5A (Army)

Type: Surface-to-surface IRBM
Status: Operational
Remarks: Few details are available. Believed to be solid-fueled and guided.

T-5B (Army)

Type: Surface-to-surface
Status: Operational (but out of production)
Performance: Range—15-25 miles
Frame: Length—31 ft.; Diameter—3 ft.; Weight—6000 lbs.
Remarks: Similar to the U.S. Honest John. Launched from tracked vehicle. Unguided. Carries HE and possibly a nuclear warhead.

T-6 (Army)

Type: Surface-to-air
Status: Operational
Performance: Range — 20-25 miles; Speed — 1500 mph; Ceiling—about 60,000 ft.
Frame: 2 stages
Warhead: HE with proximity fuze.
Powerplant: Solid fueled with cluster of 4 solid boosters.
Remarks: Fired from multiple launcher. An advanced version, the T-6A, is radar guided and believed to be operational.

T-7A (Army)

Type: Surface-to-surface
Status: Operational
Performance: Range—50 to 90 miles; Speed—Mach 5; radio command guidance.
Frame: Length—30 ft.; Diameter—2.5 ft.; Weight—about 10,000 lbs.
Powerplant: Solid fueled
Warhead: HE
Remarks: Has controllable rear fins.

T-8 (Army-Air Force)

Type: Surface-to-air (also air-to-air)
Status: Operational
Performance: Range—15 to 25 miles; Speed—Mach 2.5
Frame: Length — 13 ft.; two stages
Powerplant: First stage is cluster of two solid fueled boosters second stage is liquid fueled.
Warhead: HE with proximity fuze



T-7A

M-100A (Air Force)

Type: Air-to-air
Status: Operational
Performance: Range—3½ miles; Speed—Mach 2.5
Remarks: Solid-fueled, semi-active radio-radar command guidance.

ME-IGOR (Army)

Type: Anti-tank
Frame: Length—24 in.; Diameter—3 in.
Remarks: Solid-fueled. Fired from bazooka tube. Was operational, but probably used now only for training.

J-3 (Navy and Army)

Type: Surface-to-surface
Status: Operational with the Red Army and at least 7 Baltic fleet cruisers.
Performance: Range—450-600 miles; Speed—supersonic.
Frame: Length—36 ft.
Remarks: Booster is cluster of 4 solid-fuel rockets; ramjet sustainer. Guidance presumably is beam-riding or programed. Nuclear capability.

RS-82, RS-132, RS-132A (Air Force)

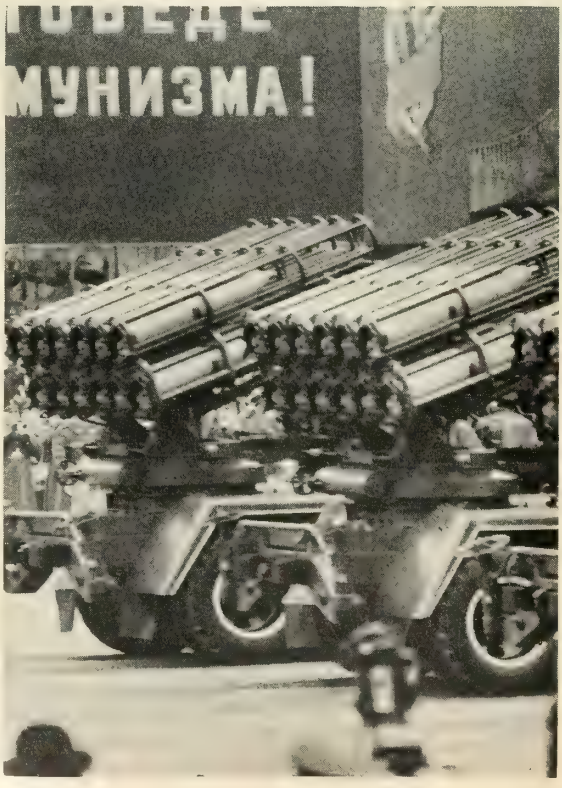
Type: Air-to-air
Frame: Length—unavailable; Diameter—5.2 in.
Remarks: Aircraft version of the GVAI. Used for training.

M-2 (Army-Navy)

Type: Anti-aircraft
Status: Operational with ground defense forces and aboard Baltic Sea cruisers.
Performance: Speed—Mach 2.
Frame: Length—about 25 ft.; 2 stages.
Remarks: Solid-fueled. Infrared, radar, or both used as guidance.



GVAI'S ON PARADE



GVAI (Army)

Type: Barrage rocket
Remarks: Multiple-tube launcher, fired in salvoes. May be phased out for more advanced versions.

KCAT-25 (Army)

Type: Anti-tank
Remarks: Never exhibited, believed to be operational.

KOMET I (Navy—CH 17 Army)

Type: Surface-to-surface
Performance: Range—100 miles; Speed—3000 m.p.h.
Remarks: Solid-fueled, the CH17 is reported to be operational with the Red Army. A crash program is underway to put the Comet I into service aboard submarines and surface ships. HE and nuclear warheads.

KOMET II (Navy—CH 18 Army)

Type: Surface-to-surface
Performance: Range—600 miles.
Remarks: Operational with the Red Army and from a surface vessel in calm waters. Crash program in progress with ship motion simulator equipment; R&D for submarines. Solid-fueled, nuclear warhead.

KOMET D (Air Force)

Type: Air-to-surface standoff
Status: In development and test
Performance: Range—55 miles.
Frame: Length—33.5 ft.; Diameter—about 4 ft.
Remarks: An equivalent to the British Avro, the turbojet-propelled missile may have beam-riding guidance. Warhead can be either nuclear or HE.



RELIABILITY...

every missile must count. A wasted firing due to a minor-part malfunction results in appalling losses in time and money. Combat condition failures are even more disastrous. Vitro Laboratories, under contract with the U. S. Navy Bureau of Ships, has developed advanced mathematical approaches to make reliability a predictable feature of design. Over a thirty month testing period predicted failures correlated strikingly with actual results. Tested equipment included radars, radar repeaters, radio transmitters and receivers, and radio terminal equipment. Reliability is another reason why Vitro is a leading name in systems engineering today.

Vitro

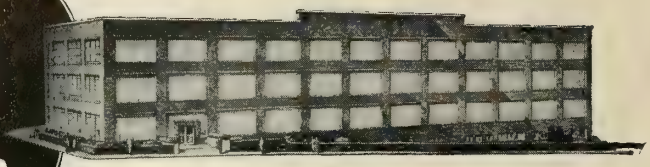
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Watch Master ELECTRONICS

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Our instruments, 40 to 30,000 cycles, are used extensively by industry and on government projects where enduring accuracy and maximum durability are required. Your inquiries on related products are invited.

PRECISION FORK OSCILLATOR UNITS

TYPE 2003



Size 1½" dia. x 4½" H. Wght. 8 oz.

Frequencies: 200 to 4000 cycles

Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)

Double triode and 5 pigtail parts required.

Input, Tube heater voltage and B voltage

Output, approx. 5V into 200,000 ohms

TYPE 2007-6



TRANSISTORIZED, Silicon Type
Size 1½" dia. x 3½" H. Wght. 7 ozs.

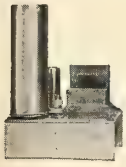
Frequencies: 360 to 1000 cycles

Accuracies:
2007–6 (± .02% at —50° to + 85°C
R2007–6 (±.002% at +15° to + 35°C
W2007–6 (±.005% at —65° to + 85°C

Input: 10 to 30 Volts, D. C., at 6 ma.

Output: Multitap, 75 to 100,000 ohms

TYPE 2001-2



Size 3¾" x 4½" x 6" H., Wght. 26 oz.

Frequencies: 200 to 3000 cycles

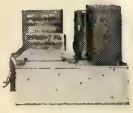
Accuracy: ±.001% at 20° to 30°C

Output: 5V. at 250,000 ohms

Input: Heater voltage, 6.3 - 12 - 28

B voltage, 100 to 300 V., at 5 to 10 ma.

ACCESSORY UNITS FOR 2001-2



L—For low frequencies multi-vibrator type, 40-200 cy.

D—For low frequencies counter type, 40-200 cy.

H—For high freqs, up to 30 KC.

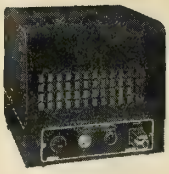
M—Power Amplifier, 2W output.

P—Power supply.

PRECISION FREQUENCY STANDARDS

TYPE 2005A

Size 8" x 8" x 7¼" High
Weight, 14 lbs.



Frequencies:
50 to 400 cycles (Specify)

Accuracy:
±.001% from 20° to 30°C

Output, 10 Watts at 115V

Input, 115V. (50 to 400 cy.)

TYPE 2121A

Size
8¾" x 19" panel
Weight, 25 lbs.



Output: 115V
60 cycles, 10 Watt

Accuracy:
±.001% 20° to 30°C

Input,
115V (50 to 400 cy.)

TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.



Frequencies: 50 to 1000 cy.

Accuracy:
(±.002% at 15° to 35°C)

Output: 115V, 75W.

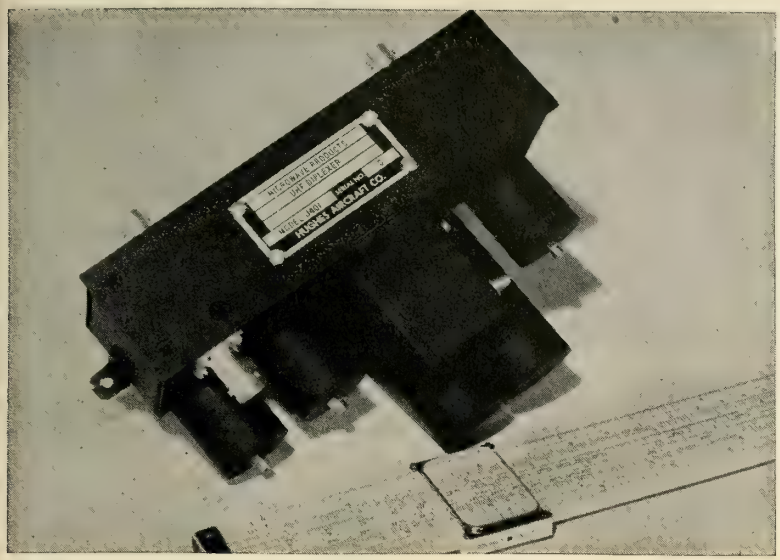
Input: 115V, 50 to 75 cy.

WHEN REQUESTING INFORMATION, PLEASE SPECIFY TYPE NUMBER

ATP

American Time Products Inc.
61-20 Woodside Avenue
Woodside 77, N. Y.

Circle No. 74 on Subscriber Service Card.



UHF Missile Diplexer

A lightweight UHF diplexer has been developed by Hughes Aircraft Co.

Known as Hughes Model U401, the diplexer permits a 100-watt transmitter and sensitive receiver to be operated simultaneously with a single antenna in the 225-400 MC band. With the transmitting frequency separated by less than ten per cent from the receiving frequency, isolation in excess of 100 db is provided in the receiving circuits, the announcement said.

To conserve transmitter power, the insertion loss between transmitter and antenna is only 0.2 db with a VSWR of 1.1. Design is such that no operational interaction between receiver and transmitter is experienced.

The unit consists of a special combining circuit together with a bridged-T network and a π– section filter on the receiving side. The assembly, which weighs less than one pound, has successfully withstood accelerations up to 150 g as well as other tests applicable to high-altitude rocket and missile environments.

Circle No. 225 on Subscriber Service Card.

APU Automatic Battery

Extremely high current output is featured in a silver-zinc primary battery designed for use in missile and space vehicle auxiliary power units by Cook Batteries. The battery is automatically activated by a reliable solid-propellant gas mechanism which has only one moving part.

The Model P80A provides 200 amps at 28 v. Maximum current is 400 amps, and discharge time is 1.8 min. An extremely efficient cell is used to provide high rate of discharge.

Circle No. 226 on Subscriber Service Card.

Printed Coax Mixer

Premier Instrument Corp. is producing a printed circuit broadband coax mixer which utilizes a replaceable printed circuit diode. The PC-Mix is a compact, low noise figure mixer with local oscillator level adjustment. The PC-Mix is capable of withstanding severe vibration and shock and is available in frequency ranges of 250 mc to 8000 mc in five basic units.

Circle No. 227 on Subscriber Service Card.

Linear Potentiometer

The Computer Instruments Corp. has added Model 111 Linear Motion Potentiometer to their present line of precision film components.

This potentiometer, designed for operation with an AC or DC input, provides, without amplification, outputs as great as 350 volts/inch of displacement.

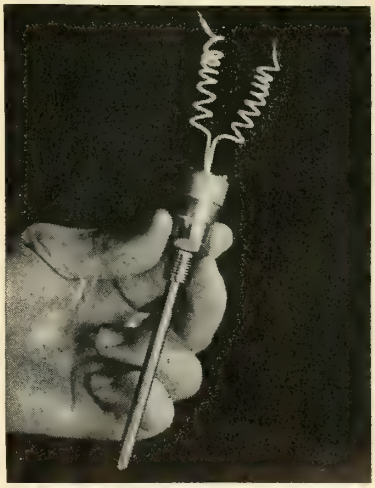


The capability of the Model 111 to detect a motion as small as 0.000005 in., coupled with its life rating of up to 30,000,000 strokes, depending on circuitry, will make it of prime interest to those involved in the design of programed machine tools or other devices requiring precise knowledge of linear position.

Circle No. 228 on Subscriber Service Card.

Thermal Switch

Hermetically-sealed by employing a ceramic seal that is resistant to high temperatures, Control Products Inc. has designed a special purpose super-high temperature thermal switch which can be calibrated up to 1800°F. The switch is a probe type unit with a special cap that is locked in place after the final calibration has been made.



Contacts may be arranged for either close-on-rise or close-on-fall in temperature. Temperature tolerance is 6°F; temperature differential and repeatability for a given switch is ±1°F, while overshoot to 2200°F or an undershoot to −100°F can be tolerated without damage to the unit.

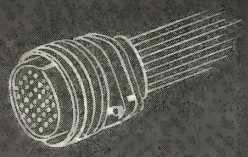
Circle No. 229 on Subscriber Service Card.

Swash-Plate Engines

A family of swash-plate engines and high-pressure pumps is available for general application from Clevite Ordnance.

The engines can be driven from any source of pressurized gas or vapor, including steam, cold gases such as

BENDIX
MS-R
ENVIRONMENT RESISTANT
Connectors



Bendix MS-R series are the small, lightweight, more efficient and compatible environment resisting class of connectors as specified in the latest version of MIL-C-5015.

Main joint and moisture barriers at solder weld ends have integral "O" rings. Grommet design of "slippery rubber" is sealing medium for individual wires. This provides easier wire threading and friction-free travel of grommet over wires.

Many other features are described in MS-R Bulletin. Send for your copy today, or

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AVNET

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AVNET•5877 Rodeo Rd., Los Angeles 16, Cal.- UP 0-6141
AVNET•751 Main St., Waltham, Mass.- TW 9-8330
AVNET•4180 Kettering Blvd., Dayton 39, Ohio- AX 8-1458
AVNET•2728 N. Mannheim Rd., Melrose Park, Ill.- GL 5-6160
AVNET•1262 N. Lawrence Sta. Rd., Sunnyvale, Cal.- RE 6-0300

Circle No. 77 on Subscriber Service Card.

. . . products & processes

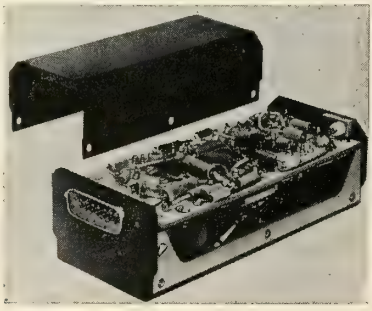
CO_2 and nitrogen, or solid and liquid rocket propellants. Engines deliver as much as 60% of input energy, and torque depends solely on pressure furnished. With input gas temperatures of 2150°F and pressures of 2000 psi, one hot-gas design delivers 100 horsepower at shaft speeds between 4000 and 5000 rpm. It weighs 30 lbs., and is 12 in. long and 6½ in. in diameter.

Pumps are available in wet and dry swash-plate design. Wet swash-plate models are suited to pumping a variety of noncorrosive liquids, including low-lubricity problem fluids like kerosene and hydraulic fluid. Dry swash-plate units are designed for pumping corrosive compounds such as nitric acid, hydrogen peroxide and hydrazine.

Circle No. 230 on Subscriber Service Card.

Strain Gage Oscillator

A transistorized strain-gage subcarrier oscillator is available from Electro-Mechanical Research, Inc. The instrument, designated the Model 179A, is intended for highly accurate conversion of strain-gage bridge signals into FM subcarrier signals on IRIG channels 1 to 14 and A.



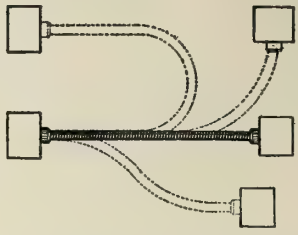
The subcarrier oscillator operates with a four-arm strain-gage bridge consisting of elements having 100 to 150 ohms resistance. There is no necessity for reactive balancing since internal oscillator circuitry automatically compensates for up to 1000 uuf capacitance across one arm.

Circle No. 231 on Subscriber Service Card.

Tapoffs, Splitters & Baluns

Blonder-Tongue Laboratories, Inc. has announced a complete line of advanced line splitters, tapoffs, and baluns. This advanced series of splitters and tapoffs can satisfy all installation requirements of large and small antenna systems in strong, intermediate and weak signal areas. A complete line of tapoffs and splitters is available for 75 ohm, 300 ohm, or mixed impedance systems.

FLEXIBLE SHAFTING OFFERS NEW FREEDOM OF DESIGN



Before the innovation of Flexible Shafting, it was necessary to transmit power from a drive unit to its driven unit by means of a solid shaft which utilized expensive and cumbrous gearing. Today the Flexible Shaft alone provides a means of transferring this power from one unit to another by going around, over, and under obstacles. This allows you more space in your design, and eliminates the age old problem of having to have perfect alignment of the shaft and its drive or driven unit in order to make a connection. Flexible Shafts are simply curved towards the unit and connected by means of a ferrule, or an end fitting. If you have any application, now or in the future, which will require control from remote places, you owe it to yourself to write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois, for complete information on Circle Ess Flexible Shafting.

Circle No. 75 on Subscriber Service Card.

MICRO-MINIATURE
"DELTA"
WAVEGUIDE
SWITCH

A complete family of switches available in over 40 models



- EXTREMELY COMPACT & RUGGED
- WEIGHT 1.2 oz. to 4 lbs.
- HIGH SPEED OPERATION (.006 sec.)
- "FAIL-SAFE"
- FROM "L" TO "Q" BAND (2.6 to 50.0 KMC)
- AC or DC OPERATION
- REMOTELY CONTROLLED to switch a single waveguide input to either of two outputs.





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division of Regan Industries, Inc.

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HAWS SAFETY SHOWERS send torrents of rushing water from all angles – washing away dangerous irritants in a hurry!

Slap open the conspicuous "Push to Operate" valve. Hard-running streams from 10 *adjustable* nozzles drench victims in seconds.

You can depend on HAWS for the instant, *positive* first aid so vital until medical help arrives.

This "Safety on tap" can mean the difference between temporary irritation and permanent injury. Get the facts! Write for HAWS new safety catalog. Do it today!

Valve shown three-quarters open.

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Coaxial cable may be plugged directly into a new type of solderless fitting and may be used with a quick disconnect. Flat 300 ohm transmission line need not be stripped, but is inserted directly into "no-strip" connectors and secured in place by tightening two screws.

Circle No. 232 on Subscriber Service Card.

Low Level Commutators

A line of low level, all solid-state electronic commutators for use in severe missile environments is available from General Devices, Inc.

Designed for airborne sampling of low level differential instruments such as strain gauges and thermocouples, the units contain up to 90 differential channels in high density packages. The 30 channel unit weighs only 2.5 oz. and is less than 1 in. in volume per channel. In addition, the units contain all necessary power converters and programing circuitry.

Circle No. 233 on Subscriber Service Card.

Miniature Torch

A miniature torch which uses gas or acetylene to produce intense pinpoint flames for delicate and close tolerance work is now available from Microchemical Specialties Co.

The Misco torch is only 7 inches long from tip to gas connection and weighs just three ounces. It features finger tip mixer controls for fine adjustment of flame and is furnished with three tips, .008″, .015″, and .020″ bore diameter. Other tips ranging from .004″ to .030″ are available.



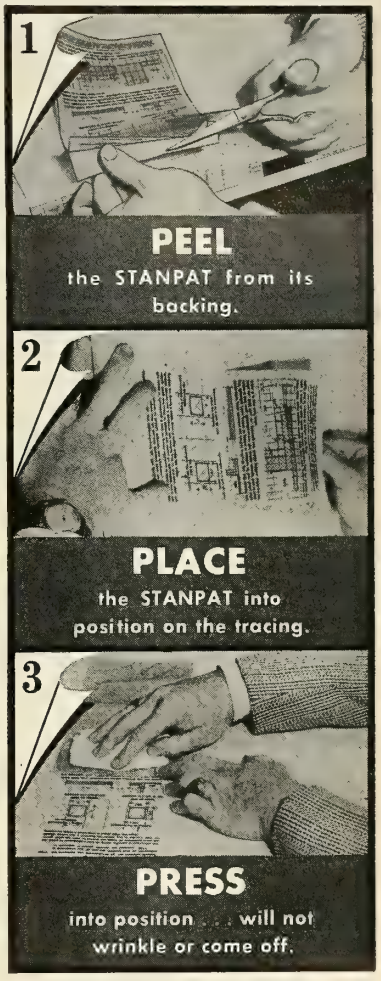
Circle No. 234 on Subscriber Service Card.

Vibration Tester

A simplified portable vibration tester for quality control analysis which can be operated by factory personnel is being marketed by Rototest Laboratories.

In addition to its portability and low initial cost, other features of Rotocon (R) are: low operating and main-

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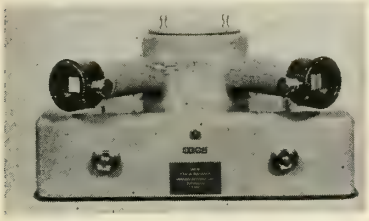
Circle No. 79 on Subscriber Service Card.

tenance, excellent sound proofing, and simple data take-off. In operation there is less than 75 db of noise measured six feet away from the machine. The tester provides a fundamental output vibration at 50 cps and overtones at predetermined multiples.

Circle No. 235 on Subscriber Service Card.

Scanning Monochromator

A McPherson Model 235 is a 50cm vacuum ultraviolet scanning monochromator that guarantees a vacuum of better than 1 x 10^{-5}mm Hg is available from McPherson Instruments Corp. This compact table model



consists of a vacuum chamber, bilateral entrance and exit slits, a 50cm radius of curvature grating with 600 lines per millimeter, and a screw-driven scanning mechanism with 12 reversible speeds. A counter reads actual wavelengths in Angstrom units from Central Image through 6000A, and is accurate to ± 1A.

Circle No. 236 on Subscriber Service Card.

Copper Clad Laminates

A complete line of thin copper clad laminates is available from the Plastic Products Division of International Resistance Co.

The materials involved include the complete range of insulation, from vinyl and polyethylene to teflon and glass reinforced teflon.

Available now is 1 or 2 ounce copper bonded to 0.005 Kel-F, 0.005 teflon-FEP, 0.007 teflon-glass cloth, 0.005 linear polyethylene and 0.006 mylar.

Circle No. 237 on Subscriber Service Card.

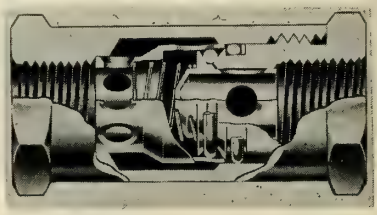
Environmental Room

Labline, Inc. is marketing a line of walk-in environmental rooms with two temperature ranges: ambient to 140°F and 0° to 140°F. Accuracy is maintained within plus-minus 1°F. The test rooms are constructed in convenient panel form, shipped knocked down to permit easy access through narrow doorways.

Circle No. 238 on Subscriber Service Card.

Surge Flow O-Ring

An engineering development positively assures O-ring reliability against high pressure split-second surge flows, in the latest from Circle Seal Products. Faster acting solenoid and other rapidly actuated valves in higher pressure systems have created new problems which the Circle Seal 200 Series Check Valve has successfully eliminated. Fool-proof



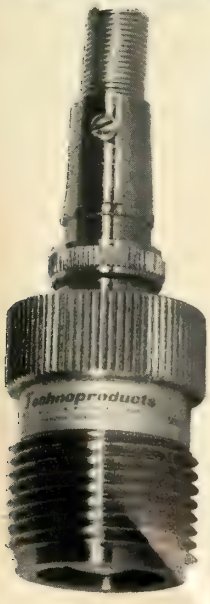
O-ring retention is assured by an ingenious cage device which positively restrains the O-ring from washout. Heavier, more rugged construction of the body provides additional protection against abuse and failure.

Circle No. 239 on Subscriber Service Card.

Four Pin Holders

Supplementing its line of three-pin transistor holders, Sealectro Corp. is producing a four-pin transistor holder. Designated as TC-400T, the new hold-

MEASURE
Dynamic High Pressures



with
Technoproducts
PT-3 TRANSDUCER

A rugged gauge for measuring large transient forces or pressures, the PT-3 Transducer has been proven by years of use in ordnance and ballistic testing. Applications include measurement of pressure vs. time in guns, gas cartridges, and explosive actuated devices; and combustion, ignition, and shock-wave research. Pressure ranges from 0-10,000 to 0-100,000 psi.

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SYSTEMS
ANALYSIS

RELIABILITY ANALYSES and EVALUATIONS

INTEGRATED SYSTEMS STUDIES

Consulting and contractual services are offered in the major areas of missile systems analysis. Special emphasis is given to reliability analyses within the framework of over-all systems concepts. Inquiries are invited.

McAllister and Associates, Inc.
203-205 Truman, N.E.
Albuquerque, New Mexico

Circle No. 81 on Subscriber Service Card.

ers feature the "Press-Fit" technique which permits fast and economical chassis insertions. Both the TC-200T (3 pin-holder) and TC-400T (four-pin holder) are constructed with extra-long terminals which act as a heat sink and permit soldering of transistors in place with greatly reduced danger of damage to the transistor elements.

Circle No. 240 on Subscriber Service Card.

High Pressure Regulators

Grove Valve and Regulator Co. has designed a new line of small volume high pressure regulators.

The regulators, or "loaders," can handle a wide range of pressures. The interior construction is highly resistant to corrosion. All metal parts in contact with line fluid are stainless steel including the filter. The regulators are designed using a minimum number of parts to reduce maintenance problems and boost repeatable accuracy.

Circle No. 241 on Subscriber Service Card.

Transistor Welder

An automatic transistor welder has been developed by National Electric Welding Machines Co.

A 3 ft. x 4 ft. table, 32-inches high, forms the top of the unit's base and is designed specifically to accommodate a standard dry box. An operator, seated at the console and hand-loading a six-station dial, can produce 2000 transistors an hour, according to National Electric engineers.

Circle No. 242 on Subscriber Service Card.

Fast Microwave Switch

A fast acting, high-power microwave switch that can be closed in tenths of a microsecond has been developed by Electric Products Inc.

The new microwave switch uses a gas discharge, similar to that in a thyratron, to create a fast acting and relatively high power switch for a microwave line. In addition to closing in tenths of a microsecond, the switch can be reopened in a few microseconds.

Circle No. 243 on Subscriber Service Card.

High Purity Gold

Gold, 99.999% pure, is available in powder and sheet form from High Purity Metals, Inc.

The gold offers semiconductor manufacturers excellent wetting to silicon at relatively low temperatures (in the order of 700°C). The gold exhibits high thermal conductivity and vapor pressure, along with superior resistance to corrosive acids.

Circle No. 244 on Subscriber Service Card.

Propellant Briefs from Callery Chemical Company

New fuel for Air Force by late summer—Callery is now modifying the Government-owned plant at Muskogee, Okla. to produce pentaborane under a new $9-million Air Force contract. Plant was originally built to produce high-energy boron fuels.

Pentaborane production begins late this summer for Air Force requirements only. At the outset, at least, no pentaborane will be available for commercial sales. Also worth noting: plant modification still maintains our capability for high-energy fuel production.

PENTABORANE (B_5H_9) Performance Data—Potential of pentaborane as a fuel is evident in its high heat of combustion—29,000 Btu/lb.—and its high specific impulse. Recent calculations yield the following shifting-equilibrium impulses for pentaborane:

Oxidizer	Is 1000/14 psia	Is 1000/.2 psia
OF_2	367	466
F_2	360	460
O_2	327	421
NF_3	326	413
H_2O_2	316	399
ClO_3F	306	391
N_2O_4	306	390
NO_2ClO_4*	302	389

*More about NO_2ClO_4, Nitronium Perchlorate, a new solid oxidizer, will appear in this column next month.

Pentaborane is soluble without reaction in saturated and aromatic hydrocarbons. May explode with oxygenated or halogenated compounds like acetone or carbon tetrachloride.

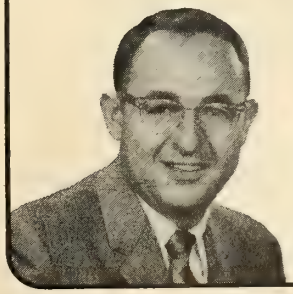
Pentaborane is compatible with all common metals, Saran, polyethylene, Kel-F, Viton A, asbestos, and graphite.

Write for Bulletin—Pentaborane C-1300.

Los Angeles office open for West Coast technical service — J. R. Perrin, new West Coast Representative for Callery, will serve fuel and propellant users in the Los Angeles area. His address is 17618 Ventura Boulevard, Encino, California. Telephone: State 4-9328.

In the Washington, D.C. area, contact Richard A. Carpenter, Room 709, DuPont Circle Building, 1346 Connecticut Avenue, N.W., ADams 4-4200.

For information or technical service: write Defense Products Dept., Callery Chemical Company, P.O. Box 11145, Pittsburgh 37, Penna.



Mr. J. R. Perrin
Manager, Western District
Defense Products Department
Callery Chemical Company

CALLERY CHEMICAL COMPANY

Circle No. 82 on Subscriber Service Card.

new literature

TEST AND SENSING GUIDE—Alden Products has published a Vest Pocket Guide and Wall Chart to help the design engineer choose the right test and sensing component. This chart contains complete specs on Alden panel lights, switches, fuseholders, test prods and jacks and molding materials.

Circle No. 200 on Subscriber Service Card.

BASICS IN THE MACHINING OF TEFLON—An informative 12-page booklet released by the Plastic Products Division of Raybestos-Manhattan contains R/M suggestions for stress relieving; tools and coolants to use; speeds and rates of feed; rakes, angles and clearances; burrs and chips; turning, boring, drilling, tapping, reaming, counterboring, grinding; fly-cutting; surface finishes; tolerances, etc.

Circle No. 201 on Subscriber Service Card.

STRAIN GAGES—A line of subminiature, free-filament wire strain gages, designed for accurate strain measurement on any test surface or material in a wide variety of applications including high temperature, are discussed in a 4-page, 2-color new product data sheet released by the Electronics & Instrumentation Division of Baldwin-Lima-Hamilton Corp. Product Data Sheet 4330 contains line drawings, graphs and tables to support the data and specifications concerning this strain gage, Type HT. Microminiature built-in thermocouples are also available if desired.

Circle No. 202 on Subscriber Service Card.

TRANSFEROBOT—USI Robodyne Division of U.S. Industries, Inc., has published literature describing its "TransfeRobot." It explains the concept of flexible and versatile automation equipment and how it is embodied in this member of USI Robodyne's family of automation products. The literature describes the design and operation of the "TransfeRobot" as well as the simple means of programing and set-up, which permits it to be switched from job to job in one-half hour.

Circle No. 203 on Subscriber Service Card.

CONTROL COMPONENTS—Over 2500 components for control of gas or liquid over a temperature range of –320° to 1500°F, and pressures to over 3500 psig are covered in a new catalog published by The Garrett Corp.'s AiResearch Manufacturing division. Major items available for aircraft, missile or process industry applications include: fuel control systems, pneumatic and electrical valves, actuators, air motors and thermostats.

Circle No. 204 on Subscriber Service Card.

ZIRCONIUM OXIDES—The Zirconium Corp. has available a well-illustrated four-page brochure on zirconium oxides and high-temperature materials. The brochure lists materials and describes the processes Zircoa uses in manufacturing their high-temperature refractories. Pictures showing plant facilities, standard and custom refractory shapes are included.

Circle No. 205 on Subscriber Service Card.

PRESSURE REGULATOR CATALOG—Now available from OPW-Jordan, an 8-page Catalog gives up-to-date information on the complete line of Sliding Gate Pressure Regulators. The brochure describes in detail the OPW-Jordan self-operated, pilot-operated, solenoid operated and back pressure Regulators.

Circle No. 206 on Subscriber Service Card.

HIGH ALUMINA TECHNICAL CERAMICS—Diamonite Products Manufacturing Co. has available a brochure covering data and the application of high alumina technical ceramics to the electronics industry. Off the shelf service for standard rods, tubes and cylinders are listed with prices in various quantities. The six-page brochure contains a chart of comparative properties of Diamonite materials for electronic applications. A graph of dielectric loss factors of Diamonite material on a comparative scale is also shown.

Circle No. 207 on Subscriber Service Card.

WIND TUNNEL DATA—How the National Aeronautics and Space Administration reduces high-speed wind tunnel data at their Langley Field, Va., test center is the subject of an application information bulletin just released by the Systems Division of Beckman Instruments, Inc. In addition to a description of the data system installation and its function, the bulletin includes system specifications, block diagram, operation explanation and photograph.

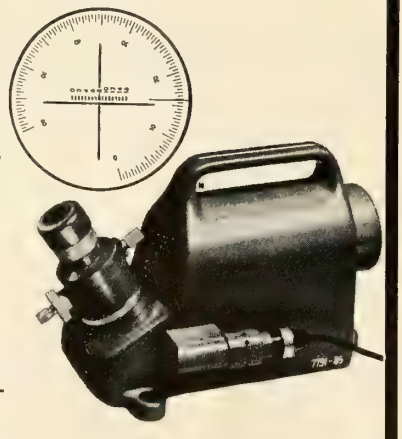
Circle No. 208 on Subscriber Service Card.

FACILITIES BROCHURE—A Research, Engineering, and Manufacturing Facilities brochure has been released here by the Gabriel Electronics Division of The Gabriel Company. The brochure depicts the new, ultramodern facilities at Millis and illustrates the utilitarian design of the structure for the engineer, research specialist, and for electronics component manufacturing.

Circle No. 209 on Subscriber Service Card.

Leitz The NEW Concept in AUTO-COLLIMATORS

- For checking angular deviations within 1/10 second of arc over an expanded range of 30 minutes.
- Short and compact design of 13" overall length, retaining 20" focal length by folded beam.
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- Large assortment of accessories.
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137MR VARICK STREET, NEW YORK 13, N. Y.

Circle No. 83 on Subscriber Service Card.

NUCLEAR LAB INSTRUMENTS—A 64 page catalog of nuclear laboratory instruments and related accessories is now available from Tracerlab. The new "General Catalog F" contains complete descriptive information and specifications on all Tracerlab products for nuclear research, education and clinical applications. Among the instruments described are scalers, ratemeters, spectrometers, geiger, proportional, and liquid scintillation detectors, manual and automatic sample changers, data printers, high voltage power supplies, radiation research equipment, sample preparation and handling equipment, and personnel and safety protection equipment.

Circle No. 210 on Subscriber Service Card.

DIGITAL VOLTMETERS—A new 20-page, two-color bulletin on NLS SERIES 20 transistorized digital voltmeters, ratiometers and ohmmeters has been produced by Non-Linear Systems, Inc. The booklet covers the premium models in the NLS line. They include the M24 Multi-Purpose Instrument for measuring DC voltage, voltage ratio and resistance; the V24 Volt-Ratiometer for measuring DC voltage and voltage ratio; and the R24 Ratiometer for measuring DC voltage only.

Circle No. 211 on Subscriber Service Card.

INERT-GAS WELDING—A revised edition of Air Reduction's catalog on its complete line of manual, semi-automatic and automatic Heliwelding (Airco's tungsten-inert-gas welding process) equipment has just been published. The booklet also contains information on accessory equipment, tungsten electrodes, and filler wires used in conjunction with this welding process.

Circle No. 212 on Subscriber Service Card.

POTENTIOMETER TRANSDUCERS—A bulletin consisting of 4 pages filled with specification data for potentiometer transducers is available from H. E. Sostman & Co. Designed to serve as an assistance for the specifying engineer concerned with industrial instrumentation, the bulletin is thorough, yet concise in its treatment of transducer specifications as applied to pressure, motion, altitude, weight, flow, indicating, recording, systems and controlling.

Circle No. 213 on Subscriber Service Card.

FLUOROSCOPY—A new 4-page folder, describing Fluoroscopy with high-speed movies is available from Philips Electronic Instruments. The text discusses the new method for inspection of components and assemblies under actual operating conditions. The folder describes how units under test can be evaluated during functional conditions such as simulated high frequency vibration. Reliability diagnostic testing during preproduction evaluation and production non-destructive testing of critical components are also covered.

Circle No. 214 on Subscriber Service Card.

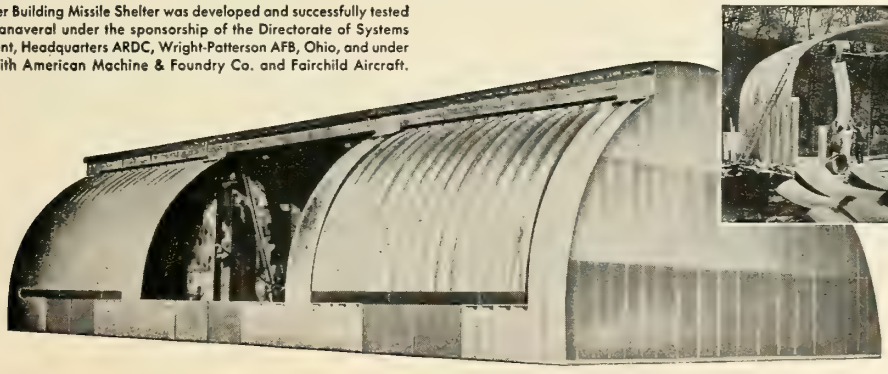
RARE EARTHS—Vitro Chemical Co. has issued a new brochure, containing complete technical information about various chemicals, metals and alloys of the rare earth group of elements, Thorium, scandium and yttrium. In addition to potential uses, it describes manufacture and lists detailed properties and chemical analysis of more than 50 products, several of which are now available for the first time on a commercial scale.

Circle No. 215 on Subscriber Service Card.

TELEMETER SIGNAL CONDITIONER CIRCUITS—Descriptions of the designs of signal conditioner units suitable for processing many types of outputs prior to transmission are included in this brochure by Texas Instruments, Inc. The more important designs, evaluated for missile use and which are available as off-the-shelf items are listed.

Circle No. 216 on Subscriber Service Card.

This Wonder Building Missile Shelter was developed and successfully tested at Cape Canaveral under the sponsorship of the Directorate of Systems Management, Headquarters ARDC, Wright-Patterson AFB, Ohio, and under contract with American Machine & Foundry Co. and Fairchild Aircraft.





Panels are heavy-gauge steel — double-curved and corrugated for rugged strength. Bolt together — self-supporting.

HOW WONDER BUILDING CAN SOLVE YOUR SHELTER PROBLEM

Three basic designs with unlimited adaptation to meet any shelter or storage need — that's Wonder Building versatility! You get a structure that fits *exactly* with no sacrifice in space, utility or cost.

Choose from straight sidewall, arch-type or wide-span "Truss-Skin" Roof Systems in widths up to 300 feet — lengths unlimited. Each provides clear-span, unobstructed interiors . . . each assembles on location, can be modified, expanded—dismantled and reassembled with a minimum of time and effort.

Wonder Building® patented construction technique means simple, fast erection—even with unskilled labor. Rugged steel panels provide a tight, weather and wind-proof structure. Upkeep is negligible—no painting, no roofing to maintain.

See your Wonder Building distributor, or mail the attached coupon.

Listed in Sweet's Architectural File Index No. 2b/Wo.

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Wonder Building

wonder building corporation of america

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Please send me literature and engineering specifications on Wonder Building Structures. I am primarily interested in

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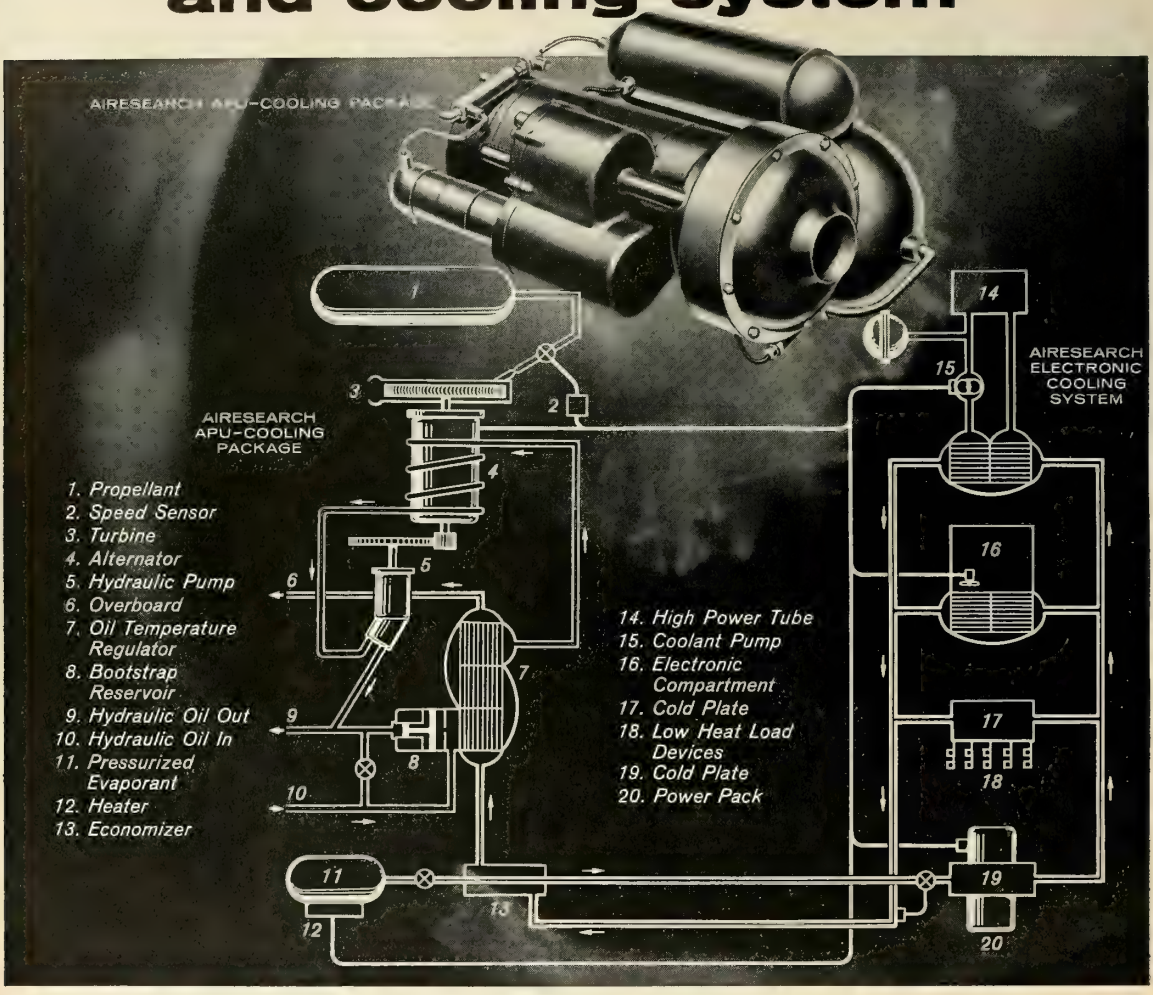
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Integrated accessory power and cooling system



meets the most advanced missile and space vehicle requirements

AiResearch has developed a *single* system package for missiles and space vehicles to meet increasing accessory power and cooling load requirements in the face of decreasing size and weight allowances.

This integrated accessory power and cooling system supplies hydraulic power for actuating systems, 3200 or 400 cycle three-phase electric power for guidance and control, and at the same time provides cooling both for the APU and all electronic equipment operating in the missile or space vehicle.

The cooling system in the example shown here uses liquid ammonia as the expendable evaporant, and each heat load area has a separate temperature control valve. Alternator and controls, turbine assembly and APU liquid propellant fuel tank are patterned after operationally proven components.

World leader in the design and manufacture of cooling and accessory power systems, AiResearch has delivered more missile APUs than any other company, and is the leader in advanced electronic cooling systems for aircraft, missiles and spacecraft.

AiResearch design and manufacturing experience in these two fields includes: liquid and solid propellant APUs; hydraulic and hot gas actuators and control systems; 3200 and 400 cycle alternators; cold plates; expendable and closed cycle gas and liquid cooling systems; cryogenic cooling systems.

Please direct inquiries to Los Angeles.

THE GARRETT CORPORATION

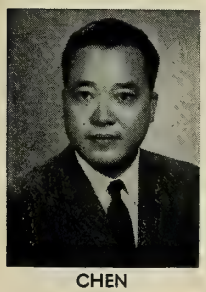
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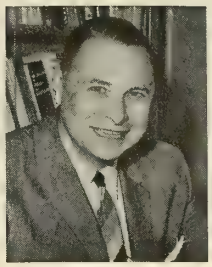
Circle No. 85 on Subscriber Service Card.

names in the news


CHEN


RABI


COTTON


GREYSON


KULLAS

B. S. Chen: Former assistant director of engineering at the space communications division of Radiation, Inc., joins Dynatronics, Inc. as manager of the design engineering division.

Dr. Isidor I. Rabi: Chairman of the President's Science Advisory Committee for the past 15 years and advisor to the Atomic Energy Commission and the Departments of State and Defense, named technical consultant to Loral Electronics Corp.

H. C. Cotton: Former sales manager for the Army's *Pershing* program at The Martin Co.'s Missile and Electronics Division, appointed to the newly created post of manager-advanced systems at Ryan Aeronautical Co.

William L. Greyson: Former director of research and development at Hitemp Wires, Inc., joins Dilectrix Corp. as director of research and development and chief of a "New Horizon" design and development department.

A. J. Kullas: Named technical director of The Martin Co.'s rocket booster portion of the Air Force *Dyna-Soar* program. He joined the firm in 1940 as a structures analyst and subsequently served as structures manager, chief engineer, manager of flight vehicle design engineering and manager of technical development.

Dr. Solomon L. Miller: Elected head of the research section of the research and development department of Rheem Semiconductor Corp. Was previously manager of the device analysis section in the semiconductor research department of IBM's Research Laboratory and prior to that a research physicist at Bell Telephone Laboratories working on semiconductor devices.

William Fitzwater, Jr.: Former senior design specialist with North American Aviation's Autonetics Division, joins Epsco-West as senior design specialist.

Arthur G. Wimer, Jr.: Named to the newly established position of chief scientist for the Air Research and Development Command (ARDC), the top civilian advisor to **General Bernard Schriever.**

Thomas LeSueur Hardy: Appointed senior systems engineer to head Arnoux Corp.'s new Huntsville, Ala., office. Previously served as design engineer for Martin-Orlando and as field engineer for both Col-Ins-Co., Inc. and Murphy Cota Co.

Myron A. Tracy: Manager of The Garrett Corp.'s Washington sales office, appointed manager of military relations responsible for conducting all prime military sales and contract negotiations for Garrett and its AiResearch Manufacturing divisions.

Peter W. Cummins: Supervisor of market research for the Continental-Diamond Fibre Corp., a subsidiary of The Budd Co., promoted to manager of product planning and market research.

Dr. Peter Fortescue: Who will continue to act as chief research and development engineer for the General Atomic Division of General Dynamics Corp., appointed chief research and development engineer of the newly organized General Atomic Europe.

Prof. Thomas Gold: Chairman of Cornell University's department of astronomy and director of its center for radiophysics and space research, elected special consultant to the National Research Corp. on projects relating to the direct conversion of solar energy to electric power.

Emory W. Farr: Special projects engineer for Statham Instruments, Inc., and **Joseph C. Sanchez,** lead engineer in the Structures Laboratory of North American Aviation, join Electro-Optical Systems, Inc., as project engineers in the Transducer Laboratory of the Solid State Division.

Donald P. Vaughan: Former director of sales for the Trimpot Division of Bourns, Inc., joins Spectrol Electronics Corp. as marketing manager.

Joseph Robert Lewis: Appointed director of engineering for the Sierra Electronic Division of Philco Corp.

Sam Cravitt: Joins Del Electronics Corp. as a senior research project engineer. Was formerly with Farrand Optical Co. as a research project engineer working in the field of infrared instrumentation, components, fire control and navigation systems.

F. Robert Walker: Former field sales manager of closed circuit TV equipment with General Electric, joins Gulton Industries, Inc. in the newly created position of manager of marketing.

Dr. Bernhard H. Goethert: Director of Engineering for ARO, Inc., contract operator for the USAF's Arnold Engineering Development Center, elected a member of a special scientific panel in the North Atlantic Treaty Organization's Advisory Group for Aeronautical Research and Development.

Charles E. Hunter: Special assistant to the president of Thiokol Chemical Corp., has temporarily been assigned to the West Coast area in connection with the corporation's rocket activities.

Louis H. Aricson: President and general manager of Daystrom, Inc.'s Transicoil Division, appointed vice president, human relations, in charge of executive development, industrial relations, public relations and advertising. He succeeds **L. E. Minkel,** who resigned to join Studebaker-Packard Corp.

Theodore Grant: Elected western office manager for the Aerospace Industries Association in Los Angeles, replacing **Capt. Leland D. Webb (USN-ret.)** retiring.

C. Wesley La Blanc: Former assistant to the president of the Magnavox Co., joins the United Industrial Corp. as assistant to the president.

Philip L. Sommer: Formerly with Chrysler Corp., where he was responsible for customer relations activities in Washington, appointed a Washington representative for Boeing Airplane Co.

John Mihalic: A vice president of Avco Corp. and president of its Nashville Div., named president of the Crosley Div., succeeding **F. C. Reith,** deceased.

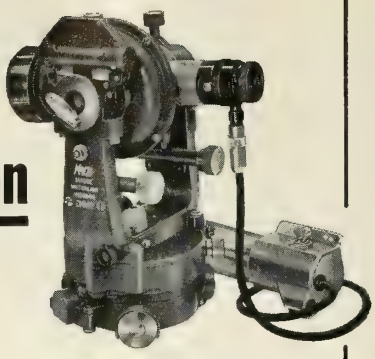
Fred L. Schwab: Former sales manager of Phillips Control, appointed sales manager of Relay Sales, Inc.

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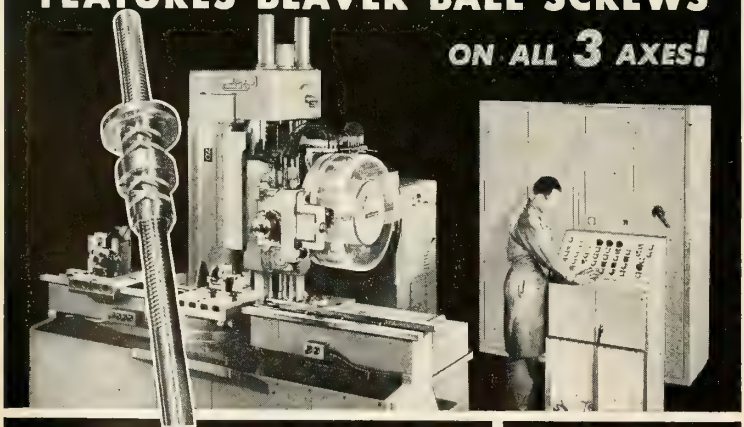
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TAPE-CONTROLLED MACHINING CENTER

FEATURES BEAVER BALL SCREWS

ON ALL 3 AXES!



A significant machine tool achievement—Milwaukee-matic numerically controls positioning, tool selection, indexing, machining, speeds and feeds. Preloaded Beaver Ball Screws with the inherent precision, essential in data control, were the choice of Kearney & Trecker designers for spindle positioning, cross feed and table feed—just as they are with most builders of numerically controlled machines.

Our engineers will be glad to work with you.

Beaver Precision Products INC.

CLAWSON, MICH.

contracts

NAVY

$1,400,000—**Melpar, Inc.**, Falls Church, Va., for target detection devices and systems.

$304,415—**Stanford Research Institute**, Menlo Park, Calif., for design, development and manufacture of a parabolic antenna.

$82,211—**Convair Division of General Dynamics Corp.**, San Diego, for design and development of a magnetic tape system.

$68,984—**Lockheed Electronics Co.**, Plainfield, N.J., for design and construction of masts and stabilized platform.

$55,000—**Microwave Electronics Corp.**, Palo Alto, Calif., for research on traveling wave amplifiers.

$31,560—**AiResearch Mfg. Co. of Arizona**, for research on the matching of propulsion systems to the ground effect machine.

$25,815—**Dage Television of Thompson Ramo Wooldridge, Inc.**, Michigan City, Ind., for research on *ARCAS* videosonde.

AIR FORCE

Cook Technological Center, Morton Grove, Ill., for study, design and fabrication of a supersonic parachute sled test vehicle. Amount not disclosed.

$247,000,000—**Boeing Airplane Co.**, for research and development connected with the hardened and dispersed concept in which the solid-propellant *Minuteman* will be placed in blast-resistant underground silos, ready for launching.

$15,625,000—**General Electric Co.'s Heavy Military Electronics Dept.**, for AN/FPS-24 frequency diversity search radars.

$5,279,088—**RCA Service Co., Division of RCA**, for the complete management and operation of "White Alice" project.

$1,000,000—**Space Electronics Corp.**, for fabrication of the electronic systems for the *AbleStar* upper stage booster. Subcontract from **Aerojet-General.**

$154,000—**General Precision, Inc.'s Kearfott Div.**, Little Falls, N.J., for necessary personnel, facilities, materials and supplies to conduct an engineering study on the techniques and applications of recursive logic.

$136,000—**General Instrument Corp.'s Advanced Development Laboratory**, Westbury, N.Y., for development of a new type of airborne "telemetry" radio transmitter which will automatically beam back to earth data on conditions of the upper atmosphere.

$108,600—**Lieb-Jackson, Inc.**, Columbus, Ohio, for fabrication, delivery and installation of a complete diffuser section and heat exchanger.

$100,000—**The Martin Co.**, Baltimore, for providing a 15-year master plan of checkout systems for manned and unmanned weapons.

ARMY

Servomechanisms, Inc., Research Division, Goleta, Calif., for development and fabrication of a 560-watt thermoelectric generator. Amount not disclosed.

Piasecki Aircraft Corp., Philadelphia, has received a subcontract for the complete airframe manufacture of a new missile. Amount not disclosed.

Redstone Machine & Tool Corp., Huntsville, for fabrication and assembly of missile components, tooling and equipment—*Saturn*. Amount not disclosed.

$7,199,262—**Convair, Division of General Dynamics**, Pomona, for development of the *Mauler* missile system. (Two contracts.)

$6,597,644—**Western Electric Co., Inc.**, New York City, for engineering services on the *Nike-Hercules*.

$4,069,000—**Western Electric Co., Inc.**, New York City, for components of the Missile Monitor system.

$3,393,601—**General Electric's Missile Production Section**, for safing, arming and fuzing systems for advanced surface-to-surface missiles. (Two contracts.)

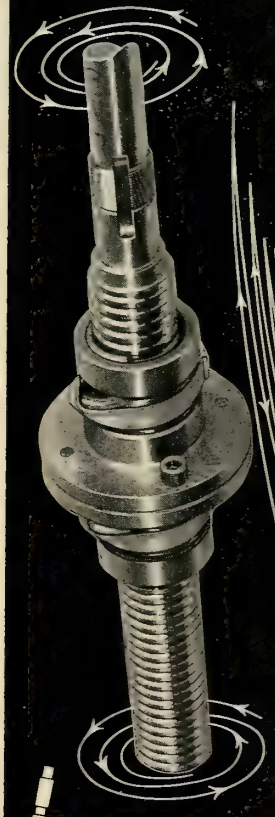
$3,159,303—**Sylvania Electric Products, Inc.**, Needham, Mass., for a large-scale mobile digital computer.

Circle No. 86 on Subscriber Service Card.

BEAVER
BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •



Beaver Precision Products INC.
CLAWSON, MICH.

$1,434,000—**Morrison-Knudsen Co., Inc.**, Honolulu, for construction of a *Nike-Hercules* project, Oahu, Hawaii.

$1,160,000—**Sylvania Electric Products, Inc.'s Electronic Defense Laboratories**, Mountain View, Calif., for design, fabrication, installation and field support of specialized electronic warfare equipment.

$1,000,000—**Hallamore Electronics, division of The Siegler Corp.**, for special test equipment for the *Titan*.

$620,187—**Brown Engineering Co., Inc.**, Huntsville, Ala., for engineering and manufacturing services—*Saturn*.

$297,955—**Edward R. Marden Corp.**, Brookline, Mass., for construction of additional facilities, satellite tracking station, New Boston, N.H.

$250,000—**Temco Aircraft Corp.**, Dallas, for manufacture of aluminum outer shells for the guidance and warhead sections of the *Hawk*. Subcontract from **Raytheon Co.'s Missile Systems Div.**

$235,000—**Lockheed Aircraft Corp.**, Marietta, Ga., for fabrication and assembly of miscellaneous components for *Saturn*.

$234,000—**Century Tool Co.**, Camden, N.J., for electro-mechanical guided missile tool kit for *Hawk*.

$172,147—**Parkhill-Goodloe Co.**, Jacksonville, Fla., for dredging a channel and turning basin to accommodate *Saturn* unloading facilities at Cape Canaveral.

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editorial . . .

Douglas Gives Our Defense Position

For some time there has been a strong conviction that the Department of Defense should outline for the defense industry its policies and plans, as near as possible, for the future. Some months back, on this page, we pointed out the need for guidance in such important matters as diversification, consolidation and reduction.

In a recent statement directed at the industries responsible for the development of most of the nation's missile/space products, James H. Douglas, Deputy Secretary of Defense, has done just that. Although he hedges with cautious admissions that forecasting even a year or two ahead is subject to a considerable margin of error, the former Air Force Secretary plants several clear sign posts for the road ahead. Some of them are:

That for the big primes in the aircraft and missile/space industry there has been a decline of 50% in the floor space requirements since 1957—with a further contraction of another 50% probable in the next three years.

That the defense industry must be increasingly alert to the possibilities of foreign sales. While he did not specify, this is particularly true in the field of small missiles and rockets, both for military use and for space exploration.

That if consolidations and mergers become necessary to maintain skills and capacities, DOD will be interested in exploring the possibilities with industry.

Mr. Douglas pointed out that in formulating the '61 budget the Pentagon made it clear there was no bright prospect ahead that world tensions would relax, and indicated the '62 budget would reflect the same thinking. Specifically in the missile/space field, he listed the following probabilities:

That there are "persuasive reasons" for believing the missile-carrying B-70, or a weapon system with similar capabilities, will be built.

That the nuclear-powered aerial platform for both air-to-air and air-to-ground ballistic missiles will not be in the inventory for a number of years.

That missile expenditures in '62 seem likely to be about the same as '61, a program designed to give us an "immense mixed capability" by the end of calendar 1963.

Our present liquid missiles and the solids under development will be followed by improved versions or by "a new family of missiles," he said.

He saw a continuing demand for rocket boosters for both our military and our civil space programs.

And finally, Mr. Douglas forecast that the dollar volume of business, although perhaps changing in character and more widely spread, would continue to be "very large" in aviation products, missiles and space products.

While the Secretary's statement may contain little that is new or startling, it is an analytical summation of DOD thinking and attitude quite in keeping with Mr. Douglas' cautious but lucid approach to the problem. It is a paper the defense industry welcomes.

Clarke Newlon



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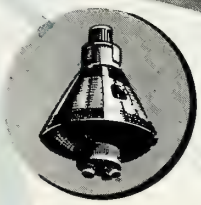
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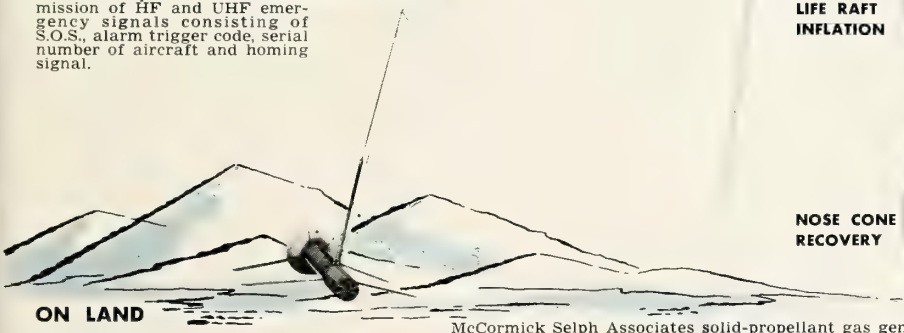


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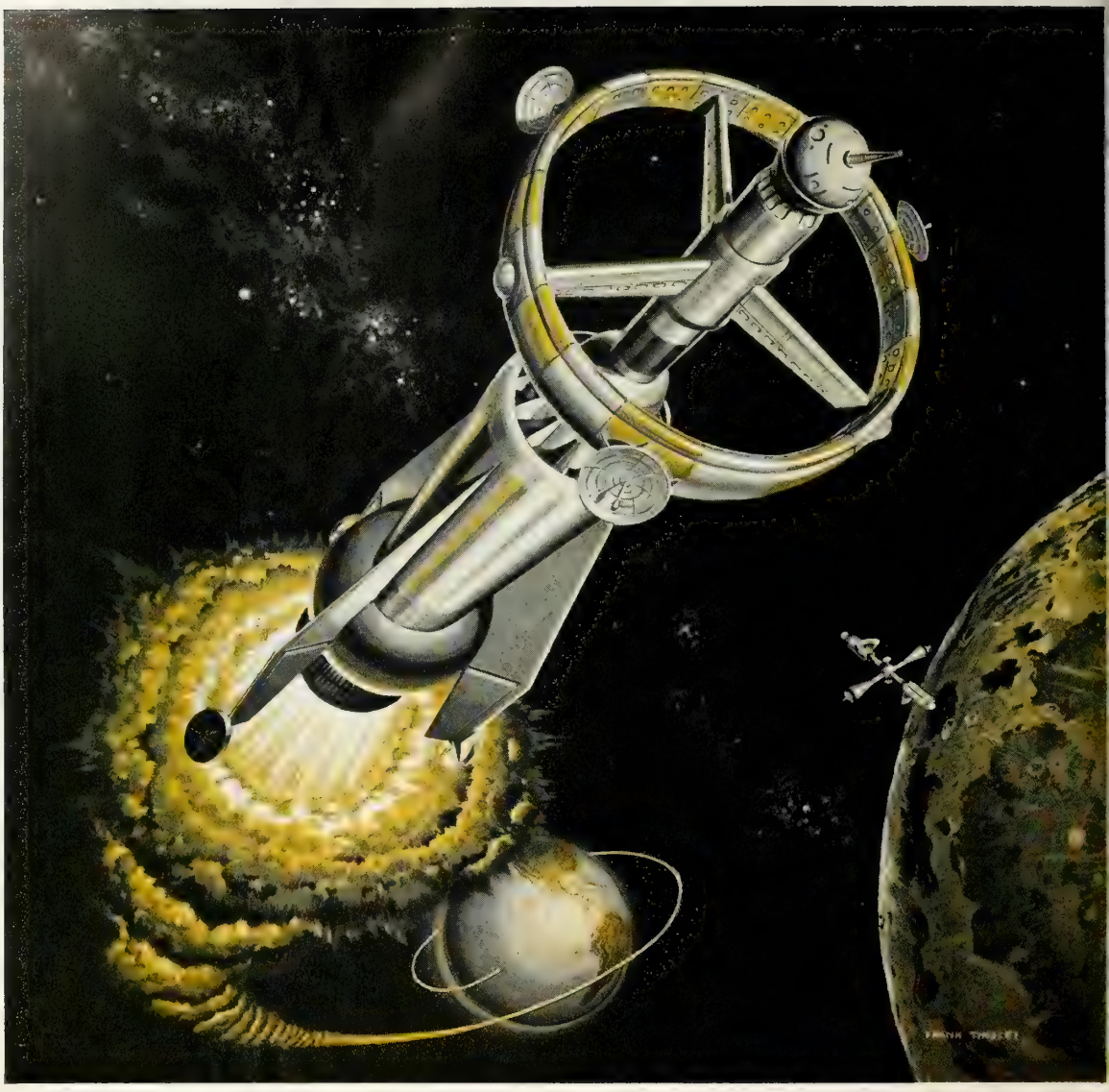
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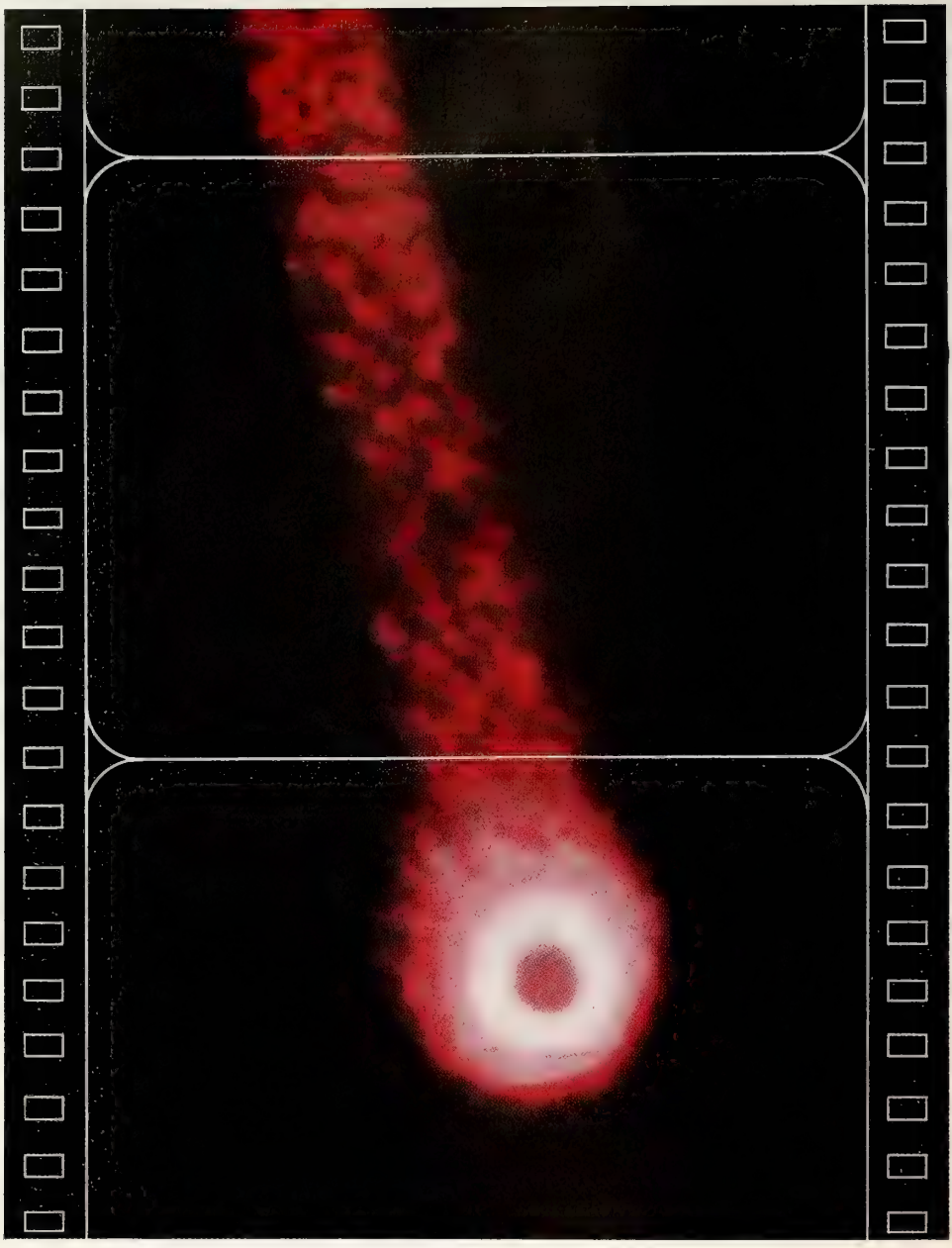
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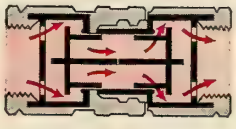
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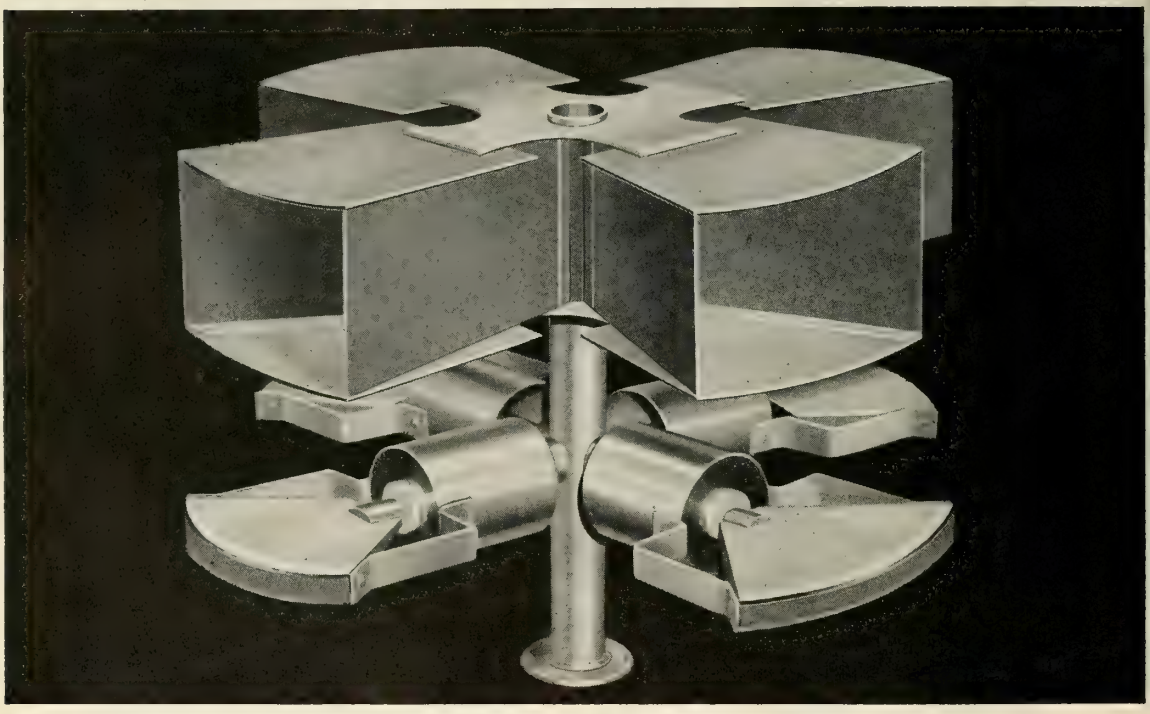
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April 13, 1960, marks a dramatic milestone in American propulsion technology—the first successful restart of a rocket engine in outer space. The mission, under Air Force Ballistic Missile Division management—launching of the ARPA-Navy Transit navigational satellite into precise orbit. The propulsion system: Aerojet's AbleStar upper stage.

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The Countdown

WASHINGTON

More Money for Polaris Subs

Expect the Navy to parlay its spectacular "proof of pudding" underwater *Polaris* shots into a Congressional request for four more missile-packing submarines. The request may come in August or in the supplemental budget. The entire FBM program may get an extra shot of steam this week at the Republican convention. Odds are good Vice President Nixon will answer Democratic "missile gap" charges by pointing to the success of *Polaris* and the fact that 32 *Polaris* missiles will be on station by Christmas.

Answer to Atlas Slippage?

Shift of responsibility for *Atlas* base construction to the Air Materiel Command's Ballistic Missile center is being interpreted in Washington as an Air Force move to prevent further slippage in the program. Maj. Gen. Thomas P. Gerrity, chief of BMC, assumes top management of base building on an equal status with ARDC's Ballistic Missile Division chief, Maj. Gen. O. J. Ritland. Gerrity's new job, however, will not extend to the *Atlas* pads at Vandenberg AFB, Warren AFB and Offutt AFB—where the slippages of three to six months have occurred.

Standby Space Rocket

"Kicking around" Cape Canaveral is a *Titan* missile that could be used for a space shot by the Air Force. The big bird—left over from a development test series—is capable of lofting about 4000 lbs. into orbit. However, there is no indication when—or if—the AF will fire it.

"Wild Life" Atlas?

Next *Atlas* to be launched from the Cape will carry a recoverable re-entry body. One rumor says the vehicle will contain some form of life—possibly a primate—for Air Force space flight research.

Pershing Moving Fast

Race is on to move up the operational date of the Army's solid fueled *Pershing*, now set for 1962. Optimistic observers feel the weapon will be ready in 1961. Tactical version will be about 30 ft. long (4 ft. shorter than R&D version); 48 in. in diameter and weigh about 10,000 lbs.

Hard Mace Sites

Acoustic and insulating problems appear to be licked in the design of a hard site for *Mace* tactical missiles. Go-ahead for construction of bases (four missiles to a site) in West Germany is expected soon.

INDUSTRY

NASA Unveils Industry Plans

Contractors are being given a look at NASA's plans—both immediate and over the next 10 years—at a classified briefing July 27-28.

Insiders?

Latest speculation has the Grumman-Westinghouse and Bendix-Republic teams on the inside track for NASA's orbiting astronomical observatory. Contract could mean up to $100 million to the winner over the next 10 years.

Fallout from Polaris

Several industry proposals to put ICBM's—*Minuteman* and *Titan*—on ships of the moth-ball fleet are still being pushed hard. But, despite the Air Force's desire for more mobility, these proposals are now given little chance in the light of the prove-out of the *Polaris* system. On the positive side: *Polaris* is now credited with knocking a full year off the development of *Minuteman* and of greatly advancing *Pershing*.

On Mahogany Row

Succeeding Richard Horner as the No. 3 man at NASA is Robert G. Seamans, 41, chief engineer of RCA's missile electronics and controls division. He will take over Sept. 1 . . . Douglas Aircraft has lost—through resignation—vice president Ed Heinemann.

INTERNATIONAL

U.S. Buying anti-jammer

C.G.S.F. (France) has U.S. orders in hand for the super-secret "Concinotron"—said to be an anti-jam device for anti-ICBM guidance.

Germany Staying With Cobra

Contrary to reports that Germany will by-pass *Cobra* (COUNTDOWN-May 30) Bolkow-Entwicklungen says the German Army is still interested in the anti-tank missile for infantry. The *SS-11* is heavier and will be deployed exclusively on vehicles.

Secret SS-11 Test

COUNTDOWN hears that a secret test of the *SS-11* was conducted recently in the Dauphine Alps near Huez by Nord-Aviation and the French Army. Alpine troops used a new waist belt fire control to launch five of the missiles at an 8,700 ft.-high site.

Over the Iron Curtain

Japan will launch its first three-stage *Kappa-9* sounding rocket this fall. It will peek over the Iron Curtain, carrying a 33-lb. payload to an estimated 248.4 miles in another step to perfect a high altitude weather reconnaissance system.



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reviews

A STUDY OF THE CORROSIVE EFFECTS OF THE COMBUSTION PRODUCTS OF BORON CONTAINING FUELS ON SELECTED HIGH TEMPERATURE MATERIALS, F. J. Loprest and S. J. Tunkel, Thiokol Chemical Corp. for WADC. Order PB 161421 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C., 331 pp., $5.

The corrosion behavior of a wide cross section of high temperature alloys, under unstressed conditions in the combustion products of boron-containing fuel was examined. Much of the study was devoted to dynamic testing. Test conditions simulated combustion products from a potential boron containing high energy fuel.

CLASSIFICATION OF ELECTRON TUBES, J. Haantjes and H. Carter. Macmillan, New York. 100 pp., $3.50.

A beautifully illustrated and well written book of especial interest to the student and "layman" who needs a general understanding of the types and functions of electron tubes.

Cutaway color views and brief descriptions explain the operation and applications of all major types. Basics of electron theory are also simply presented.

A glossary of "odes" and "trons" defines common terms used in the designation of tubes and their components.

INVESTIGATION OF THE STRENGTH AND DUCTILITY RELATIONSHIPS IN TITANIUM-ALUMINUM ALLOYS BETWEEN 6 and 15% ALUMINUM FOR APPLICATION AT ELEVATED TEMPERATURES. B. S. Lement and others, Manufacturing Labs, Inc., for WADC. Order PB 161424 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 74 pp., $1.75.

The results of a one year study of the strength and ductility relationships in a series of titanium-aluminum alloys varying from 6 to 15% aluminum are reported. The main objective of this investigation was to learn more about the embrittlement phenomenon in order to extend the useful range of aluminum content.

INVESTIGATION OF LIQUID NITRIC OXIDE AS A ROCKET OXIDIZER. L. E. Bollinger and R. Edse, Ohio State University for WADC. Order PB 161300 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 29 pp., $.75.

This is the final report of a series of studies on the use of liquid nitric oxide as an oxidizer for rocket engines. From the limited experiments conducted, researchers did not find liquid nitric oxide favorable as a rocket oxidizer because of the long residence time required for nitric oxide to react fully with the fuels used. The studies also show that nitric oxide may affect the smooth combustion of nitric acid with a fuel because of the long chemical reaction time of nitric oxide.

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—when and where—

JULY

Thermochemistry of Rocket Propulsion, a short course, University of California, Los Angeles, July 25-Aug. 5.

Denver Research Institute, Seventh Annual Symposium on Computers and Data-Processing, Stanley Hotel, Estes Park, Colo., July 28-29.

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Professional Group on Communications Systems, and U.S. Army Signal Corps, Statler Hilton, Washington, D.C., Aug. 1-3.

Massachusetts Institute of Technology, Special Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.

International Symposium on Rarefied Gas Dynamics, University of California, Berkeley, Aug. 3-6.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19.

Annual Meeting of the Association of the U.S. Army, Sheraton-Park Hotel, Washington, D.C., Aug. 8-10.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Aug. 8-12.

ASME-AIChE Heat Transfer Conference and Exhibit, Statler-Hilton Hotel, Buffalo, N.Y., Aug. 15-17.

XIth International Astronautical Congress, IAF, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and National Bureau of Standards, Boulder, Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Institute, Storrs, Aug. 28-Sept. 9.

The Combustion Institute, 8th International Symposium on Combustion, California Institute of Technology, Pasadena, Aug. 29-Sept. 2.

10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

SEPTEMBER

Society of Instrument Technology and British Interplanetary Society, One-day joint symposium on Rocket and Satellite Instrumentation, Manson House, London, Sept. 1.

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

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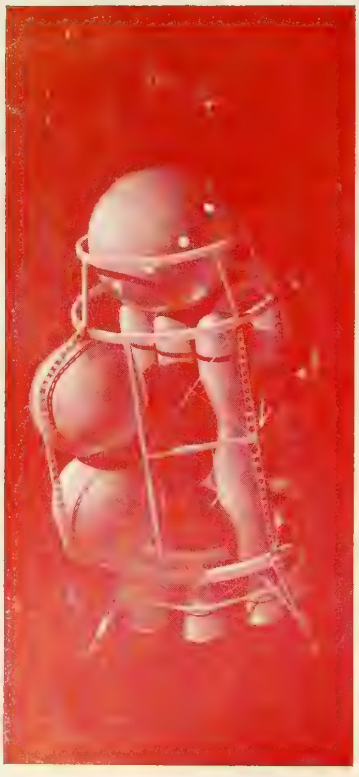
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OUTERSPACE VEHICLES—Sundstrand has been the prominent factor in the development of a solar mechanical engine which, using an advanced working fluid, is capable of providing a continuous source of power generation for satellites, platforms and other space vehicles. A closed cycle power conversion system, this exotic, advanced power system is typical of the research and development work *currently* being conducted by Sundstrand for outerspace vehicles.



UNDERWATER VEHICLES—With an increasing interest in utilizing the deep oceans for both peaceful and defensive purposes, Sundstrand is *currently* engaged in a program investigating the use of a common working fluid in closed cycle systems for underwater propulsion. This work also includes the study of advanced research torpedo configurations.



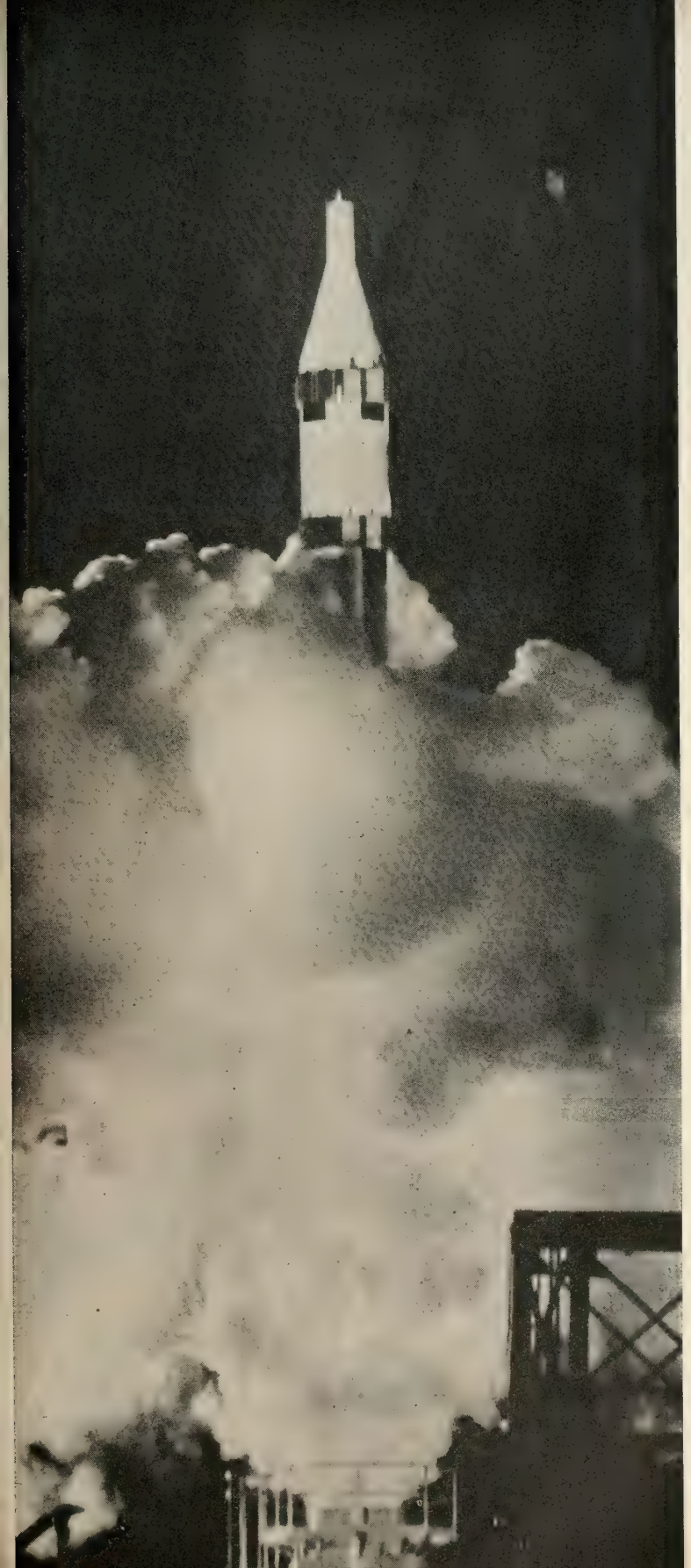
RE-ENTRY VEHICLES—Since Sundstrand developed the first successful monopropellant missile APU in 1952, Sundstrand has produced a continuous flow of advancements in this area. Sundstrand is *currently* developing a chemically fueled open cycle power generation system which, using hydrazine or hydrogen and oxygen as the propellant, drives a generator for electrical power. It is proposed for re-entry vehicles and similar applications.

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POLARIS

FBM Program Starts Rolling: A Special Report

- Double Shot from submarine proves out missile, spurs October deployment 12
- NATO moving toward 1000-missile force—heavily spiked with Polaris 12
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- Hotter fuel speeds development of 2500 mile Polaris motors 20
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system is proven . . .

The Issue Now: How Many Polaris Subs

by James Baar and William E. Howard

CAPE CANAVERAL—The mighty *Polaris* missile system last week raced toward its October operational date with the issue of how large a *Polaris* fleet is to be built still in doubt.

The nuclear-powered submarine George Washington successfully launched not one but two operational *Polarises* for the first time while submerged off the coast of northern Florida.

The stubby 28-ft. missiles roared more than 1000 nautical miles down the Atlantic Missile Range within less than three hours and were reported to impact well within the target area.

The tests were considered to be the "proof of the pudding" by the men who have worked at almost killing speed since 1957 to develop the *Polaris* system.

The sending of the George Washington on station by October with 16 nuclear-tipped *Polaris* missiles in her magazine appeared assured. The Patrick Henry—second submarine of the *Polaris* fleet—is expected to follow by December.

But how many more *Polaris* launching subs will follow the first two into the oceans around the Soviet empire remains to be determined.

The Navy is continuing to press for a *Polaris* fleet of 45 submarines. The total cost is estimated at $8.6 billion.

The Eisenhower Administration to date has agreed to construction of only 14 *Polaris* subs along with procurement of long-lead items for seven more. Administration authorization for two—originally added by Congress over Administration objections last month—was disclosed within a hour after the second successful launching.

Pressure to increase the number of submarines is expected to result in one of the hottest issues of the presidential election campaign. Congress could authorize more when it meets again next month.

Meantime:

• The George Washington will continue missile launching tests off Cape Canaveral for the next several months. The Patrick Henry will join her sister ship at the Cape probably by late summer.

• The Navy's Special Projects Office, directing development of the *Polaris* system, is pushing work on the 1500-mile-range version of the missile and looking toward development of a 2500-mile model. The 1500-mile *Polaris* is expected to be operational before 1963.

Polaris Major Factor in Proposed 1000-Miss

by Clarke Newlon

PARIS—Spurred on by the increasing truculence of Nikita Khrushchev, Supreme Headquarters Allied Powers Europe is pushing forward with plans for a thousand-weapon NATO missile force to help contain the threat from the Communist armies of Eastern Europe. The force would be land-based and mobile.

When and if approved by the NATO ministers, the strategic force will be strung through the 12 NATO countries of Western Europe.

Projection of the missile arm follows recent statements by General Lauris Norstad, Supreme Allied Commander, that the forces needed now to defend Western Europe are double those deemed necessary in 1949, when NATO was founded.

The missile group will constitute a force in being actually under the command—in peacetime as well as in event of war—of Gen. Norstad.

There is every possibility that formation and actual training of the force will begin within the next six to nine months.

It would be armed probably with either the American *Polaris* or *Pershing*—or a mixture of the two—and probably would not be operational for two years or more.

• **Planned long ago**—The first step toward a missile force was taken more than a year ago when *Jupiter* IRBM missiles presently being installed in southeastern Italy were placed under direct SHAPE command. The Italian bases have been kept under wraps due to strong Communist opposition.

It has just been revealed that base construction has been completed and the pads are ready for the missiles. They will be manned by Italian crews under SHAPE command, with the *Jupiter* atomic warhead under U.S. control.

All other forces committed to NATO are under national command (as are the *Thor* ICBM's in Britain) and are simply committed to SHAPE in event of war.

SHAPE has long had plans for such a force but only recently has pressed strongly for action. General Norstad, it is understood, has asked for an organization to be armed with about 300 missiles, which would be increased gradually up to 1000.

The entire matter now rests with the NATO Council of Ministers, which must approve the plan for the NATO missile force before it can be implemented by SHAPE. Because of political implications, the SHAPE military is very reluctant to discuss concrete plans.

• **U.S. offer**—There is little doubt that any such force would be armed with U.S. missiles—if for no other reason than that they will be available. Following the last Defense Ministers' meeting in April, U.S. Defense Secretary Thomas Gates said:

"I am a little bit bound by a commitment that I made along with other Defense Ministers not to discuss this. However, parts of this have come out. We made a preliminary offer to the NATO meeting for consideration by the NATO Council to sell them certain land-based mobile missiles and this had certain restrictions and caveats in connection with it, and the missile under discussion is the *Polaris* missile, but I don't think that I would like to breach my commitment to the NATO Council to say where they would go from there.

"It is a complicated business and it will take some time and thought on the part of the nations involved to see whether they want to proceed with it or not."

When word of Gates' offer of the *Polaris* became known at the Pentagon the Army immediately moved forward with a counter offer of the *Pershing*. Originally developed as a 200-mile surface-to-surface missile, the *Pershing* has now been projected to much greater distances—staying within its five-ton propellant weight—and

• The NATO Council is considering purchase of hundreds of the current 1200-mile-range *Polarises* for deployment in land-based fixed and mobile launchers in Western Europe. If the European NATO nations buy *Polaris*, they are expected to order missiles coming off the current production line.

• **Watchful waiting**—The historic first launching of a *Polaris* from the George Washington took place at 1:39 p.m. EDT on July 20. The 380-ft. submarine was cruising beneath the surface in about 250 feet of water, some 30 miles due east of Cape Canaveral.

The Observation Island Test Ship lay at anchor about 2000 yards away. A destroyer circled the operating area in search of Soviet submarines and "spy ship" trawlers.

Rear Adm. William F. Raborn, director of the *Polaris* program, was aboard the George Washington. So were representatives of the leading members of the *Polaris* industry team: Lockheed, General Electric, Aerojet-General, Westinghouse and Sperry. Members of the George Washington's Blue Crew launched both missiles.

Unlike two days earlier, when range instrumentation problems forced a launching to be postponed, the countdown for the first *Polaris* was stopped briefly only two times—once because a merchant ship had sailed into the impact area.

Nothing could be seen of the George Washington except the tip of a tall telemetry mast that poked through the deep blue Atlantic. The mast, which towered high above the top of the submarine's sail is needed for range communications and is not part of the operational system.

Seconds before the countdown reached zero, a puff of green smoke appeared near the mast's tip as a signal to cameramen on the Observation Island. Then the champagne bottle-shaped missile ripped from the sea, pulling a spout of water behind it. The first stage ignited in the air and the missile shot into the clear Florida sky.

The second stage separated from the first about 54 seconds after the launching and the missile continued downrange, leaving a long thin trail of white smoke behind it.

The George Washington successfully launched the second *Polaris* at 4:32 p.m. EDT. Again there were only a few minor holds. Most of the time was needed for the normal adjustment of the test range between shots.

• **Reward for four years**—The "proof of the pudding" launchings culminated a development effort that began in December, 1955, when the Special Projects Office was established with Raborn as its head. SP's assignment was the development of a sea-going fleet ballistic missile.

The Navy first attempted to adapt the liquid-propelled *Jupiter* for shipboard use. A year later it switched to development of the solid-propelled *Polaris*.

The original program called for producing a 1500-mile-range *Polaris* by 1963. However, three years were shaved from the program, primarily by reducing the range of the initially operational missile to 1200 miles.

Before this month, all components of the missile had been proven. A *Polaris* had been successfully launched from the Observation Island. A cut-grain test vehicle had been launched from an underwater tube off San Clemente Island, Calif. But *Polaris* had still to be "married" to a submarine.

The wedding took place at 1:39 a.m. EDT July 20.

rce for NATO

the Army claims that within two years it will have a 1200-mile capability. Certainly it should develop into a 600 to 700-mile capability.

Both *Polaris*, with its 1200-2500-mile potential, and *Pershing* are solid-fuel missiles. Both are mobile, in the sense that they could be fired from rail cars, barges or even trucks.

• **Broad advantages**—The prospect of a NATO missile force has fascinated military planners for several years. It could solve several of the major problems which have beset SHAPE since its inception some eleven years ago, including:

• Control of the nuclear warhead.

• Reassignment of national forces.

• Centralized and unified training with a common weapon.

• Logistics and supply.

There are literally a dozen different forms which such a NATO missile force could take. One might be a completely integrated force complete with officers and enlisted personnel. Another might be local troops with NATO officers. Still another might be completely national units with NATO officers for liaison with SHAPE and to control nuclear weapons.

• **Amendment called for**—Under any arrangement, it would be necessary to amend the Atomic Energy Act to permit the United States to hand over control of nuclear warheads to SHAPE or to delegate SHAPE as the agent for the U.S. It is generally believed Congress would go along with some such proposal.

In a speech made in December, 1959, General Norstad said:

"It should not be assumed that even the creation of a multinational atomic authority—making an alliance, NATO for instance, the fourth atomic power—would necessarily influence the desire of some nations to pursue their own independent quest for an atomic weapons capability—although such action might very well remove a good part of the motivation of others to do so.

"Our present strategy influenced as it must be by the hopes and the needs of 15 nations, is inevitably one of compromise. This has certainly given us a useful start. But for the Alliance to have continuing life and meaning, it needs an increasing authority.

"Action to pass to the Alliance greater control over atomic weapons and subjecting their use more directly to the collective will, if politically feasible, could be a great new step."

The problem of national forces which had been earmarked for NATO being moved out of SHAPE's domain has be-deviled every SHAPE commander. France, with her North Africa preoccupation, has been a particular offender. The establishment of a NATO missile force should cure this ailment.

With one—or even two—missiles, a central training base could be established in Europe to train crews of any country participating, whether they were to be used as national units or mixed forces.

The supply and logistic difficulties, normally tremendous in maintaining such a force equipped with multiple and varied weapons, would be greatly reduced by using a common weapon and common support equipment.

Twelve European NATO countries could be involved in basing such a NATO missile force. Of these, two—Britain and Italy—either have or soon will have missiles. Turkey has requested them and will probably receive the *Jupiter*. France might agree or might demand special autonomous consideration. Neither Norway, with its common border with Russia, nor Denmark is likely to base atomic missiles on its soil for internal political reasons. Portugal would be uncertain. Most of the other NATO nations are believed likely to accept them.

Navy to Use Corvus Money For New Air-to-ground System

Money recovered from the cancelled *Corvus* program will be spent on a newer air-to-ground missile system, the design of which is already under study, a Navy spokesman said after the $80-million cancellation was announced.

The Navy is believed seeking an air-launched missile with a potential range up to 500 miles, thus increasing its capabilities in the strategic area. *Corvus* range was only 100 miles and apparently the Navy saw no feasible way to extend this greatly.

The Navy knocked down reports that the *Corvus* money would be spent on either the *Polaris* or the super carrier programs, both of which carry national priorities and for both of which the Navy would like more funds. Nor, said the Navy, would the money go for *Eagle*, an air-to-air missile under development which could conceivably be adapted for air-to-ground deployment.

Prime contractor for *Corvus* was Temco Electronics and Missile Co. at Dallas. About $80 million had been spent on the missile, which was nearing production. The overall program envisaged spending $450 million. The Navy declined to say how much of which had been committed and how much was recoverable.

In rationalizing the $80 million spent, the Navy said that much had been learned from the program, particularly in the guidance field. Cancellation came because newer designs carried greater potential.

The Air Force *Hound Dog*, a currently operational air-breather with a 500-mile range, is too heavy for practical Navy use—as will be the USAF's ballistic, 1000-mile range *Sky Bolt*. *Corvus*, designed to be fired from carrier-based aircraft, carried the following specifications: range, 100 miles; speed, supersonic; payload, H.E. or nuclear.

Temco Spokesmen 'Flabbergasted'

DALLAS—"We were flabbergasted," Temco Electronics and Missile Co. officials told M/R when asked for their reaction to the Navy's sudden cancellation of the *Corvus* air-to-surface missile.

First word of the contract cancellation reached Temco, a subsidiary of Ling-Temco Electronics, Inc., in a report in the Dallas *Times-Herald*. One of its reporters had been informed of the Navy's action through a release from the Washington office of Rep. Bruce Alger (R-Tex.)

A highly successful flight of the *Corvus* missile had been made only a week ago at Pt. Mugu, Calif. A company representative was in the Pentagon at the time of the contract cancellation trying to clear a news release describing the near-perfect mission.

Work on the *Corvus* project accounted for nearly 20% of the company's backlog. "As far as the public is concerned," said an official, "this comes at a particularly bad time since we have just completed the Temco merger with Ling-Altec Corp."

All subcontracts were immediately cancelled by Temco. Principal subcontractors include: Reaction Motors division of Thiokol Chemical Corp., propulsion; W. L. Maxson and Texas Instruments, guidance; Emerson Research Laboratories, target detection; Horkey-Moore Associates, launcher; Talco, Inc., recovery system; and Bulova Watch Co., safety and arming.

Layoffs of 200 hourly-paid workers started Tuesday afternoon and up to 500 others will be dropped within the next two weeks.

Since Temco had a recruiting campaign on for professional and skilled technicians, most of these employes on the *Corvus* program will be transferred to other jobs.

Temco has no other missile systems contracts but is doing subcontract work on *Minuteman* (engine components), *Sergeant* (motor cases), *Hawk*, GAR-9 *Falcon*, and *Davy Crockett*. The company said it also has proposals out for a boost-glide type space vehicle.

Court Ends Camras' Patent On Magnetic Tape

The broad magnetic recording tape patent held by Marvin Camras and assigned to Armour Research Foundation is "clearly invalid," says the U.S. Court of Appeals, Seventh District—Chicago.

This ends the 5-year litigation freeing the entire industry of the restraint under which it has operated since Camras was issued the patent in November, 1954.

Plaintiffs, Armour and Minnesota Mining and Manufacturing Co. (who controlled the patent), charged C. K. Williams & Co. and Technical Tape Corp. with infringement in 1955. The U.S. District Court, East St. Louis, Ill., upheld the defense in February, 1959. The appeal followed.

Williams is a basic producer of iron oxide pigments and magnetic iron oxides. TTC used the Williams iron oxides to manufacture and sell magnetic recording tape.

Camras' patent No. 2,694,656 was unusually broad, covering his invention of certain types of magnetic iron oxides, methods of producing them, and their use for magnetic recording and reproduction.

Other tape manufacturers favorably affected by the decision include Audio Devices, Inc.; Ferrodynamics Corp.; ORR Industries Div., Ampex Corp.; Reeves Soundcraft Corp.; and American Recording Tape Co.

Lockheed Strike Ends As Workers Accept Contract

BURBANK, CALIF.—Lockheed Aircraft Co. machinists returned to work last Monday after ending their month-old walkout by a 3-2 vote.

A company official said the new contract accepted by workers in the Missiles and Space Division is essentially the same as that tendered by Lockheed and rejected by the International Association of Machinists last month.

Affecting 10,500 hourly workers in six plants, the new pact includes these principal provisions:

- A wage increase, retroactive to June 13, of 4 cents/hr. plus a 3-cent/hr. increase next year.
- Preservation of an additional 2 cents/hr. cost-of-living raise from the previous contract, and freezing at 6 cents/hr. of previously granted c-of-1 pay. New provisions are made for any increase in cost of living after July, 1961.
- Layoff benefits of $50 for each year of employment up to $500 maximum.

The union's demand for an agency shop (whereby all workers eligible for union membership would pay dues even if they did not join the union) was the main strike issue, according to the company. It was not granted.

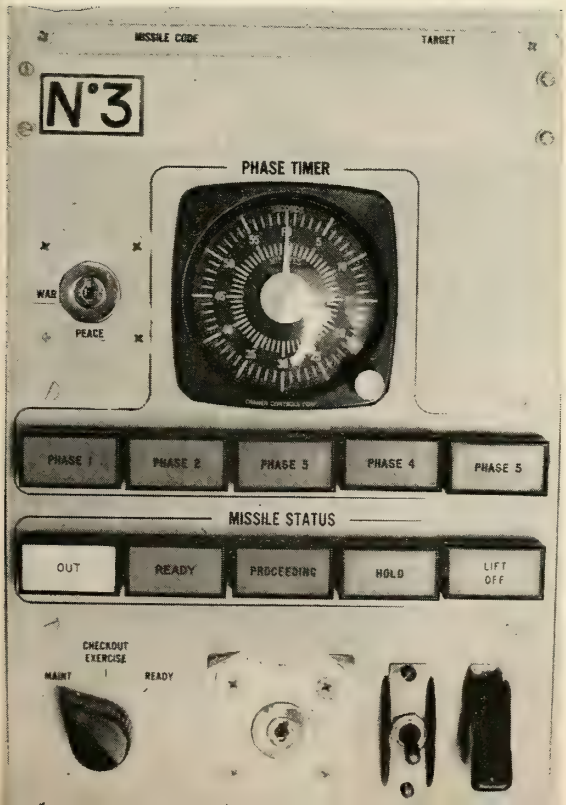
An IAM spokesman said the walkout resulted from Lockheed's attempt to reclassify jobs. He said this would have cost workers an average of $20/wk.

The division is prime contractor for the Navy's *Polaris* IRBM and for the *Discoverer, Samos* and *Midas* satellite systems. Despite the strike, all critical defense contract dates have been met, Lockheed said.





This is How Thor 'Double Veto' Works



FELTWELL, ENGLAND—In the event of war, one of the keys hanging around the neck of USAF Major Curtis Hintze, left above, could loose the first atomic missile to strike at the Soviet heartland.

Under the famous double-key, double-veto system employed at the *Thor* IRBM base here, one British and one American officer, under instructions from their governments, must turn the keys in the locks which will permit the firing of the 1500-mile missile. As the system works, the British officer turns the key which starts the countdown and carries it (see below) through Phases 1, 2, 3, 4 and most of 5. With about two seconds of Phase 5 remaining, Major Hintze or his counterpart must take one of the keys from the chain around his neck, insert it in the lock pictured below and turn as marked—from peace to war.

His key activates the nuclear warhead and clears the way for the final seconds of countdown before the weapon lifts from the pad. When on duty, Major Hintze and his counterpart officers sit beside a direct-line phone to SAC headquarters in Omaha, Neb.

Above, the dogs which help guard this *Thor* base. Turn the page for further pictures.

(NATO official photos)

Last step is turning the second key for

SHOULD THE WARNING of war come, Flight Lieutenant Couttes, shown below, left, talking with Major Hintze, would turn his key and the action pictured on these pages would take place.

Phase 1: About 2 minutes; the hangars covering the *Thor* would slide back (right).

Phase 2: about 2½ minutes; the missile would be raised to vertical position (center).

Phase 3: about 8 minutes; the missile is now being fueled with kerosene and liquid oxygen. Through Phase 3 the countdown can be held for hours if desired.

Phase 4: about 2 minutes; waiting for stabilization and topping of the fueling operation.

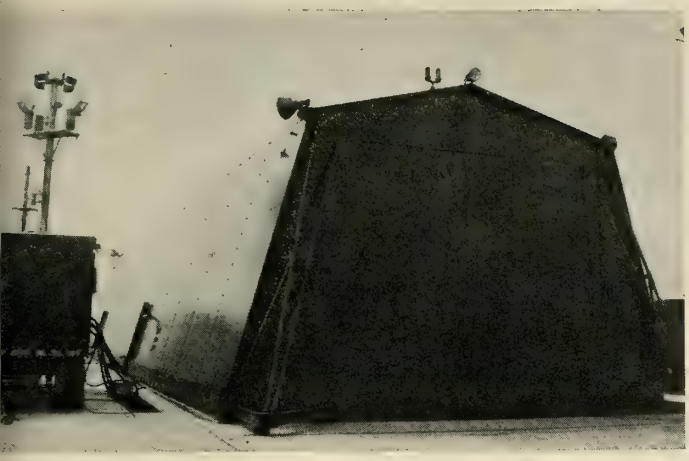
Phase 5: about 2 minutes; final visual checking for guidance alignment and automatic sequencing. And—if the second key is turned—activation of the warhead and blastoff.



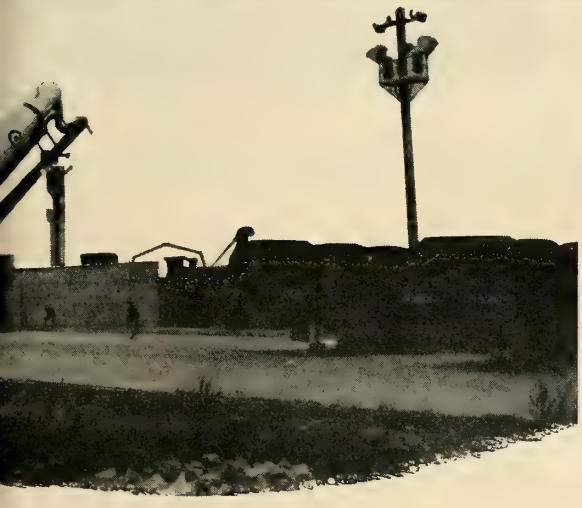




y in case of war . . .









THE THOR firing shown at right occurred at the USAF testing and training base, Vandenberg AFB, Calif. No *Thors* have been fired from Feltwell—nor will they ever be except in event of war. It is one of four such IRBM bases strung along the northern coast of England. The others are Helmswell, Driffield and North Luffenham.

Each base is of squadron strength—15 missiles. Each base consists of a main site and four satellite sites, each with three missiles. Maintenance and housekeeping facilities are at the main site. Each base has about 1000 RAF personnel and 100 USAF personnel. The Americans are responsible for nuclear warhead storage and maintenance, for technical supply and training. Main site and satellites are separated by about 20 miles.

At each base five crews of 16 men and several trained dogs operate on an around-the-clock basis. The crews consist of one officer and six non-coms for launching; one U.S. officer with the second key; five police guards, one fireman-driver, one cook and one motor transport man.

POLARIS
SPECIAL REPORT



Integration Expedites Production

Successful program also boasts easy interchangeability of units, rigid tolerances and highly detailed manufacturing procedures

by Frank G. McGuire

SUNNYVALE, CALIF.—Much of the success of *Polaris* is a result of applying hydrodynamic design to an aerodynamic mission.

The missile spends only a few seconds passing through a few feet of water, but this short journey has had more influence on its configuration than the ensuing 1200 miles of travel through the atmosphere and space.

Lockheed Missile and Space Division points out that the strength, clean lines, compactness and safety features required by the missile's operational launching method and environment have helped, rather than handicapped, the FBM's mission.

LMSD is missile system manager and prime contractor for *Polaris*, operating under the Navy's Special Projects Office headed by Rear Admiral William F. Raborn, Jr.

Integration of the dual roles—a hydrodynamic body and an aerodynamic body—is characteristic of the integration required throughout the vehicle and the supporting systems, including the submarine.

Interchangeability for ease of servicing aboard submarines is another *Polaris* keynote. The guidance system, hydraulic jetavator actuator units, and other subsystems are plug-in units which may be replaced or serviced by submarine crew members while the missile remains in its launch tube.

The one major subsystem not serviced aboard the submarine is the reentry body and its contents. The solid-rocket motors, produced by Aerojet-General Corp., presumably require no servicing at all.

For those maintenance problems or routine cycles not within the submarine's capability, the Navy is outfitting special submarine tenders for the *Polaris*-launching fleet of nuclear submarines. This of course does not prevent them from servicing any other type of submarine in the fleet, as well.

These tenders, the first of which is the USS Proteus, will have an extensive supply of spare parts, technicians, checkout and test equipment, and other highly specialized items. Nevertheless, dependence on the tender has been reduced by the placement of plug-in spares aboard the submarine.

• **Production underway**—Production of "war inventory" *Polaris* missiles has begun at LMSD's facility here, but not at maximum capacity. Missiles are shipped to the naval base at Charleston, S.C., in dismantled condition. The two propulsion units are shipped separately by Aerojet from Sacramento, while LMSD ships interstage structures, equipment bays, re-entry bodies and other accessory items and systems. These packages are assembled at Charleston before loading aboard submarines.

A similar system is used for flight test vehicles, except that the assembly is done at Cape Canaveral. Despite this method of piecemeal shipping to an assembly point across the country, LMSD can completely assemble and test missiles at its Sunnyvale facility in order to insure reliability. Test equipment used in this program is itself tested periodically.

Manufacturing procedures in the program are far more detailed than standard manufacturing routines. Fabrication steps are spelled out in minute detail, tolerances are tighter than those used in modern jet aircraft, and inspection is extremely rigid.

Second, and sometimes third, sources are established for most com-

ponents. When requests for specialized items are sent out to industry, LMSD evaluates replies, eliminates unsuitable designs, picks the best as early as possible to avoid supporting parallel designs too long—and then establishes, if possible, several sources for this preferred design.

Some components are made in-house; for example, the molding of electrical conduits, which has advanced to the point where it is now an almost completely automated operation. The company tries to avoid procuring proprietary items because of the complications involved in establishing several sources.

• **Cut-rate skirts**—A prime example of items made in-house is the conical skirt which connects the second stage and the re-entry body. Constituting "one of the most frustrating and time-consuming steps in the manufacturing process," this skirt was procured—on a trial basis at first—from the area's biggest and most experienced fabricators. Not one acceptable skirt was ever delivered.

A company engineer, Robert O'Neill, came up with a device to hold the work piece at its apex while a large roller proceeded to bend the piece into a perfect skirt on one pass. This operation, requiring only a few minutes, replaced the previous one in which two men worked for eight hours to get similar results.

The newly-devised method saved $50,000 annually, increased production rate, and reduced the number of rejected parts. It turns out a mechanically perfect cone in every operation, Lockheed says, and does away with the necessity of replacing each rejected piece of raw material at $500 per cone.

A precision-tolerance item, this truncated cone surrounds the equipment bay forward of the second-stage rocket motor. Pressurization is intended to simplify design of the electronic equipment. Operating in a consistent environment such as this, the electronics systems operate easily when passing through water, atmosphere, space, then re-entry.

Sealing of the pressurized bay is essential to avoid the escape of air underwater. Because the *Polaris* is not guided in its underwater phase, the configuration must be hydrodynamically clean. An air leak might induce cavitation that would affect its stable ascent to the surface.

In designing the destruct system for *Polaris,* which is included on every vehicle except war birds to be fired in anger, LMSD had a knotty three-way problem. First, neither the destruct system nor the rocket ignition system can be armed while the missile is in the launch tube. Secondly, the destruct system must be armed before the igniters can operate. Thirdly, in case the igniters fail to function properly, the destruct system must be disarmed immediately, so that an explosion does not occur when the bird falls again.

The destruct system consists of a shaped charge located at the head end of the rocket motors for each stage. In event of actuation, the charge ruptures the head closure to such an extent that the propellant burns, but has no propulsive effect, since gases escape from each end simultaneously.

• **Fabrication problem licked**—Early in the program, LMSD's Manufacturing Development Engineers were asked to come up with an acceptable method of welding magnesium-thorium, an alloy with good physical properties at high temperatures, but with poor welding qualities. Technique was apparently the key to the problem, rather than any inherent quality in the material itself.

Distortion and cracks developed under normal circumstances, leading to a great deal of unacceptable work after processing. LMSD has since adapted machinery, laid out X-ray methods, working speeds, and other details for successfully welding the alloy. Previously, no standards existed for the inspection of such Class A welds.

Present operations with magnesium-thorium utilize automatic machinery, adequate ventilation to carry away gases produced, and TIG (tungsten inert gas) and MIG (metal inert gas) welding methods.

The gas used is a mixture of 75% helium and 25% argon. A backup bar of either copper or steel is used for its chilling effect on the metal to avoid overheating getting beyond the weld area. Steel is preferred because it is similar to copper in effectiveness, but costs less.

A channel in the backup bar permits gas, as well as the 75 helium/25 argon mixture, to flow through it, then pass into the immediate weld area through small holes drilled the length of the backup bar. This gas has a cooling effect on the weld.

The detailed procedure to prevent overheating of parent metal beyond the immediate weld area is designed to insure consistent quality at high temperatures throughout the parent metal, heat-affected zone, and the weld. LMSD manufacturing development engineers found that magnesium-thorium alloy is best welded in the hardened condition, to avoid the necessity of heat treating later. Although the resulting weld is not as efficient as possible at room temperature, the most effective strength distribution occurs at anticipated operating temperatures.



CONICAL SKIRT for *Polaris* is guided through the giant roll. Lockheed says the technique saves about $50,000 a year.



LOCKHEED Missiles and Space Division electronic technicians ready microminiaturized telemetry units for test vehicles.

Special Report

Longer Range Promised Through Improved Motors

Aerojet program has already hiked I_{sp} by 15% and more gains are expected; plans call for hotter propellants, fiberglass casings

SACRAMENTO, CALIF. — Substantial changes in the propulsion system for the *Polaris* fleet ballistic missile will boost range of the weapon toward the 2500-mile figure.

Aerojet-General Corp., producer of the propulsion system for *Polaris*, revealed a number of improvements in the offing, including:

- New, hotter propellants to raise specific impulse.
- Use of fiberglass for second-stage motor casing.
- Switch from jetavator thrust vector control to movable nozzles.
- Adoption of lighter inert parts through all parts of the system.

Aerojet disclosed that the continuous program for product improvement has resulted in a 15% increase in specific impulse over the past three years. This increase is expected to continue.

W. R. Kirchner, Director, *Polaris* Program at Aerojet, cited other carefully planned changes in *Polaris* production, intended to take advantage of everything which will result in higher performance and reliability.

Present roll and weld motor casings of 6434 steel (an offshoot of 4340) may be replaced by hydrospun casings. Cases formed by hydrospinning have already been flown on *Polaris* test vehicles. Additionally, explosive forming will be exploited for use on heads of cases.

"When our development program permits it, we will use fiberglass cases on second-stage motor casings to lighten their weight," Kirchner said, pointing out that mass fraction is more vital on the second stage than on first stages.

In the second stage now being used with the FBM system, combination plastic and metal nozzles are being employed, with a refractory throat insert. This method has reduced the weight of the nozzles by 30%. However, a switch to the higher-performance, hotter propellants previously mentioned may force a return to all-metal nozzles, due to the inability of presently-known plastics to withstand the temperatures.

The temperature of the new propellants will be well over 6000°F, or hotter than the propellants now used in *Minuteman*. Most credit for the boost in performance in the new propellants goes to the additives used, mostly aluminum, but also to some other materials intended to increase compatibility.

- **Synthesis**—Aerojet also is pressing for a method to synthesize fuel systems. Materials likely to be used in event all the propellant improvement projects bear fruit, include tungsten (melting point 6300°F) or graphite (sublimation point of 6500°F).

Combustion pressures in the first stage of present *Polaris* configurations is about 1000 psi, while the second stage is 500 psi.

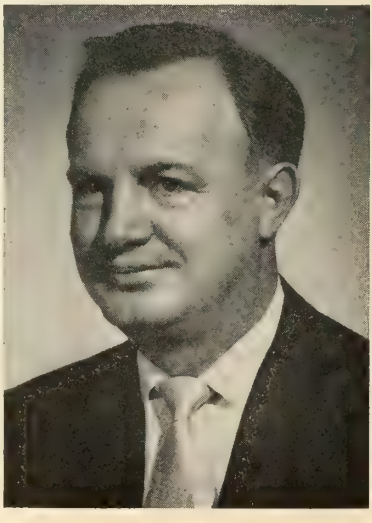
The use of jetavators may also be ruled out with the newer propellants now in sight. In addition to presenting an obstacle to the exhaust stream, the materials may be affected by the heat to such an extent that efficiency and reliability become marginal.

- **Nozzle thoughts**—A major change, proven possible by *Minuteman*, would be in the thrust vector control system. Movable nozzles, swivelling on one axis during powered flight, will be incorporated into the missile design.

Nozzles now under consideration at the Sacramento facility of Aerojet are being tested on a liquid propellant rocket engine, capable of being shut down at various burning periods, to study effects on new designs.

One of Aerojet's proudest accomplishments is the success of the continuous mixing process used in the propellant processing phase. The plant, designed and constructed by the com-

Kirchner New Director of Aerojet Polaris Setup

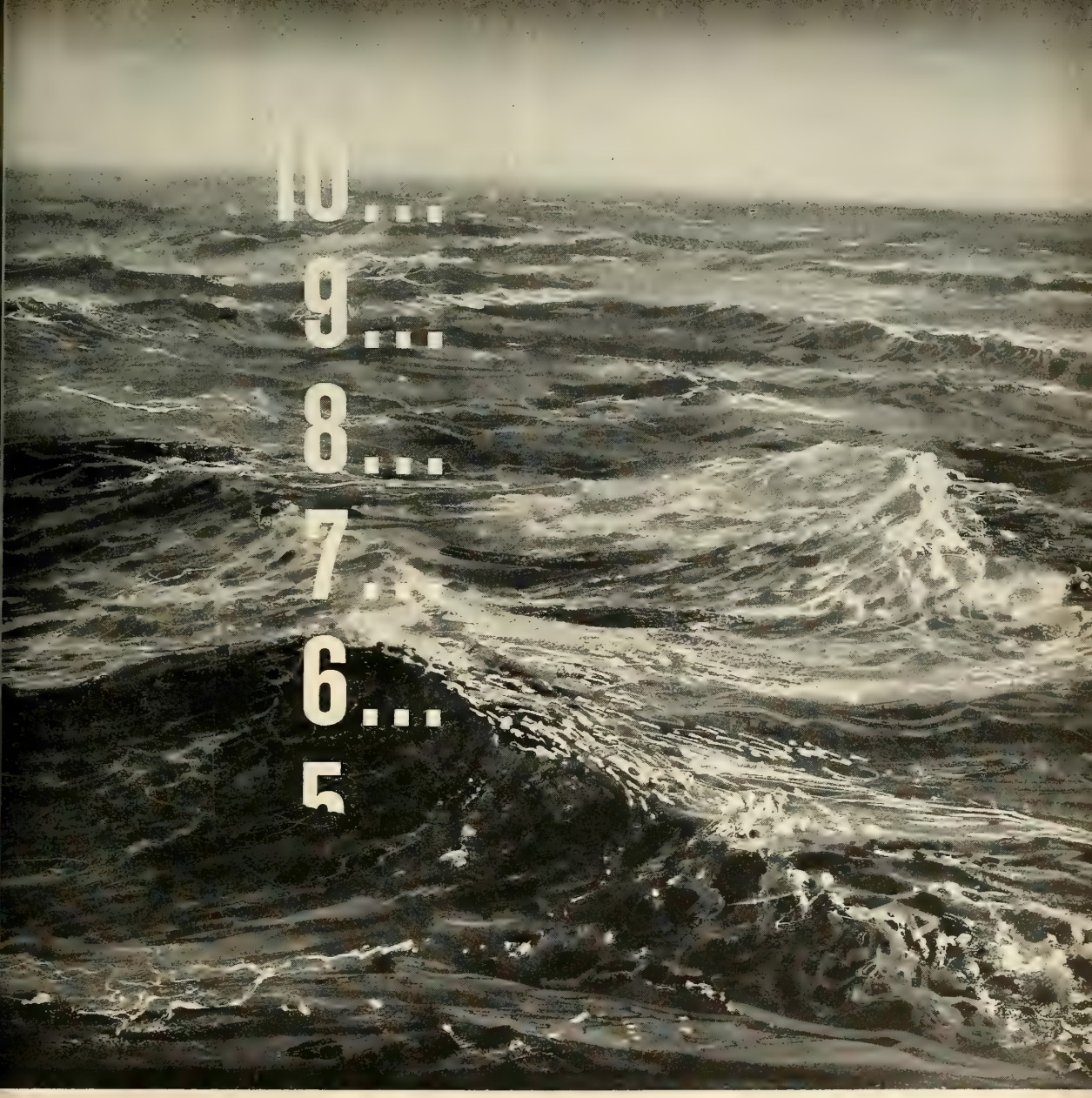


Sacramento, Calif.—A reorganization designed to streamline Polaris production operations at Aerojet-General Corp. has been set up. The new arrangement will place all fleet ballistic missile operations under one director.

Affected activities include contracts, procurement, quality control, fabrication and testing, which were previously handled by corporate groups. The new organization brings all FBM work into one group under W. R. Kirchner, formerly Associate Manager for Solid Rocket Research and Development.

Divisions within the new Polaris group are Manufacturing and Material, Engineering, Testing, Advanced Design, Engineering Services, Reliability and Quality Control, and Contract and Program Administration. Organization is therefore a self-contained unit.

Factors bringing about the reorganization, in addition to accelerated production schedules, include probability that the FBM will eventually become a land based IRBM as well as a weapon for use from surface ships. These applications would increase both quantity and time span of Polaris production.



Day by day the Polaris missile gets nearer to its first submarine test firing... nearer the day when, operational, it will become one of our nation's most formidable deterrents to aggression. For with submarines serving as mobile missile launching pads, any target on earth is within deadly striking range if retaliation becomes necessary.

The Polaris-launching submarines are splendidly fitted out not only to aim and fire and accurately guide the missile, but also to defend themselves. Advanced Sperry submarine equipment contributes to both these functions. For precise navigation there is SINS (Ship's Inertial Navigation System), automatic steering and stabilization, depth detectors, gyrocompasses, diving and maneuvering controls, instrumentation, and computers... and the NAVDAC computer which correlates all navigation data. For anti-submarine warfare the subs have Sperry torpedo fire control systems, sonar sub detection equipment, the attack periscope itself. At two special laboratories both aspects of the Polaris program are being refined and integrated: one of which simulates submarine navigation, the other the environments of the sea.

Sperry's role in the Polaris program is typical of the Company today, achieving through specialized divisions an integrated capability that is contributing to every major arena of our environment. General offices: Great Neck, N. Y.

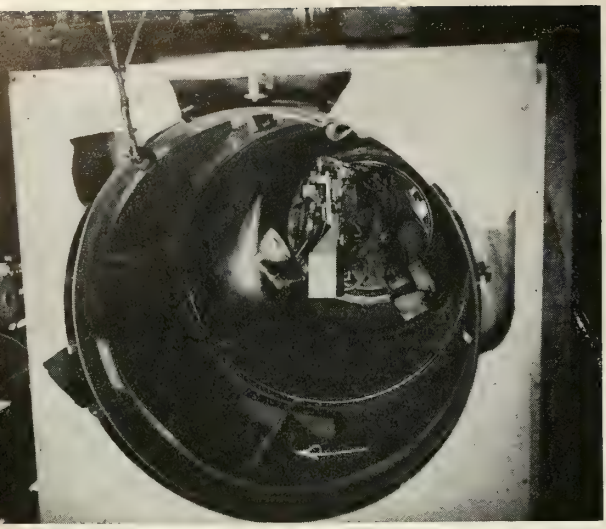


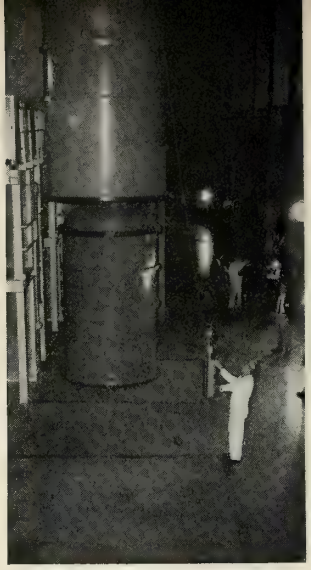
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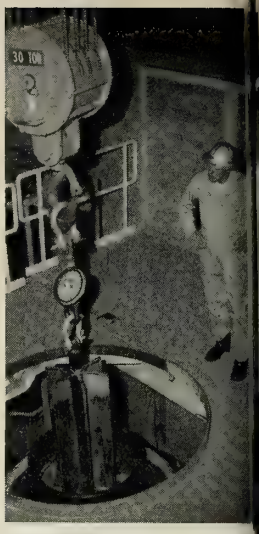
SPERRY

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STEPS IN motor production. **Left to right: Inside welding of girth seam, *Polaris* first stage; casting bell installed over motor; grain-forming core removed from motor; positioning first stage for welding; second stage motor loaded for shipping.**

pany, is billed as the first solid fuel continuous mix plant to go into production in this country. The plant has established records for propellant production already, Aerojet says.

The ratio of operating personnel required by the batch vs. continuous mix processes is about 6:1, the company adds, with great savings in money and time. Much closer quality control and tolerances are also realized.

The final product of a continuous mix line is reported to be safer than by other methods, despite a sensitive period during the process. Maximum amount of propellant involved at any one time in the continuous mix facility is about 20 lbs., said Kirchner, whereas batch mixing can bring large amounts of propellant together.

"If we should ever have an accident with this continuous mix plant," Kirchner said, "all we would lose is 20 pounds of propellant." He emphasized, however, that the new processing method is considerably safer than any method of batch mixing.

Polaris missiles using continuously mixed propellant have already been fired successfully at Cape Canaveral, indicating a favorable result of the change of processing methods.

Ignition of the solid-propellant motors is accomplished by a unique electromechanical device which has the elementary functions of a computer, but is not considered as such in the usual sense of the word. Built by Donner Scientific Company, the unit bases ignition on a sequence of events occurring within permissive time intervals. The missile must acquire a certain velocity within a specified time as preprogramed, or the system aborts. The parameters of ignition do not include broach sensing.

Seals developed for the nozzles while underwater consist of two pieces of material. One, a graphite seal, is located at the throat of the motor. Several inches downstream from this, in the conical exhaust nozzle, is a styrofoam plug weighing about 244 grams and containing a one-way valve.

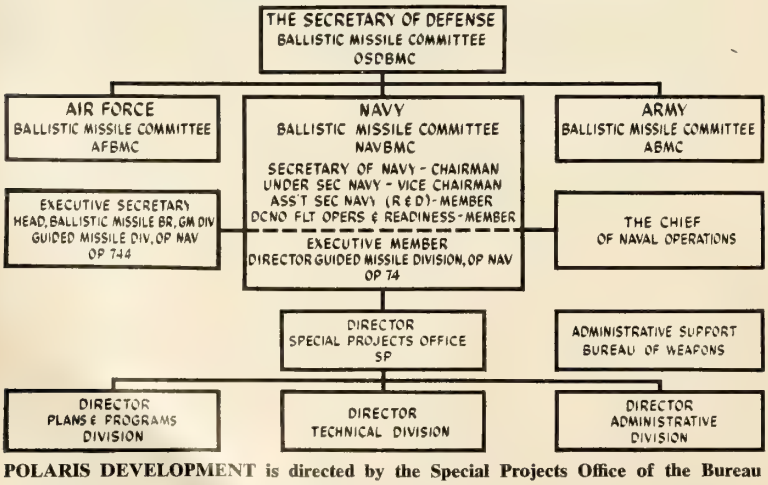
This valve permits excess pressurizing gas from the motor to exhaust, but prevents sea water from entering. A narrow tube of plastic passes through the plug via this valve. The plug is cemented to the straight nozzle walls, and is blasted free upon ignition of the motor.

Theoretically, says Aerojet, passage of the missile through the water is at a rapid enough rate to insure that sea water would not enter the nozzle, but the seals were developed as added insurance.

Major Aerojet contributions to the *Polaris* program, as seen by the company, include:

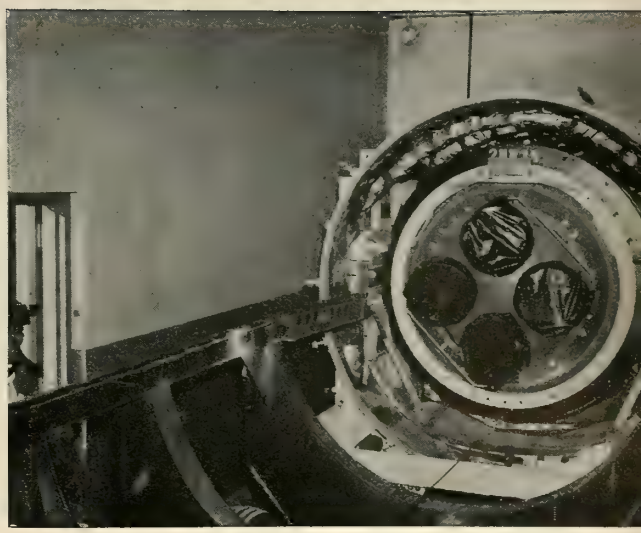
- Developed and static fired in 1956 the largest solid propellant rocket motor in the U.S., and probably the world, to prove capability of solid fuels. Present version of this motor is used on the first stage of *Scout* vehicle, producing 100,000 pounds thrust, for a total energy release of over four million pound/seconds.
- Developed means of terminating

Organization of the FBM Program



POLARIS DEVELOPMENT is directed by the Special Projects Office of the Bureau of Weapons, headed by Rear Adm. William F. Raborn, Jr.





thrust within milliseconds, in order to insure accuracy.

- Developed jetavators needed to provide thrust vector control.
- Designed and constructed first continuous mix plant for solid fuels to go into production.
- Developed method of using nuclear energy to inspect *Polaris* rocket engines and to insure quality control during manufacture.
- Developed partial burning charges propellant for use in test missiles to check out launch systems.

Post-Storage Test Success

An operational-type first-stage *Polaris* motor has been successfully static-fired after being stored for more than 1½ years, Aerojet-General reports.

Storage conditions duplicated temperature of storage in a submarine launch tube. Aerojet said the test proved that *Polaris* motors can be stored aboard subs for very long periods and then perform as required on command.

Dr. Kirchner, Director of Aerojet's *Polaris* program, declared that development of the missile represented a huge advance over a four-year period. When the program began, he said, the largest operational solid rocket was the Navy *Terrier*. He said the *Polaris* first stage is about 10 times as powerful as *Terrier*, and the second stage at least four times.

"The difference between the *Polaris* and the largest solid rocket in production for field use at the time the attempt to develop *Polaris* was begun is phenomenal," Kirchner said. "The aircraft industry would have accomplished the same feat if they had jumped from production of the P-33 to the jet-powered F-100 within the same time span of four years."

Polaris Box Score

First launch in the Polaris test program was in the summer of 1957, when an FTV (flight test vehicle) failed. The remaining 21 vehicles in the FTV series were successful.

VEHICLE	DATE	RESULTS	REMARKS
AX-1	9/24/58	Partial success	Programer failed to pitch over.
AX-2	10/15	Failure	First stage exploded destruct.
AX-3	12/30	Partial	Second stage destructed.
AX-4	1/19/59	Partial	Fell short due to control problem.
AX-5	2/27	Partial	Control problem in first stage.
AX-6	4/20	Success	
AX-7	5/18	Partial	Control problem caused outside loop.
AX-8	5/8	Success	700 miles.
AX-9	6/29	Success	730 miles.
AX-10	6/12	Partial	Second stage destructed.
AX-11	7/15	Partial	Performed loop. Flew 73 seconds.
AX-13	8/14	Success	First from ship motion simulator.
AX-14	9/28	Partial	Destructed.
AX-15	8/6	Partial	Second stage failure.
AX-18	8/25	Partial	Second stage failure.
AX-20	10/2	Partial	First stage destruct.
AX-22	8/27	Success	First from EAG ship.
A1X-1	9/21/59	Success	900 miles.
A1X-2	10/12	Partial	Second stage failure.
A1X-3	11/20	Success	
A1X-4	12/7	Success	
A1X-6	12/15	Partial	Second stage failure.
A1X-5	12/21	Partial	First stage failure. SMS launch.
A1X-7	1/7/60	Success	First fully-guided shot.
A1X-8	1/13	Success	
A1X-9	1/20	Success	
A1X-10	1/27	Success	
A1X-11	2/10	Success	
A1X-12	2/4	Success	
A1X-13	2/26	Partial	Second stage destruct.
A1X-14	3/9	Success	
A1X-15	3/18	Success	Ship motion simulator.
A1X-16	3/25	Partial	Second stage failure. SMS launch.
A1X-17	5/23	Partial	EAG launch.
A1X-18	3/29	Partial	Second stage terminated. EAG launch.
A1X-19	4/18	Partial	EAG launch.
A1X-22	4/25	Success	
A1X-23	4/29	Success	First "double-header" on same day.
A1X-25	4/29	Success	Ditto.
A1X-27	6/7	Partial	
A1X-30	5/18	Success	Ship motion simulator launch.
A1X-32	6/22	Success	EAG launch.
A1X-34	6/22	Success	SMS launch.

As of 29 June 1960, list is complete to A1X-34.

FBM Accuracy Starts with SINS

Ship's Inertial Navigation System is proud keystone in the Polaris program, uses triple redundancy to guarantee pinpoint accuracy, is immune to countermeasures

by Charles D. LaFond

The ultimate in guidance and fire control systems for the *Polaris* fleet ballistic missile would go for nought without the checkreins of ultra-precise and reliable navigation of its submarine launching platform.

Development of such a system and the support facilities to test and maintain it represents a glowing chapter in the book of *Polaris* technological achievements.

Offering a precision of the same order of magnitude as missile-borne inertial guidance, SINS (Ship's Inertial Navigation System) provides pinpoint location and "inner-space" guidance accuracy over many months, rather than minutes.

• **Early history**—A Navy feasibility contract for a similar inertial system was awarded to Sperry Gyroscope in 1951. Sperry's scientists recommended a heavier but advanced version of its more conventional Mk-19 gyrocompass, in development since 1948.

In 1952, Dr. Charles S. Draper, of Massachusetts Institute of Technology, was given a design contract for a prototype inertial system. When it had been built and tested, this unsophisticated system was big and its performance was relatively poor. But it proved the feasibility of such a design.

Bids then were requested for a redesign of the MIT system with tightened requirements. Two contracts were awarded: Autonetics Div. of North American Aviation and the Marine Div. of Sperry.

NAA had a system, the N-6 developed for the old *Navaho* (XSM-64, surface-to-surface ICBM). With beefing up, the system could be made available before the Sperry version.

Although similar, the two systems were never intended to be interchangeable. NAA's version is called the Mk-2 Autonavigator, N-7A. Sperry's is the Mk-3 Gyronavigator. Both systems are referred to as SINS.

MIT has continued to collaborate with both manufacturers on the navigational systems. Sperry integrates all of the equipments used in the navigation system, conducts performance testing, and develops maintenance and repair routines and instructions. In effect, Sperry has been the navigation systems manager.

• **Tri-redundancy for reliability**—SINS' function is to determine true north, true vertical ship position and speed necessary for accurate missile firing.

Immune to countermeasures, SINS can if necessary steer a submarine to any predetermined position at sea without using external reference points.

It employs a 3-gyro stable platform for directional control and accelerometers for distance indication.

To assure accurate and reliable in-



SPERRY MK-3 SINS is ready for the Navy's third and fourth *Polaris* subs. Foreground, one of three inertial platforms; rear, NAVDAC computer and control cabinets.

formation, a system of "checks and balances" is used.

The navigation center consists essentially of four systems: three separate SINS, a Type 11 Stabilized Periscope System (for celestial navigation while submerged), radio navigation systems (other details classified), and two NAVDAC—Navigation Data Assimilation Computers. These are general purpose analog/digital computers, employing sequential programing and a 13,000-word memory drum.

The optical star tracker has its own analog/digital computer called STARDAC, a data stabilization computer which receives ship's motion information directly from SINS. It helps keep the periscope locked onto the "fix" star, computes ship's position and feeds the data to NAVDAC.

Over long periods of time, the gyro stable platforms tend to drift slightly. The three SINS are used for comparison and to permit reset continuity. Data from the radio navigation system and the Type 11 star-tracking periscope also are fed into the computer.

Data from the five inputs are compared continually. When one of the SINS is determined to have drifted beyond tolerance, NAVDAC, on operator's command, resets the wayward instrument.

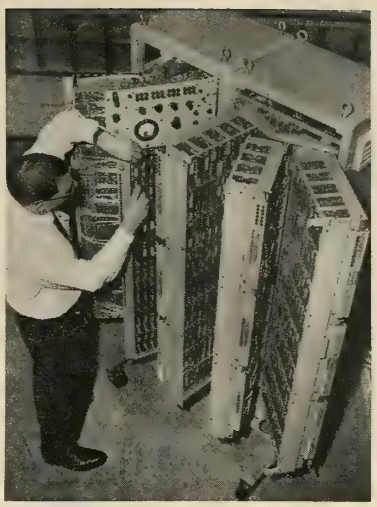
Ships' position (lat. and long.), true heading or course, ground speed, pitch and roll conditions all are computed with remarkable accuracy. In missile launching operations these data are fed to the fire control system.

(The fire control system was designed, developed, and produced by General Electric's Ordnance Dept. Besides the data from SINS, target location from the fire control officer is provided so that the FCS can solve the ballistic problem prior to launch.)

• **Tests ashore and afloat**—The first experimental Sperry SINS was delivered to the Navy's USS Compass Island for surface tests in September, 1956. NAVDAC was delivered to the floating laboratory in January, 1958.

Finally—in October, 1958—Sperry completed its "Ashore *Polaris* Navigation Center." This is a complete replica of the submarine navigation control center used to conduct intensive tests and system evaluation. Equipment integration and optimum performance of the entire complex are assured from the research performed at the Syosset, N.Y. center.

Now installed on the Navy's other floating test lab, USS Observation Island, the Navigation Center has undergone practical use in firings at sea with fully guided *Polaris* missiles.



CELESTIAL navigation data is obtained rapidly with the Type 11 Stabilized Periscope and this STARDAC control computer. Developed by Epsco, Inc., the system determines absolute coordinates between the "fix" star and earth and feeds the data to Sperry's NAVDAC for SINS gyrodrift connection.

• **$5 million repair shop**—By 1961, the *Polaris* submarine tender Proteus (AS-19), commissioned July 8, 1960, should be fully outfitted. Capable of performing almost any repair at sea, the vessel includes a $5-million navigation repair center.

Housed in a 34 x 20 ft. room is everything needed to check out and repair any of the navigation equipment. NAVDAC's will be used for performing test sequences in conjunction with a variety simulation gear.

A dual binnacle is provided to mount both types of SINS. These will be used as "standards" against which operational systems may be compared. This will be accomplished by module replacement.

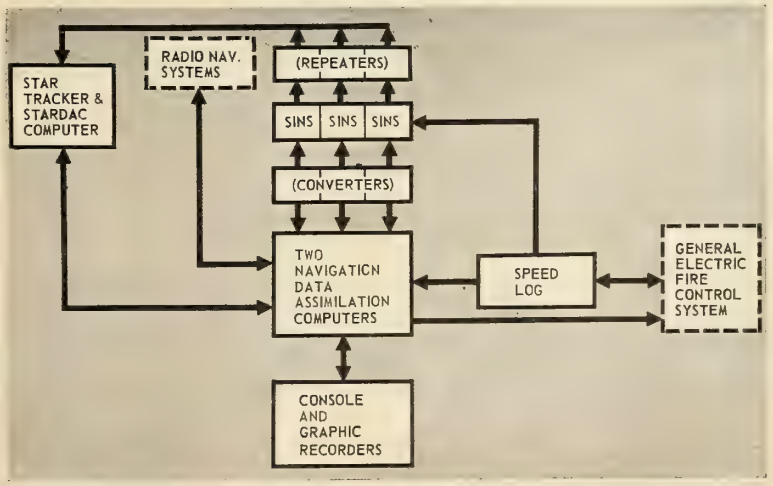
The repair center designed and installed by Sperry carries a considerable amount of equipment for fault location. It includes a SINS patchboard switching rack capable of handling either type, together with three gyroscope and accelerometer storage ovens, multispeed SINS repeaters (translators), a time-frequency standard, individual equipment test racks and module testers.

Very little actual repair of navigation equipment will be performed by the facility. Its 16 enlisted personnel, according to Warrant Officer P. X. Barger, Chief of the center, will work mainly on fault isolation, module replacement, adjustment and alignment of systems. Faulty parts will be tagged and sent to appropriate repair depots ashore.

• **SINS improvement continues**—With 12 of its Mk-3 SINS delivered so far to the Navy, Sperry says it will deliver 19 more starting in July. These will have a different computer system.

Sperry also said that the newer systems include two important advances: interchangeable gyroscopes and "an improved and integrated" polar mode of operation permitting improved operation under ice.

The Mk-3 SINS will be installed on the third and fourth *Polaris* subs—the USS Sam Houston and USS John Marshall. These are both of the newer and larger 608-class. (The USS George Washington, first *Polaris* nuclear sub, is 598-class. North American's Mk-2 SINS will be installed in these boats.)



SIMPLIFIED BLOCK DIAGRAM of *Polaris* submarine navigation center using SINS. Control equipment is in Attack Center below the sail of newer nuclear subs.



FROM THE EXPERIMENTAL BUMPER IN 1950 TO THE ATLAS IN 1960 . .

CAPE CANAVERAL'S FIRST

Just ten years ago yesterday, the first experimental missile was fired from Cape Canaveral. Here, General Electric reports on this key U.S. missile and space research center's first ten years of progress.

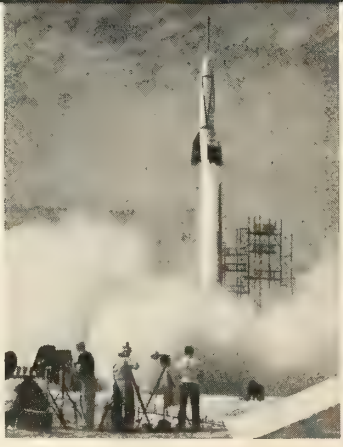
A few men, a quickly constructed wooden "command post" and the firing of a hybrid Army Wac Corporal/V-2 missile called BUMPER 8 . . . this was the beginning ten years ago yesterday of what today is the largest missile test center in the world: Cape Canaveral.

AS BUMPER 8, developed under General Electric systems management, climbed away from the then Long Range Proving Ground Division, the only horizon-breaking landmark was a lighthouse tower near a cluster of homes. Today, this scene has been dramatically changed with miles of hard top roads leading to hundreds of launch sites, test centers, hangars, fuel supply areas and block houses.

Behind this changed scene lies a record of more than 800 successful launchings that have been conducted by the three U.S. military services and other government agencies working with Air Force Missile Test Center personnel who maintain and operate "the Cape," or Station One of the Atlantic Missile Range and the islands "downrange."

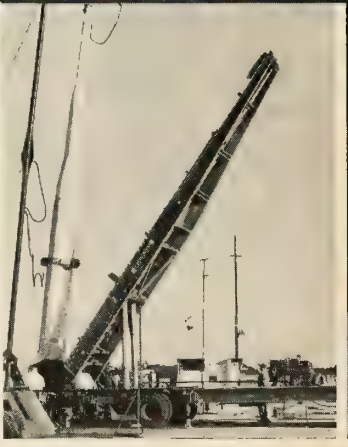
AMERICA IS ACHIEVING IMPORTANT MILITARY AND SCIENTIFIC PROGRESS FROM CAPE CANAVERAL MILESTONES LIKE THESE . . .

FIRST CAPE LAUNCH



Wac Corporal/V-2 missile called BUMPER 8 was fired by handful of Army and G.E. personnel on July 24, 1950. It provided vital data as basis for early missile progress.

X-17 THREE STAGE MISSILE



First fired in July, 1956, Air Force X-17 re-entry test vehicle was designed to achieve high re-entry velocity and yielded important information relative to ballistic flight problems.

EXPLORER I SATELLITE



This nation's first satellite was launched on January 31, 1958 from the Cape and is still in orbit. Army Jupiter-C booster placed this historic satellite into orbit around the earth.

YEARS OF MISSILE AND SPACE PROGRESS

These launchings have paid immeasurable dividends. In the area of U.S. missile progress, Cape Canaveral test launchings have led to the present operational status of Thor, Atlas, Jupiter, Snark and Matador, and are now speeding the development of Polaris and Titan.

In the area of space technology, missile test flights from the Cape have proved the reliability of U.S. ICBM re-entry vehicles and the accuracy of U.S. ICBM radio command guidance, provided information on the belt of radiation around the Earth and other valuable data about space environment and flight that will serve scientists in their efforts to conquer space.

In satellite progress, the successful launchings of Pioneer, Explorer, Transit, Tiros and other satellites from the Cape have paved the way for a whole new generation of orbiting bodies that will aid in communications, navigation, weather forecasting and in the protection of the Free World.

This progress has truly been the result of team effort. The military services and government space agencies together with companies like General Electric . . . a member of the Cape team since its Bumper 8 missile beginning . . . have made vitally important contributions. General Electric, its Defense Electronics Division and the Defense Systems, Heavy Military Electronics, Light Military Electronics, Missile and Space Vehicle, and Ordnance Departments that are a part of this Division are proud to be members of this team and contributors to this progress.

A unique 15 x 19-inch four color illustration, suitable for framing, of the historic first missile launching from Cape Canaveral is available upon request from General Electric Company, Section 160-88, Schenectady, N. Y.

DEFENSE ELECTRONICS DIVISION

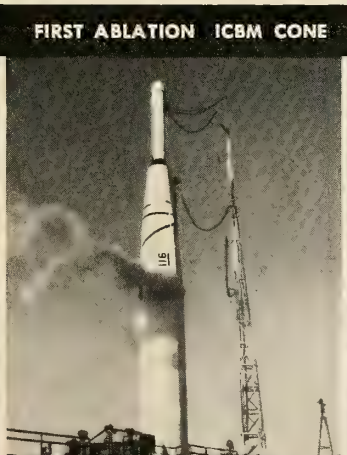
GENERAL ELECTRIC

1ST PAYLOAD RECOVERY



First payload, a re-entry vehicle data capsule, to be recovered from space was launched by USAF Thor missile in 1958. G.E. built both re-entry vehicle and capsule.

FIRST ABLATION ICBM CONE



First ablation re-entry vehicle to fly full ICBM range was developed by G.E. and launched on July 9, 1958 . . . proved feasibility of ablation for ICBM re-entry.

FIRST POLARIS SHIP LAUNCH



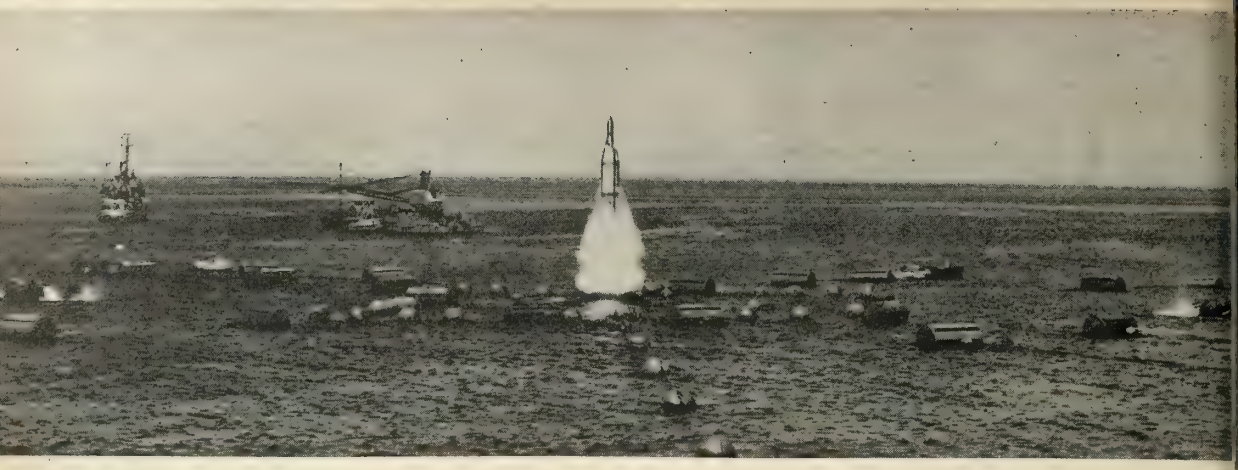
First Polaris shipboard launch was made from Navy's USS Observation Island on August 27, 1959. G.E. is producing Polaris fire control and inertial guidance systems.

LONGEST MISSILE FLIGH



USAF Atlas with G.E. radio command guidance and re-entry vehicle launched this May flew more than 9000 miles . . . longest Free World missile flight recorded to date.

Circle No. 4 on Subscriber Service Card.



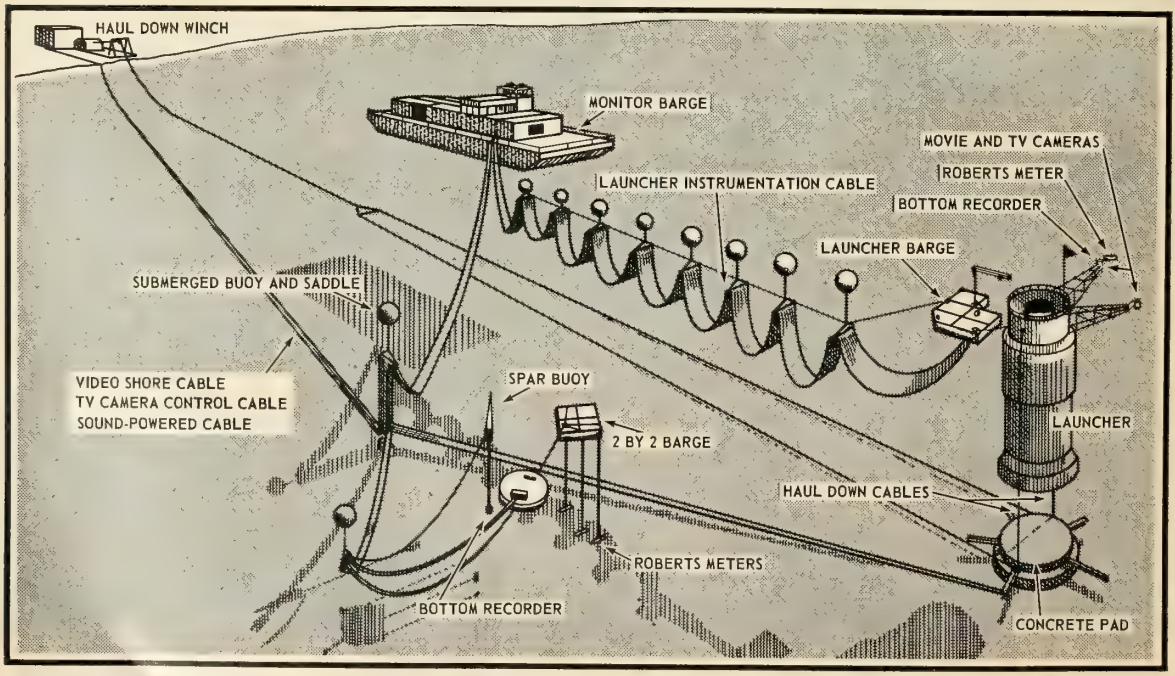
Special Report

'Pop-Up' Site Saves Millions in Polaris R&D

THE NAVY ESTIMATES it has saved millions of dollars in *Polaris* research and development with its unique underwater missile test range off the coast of California.

A part of the Naval Ordnance Test Station, the San Clemente Island facility has provided the program with invaluable test data on underwater launching since its inception a little over two years ago. The "Pop-Up" site has fired a number of test vehicles ranging from totally inert "slugs" to powered missiles.

Early tests helped perfect tech-



MONITOR BARGE is "central control" of Navy's underwater missile test range. Control and monitoring equipment on the barge is connected by underwater cable to launcher and instrumentation. Test data on each firing is collected by recorders, meters, TV and movie cameras, and 150-channel cable-telemetry systems. Telemetry ground station and radar plotting station are located on a hill above the launching site. (Drawing is reproduced by courtesy of Naval Institute Proceedings.)

←

FIRST TESTS at San Clemente Pop-Up station helped determine and refine techniques for compressed-air firing of missiles from submarine tube. Nets suspended from buoys surrounding the launcher catch the test vehicle when it falls back to the surface.

→

DOLPHIN test vehicles were used in the Polaris R&D program to check submarine launching systems, train submarine crews in missile launching and determine underwater trajectories of missiles in sea conditions ranging in severity up to hurricane force.

niques for "firing" the missiles by compressed air from under the sea's surface. Later in the program, inert *Dolphin* test vehicles were used to check out submarine launching systems, train missile sub crews, and determine underwater trajectories of missiles in different sea conditions.

Last April, the first powered *Polaris* was fired from the submerged pad. It was identical to an operational model with the exception of a dummy second stage and a short-run first stage. This and a later test, checked out the launching and actual ignition of first-stage motors.

The big money-saving feature of the test program is, of course, the capability of recovering the test vehicles for re-use. In addition, equipment checkout and crew training was conducted without loss of missiles or the use of submarines. The net result was to have an operational missile, launching equipment, and trained crews ready at the same time as the fleet ballistic missile submarine.

Now that the 1200-mile *Polaris* research and development program is completed, modifications to the launching equipment will be made to accommodate first models of a new 1500-mile (or longer-range) version. The primary change will be in lengthening the launcher tube. New missiles will be longer than the present operational model, but their diameter will be the same.

San Clemente Island provides an almost ideal spot for the NOTS test facility. Uninhabited except for Navy personnel and about 2000 wild goats and a few other animals, the island is only about 55 miles from the coast of Southern California.

During World War II, it was used as a training site for amphibious landings. After the War, the island was relegated to caretaker status for several



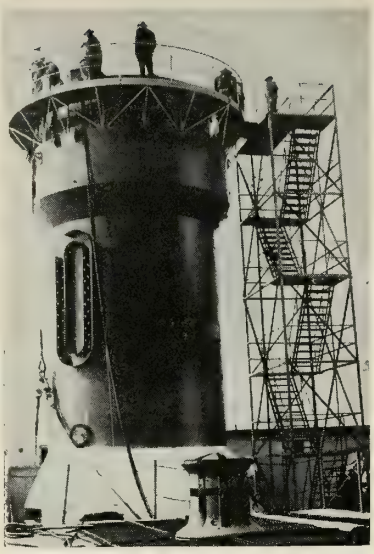
years. In 1949, Bureau of Ordnance started using San Clemente for development testing and evaluation of underwater ordnance. Several torpedoes, *Weapon Able*, and *RAT* (rocket-assisted torpedo) were all tested here during their development. The island's use as an underwater missile range began in March, 1958.

• **How it works**—The *Polaris* Pop-Up test facility centers around a concrete pad on the ocean floor just offshore from Wilson Cove. Directly over the pad—and attached to it by haul-down cables—is a launching tube which simulates the submarine launcher. This tube is installed in a barge which is the terminal point for the launcher instrumentation cable. Tanks on the sides of the launcher tube are flooded to stabilize the tube during lowering and while resting on the submerged pad.

A monitor barge is moored between the pad and the shore. This serves as an acquisition station for data gathered during a launch. Missile and launcher information is collected from 150 cable-telemetry channels. In addition, closed-circuit television cameras are monitored on the barge to check on launcher lowering and diver-inspection of instrumentation and firing lines. TV cameras also cover the underwater firing operation.

Movie cameras are installed on the tube and on shore to record water-exit angle, acceleration, and initial air trajectory of each vehicle. Other recording and measurement instruments are suspended from a small barge near the launcher tube.

A telemetry ground station and a radar plotting station are located on a hill overlooking the launch site. Approximately 80 men are stationed on the island to operate the equipment during firing.



TWO-HUNDRED-TON tube simulates the launcher in *Polaris* submarine. The tube is lowered to a concrete pad on the ocean bottom near San Clemente for firing the underwater-launched missile.

• **Recovery**—Two different methods are used to recover test vehicles after firing. One fall-back system consists of two horizontally buoyed nets which surround the launch area. After ejection, explosive bolts holding the nets open are fired to allow the nets to close and catch the missile when it falls back into the sea.

For tests where it is not desired for the missile to impact into the water, a special Fishhook crane catches the vehicle at its apogee. Crane cables attached to the missile are reeled as it is fired and stopped as it reaches its highest point. The test vehicle is thus suspended with no fallback.

During a launch operation, the missile is checked out and loaded by a staging vessel built on two barge hulls. This vessel carries a 50-ton crane to handle the missile, and supports to hold the 200-ton launcher in place during checkout and loading.

After checkout and loading is completed, the launcher vessel is lowered to the underwater pad by cables operated by a winch on shore. A charge of compressed air ejects the missile from the tube to exactly simulate its firing from a submerged submarine.

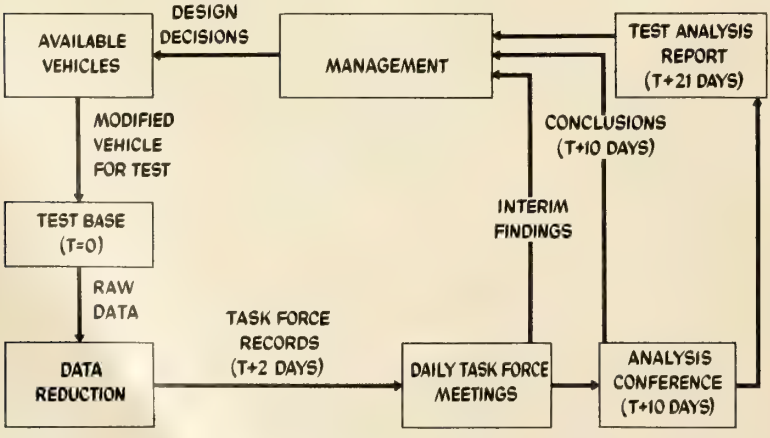
Results of test firings from the nation's only underwater missile range have been highly successful, according to the Navy. They give much credit to the San Clemente facility for its part in contributing to the overall success of the *Polaris* weapons system.

How Polaris Test Data is Sped to Analysis

Analysis time cycle of the loop between test and availability of reduced data to the design modification group is shown in the accompanying chart of Lockheed's data flow system.

Following test, raw data is flown from Atlantic Missile Range to Sunnyvale for data reduction, arriving within 24 hours after test launch. In parallel, flash reports are sent to Sunnyvale at five-minute, one-hour, two-hour, and 24-hour intervals after launch time.

These flash reports contain first impressions of test on the basis of limited pickoff available at AMR.



DATA HANDLING system extracts and digests key information within 10 days.

Within 48 hours after launch, initial reduced records, designated Task Force Records, become available to the Analysis Task Force. Reduction and compilation of complete reduced test data continues, resulting in a "Quick-Look" data report, the first important segment of which is issued within five days after launch.

Within 10 days, the cream of the results have been extracted and digested, being communicated to management and other people outside the analysis loop. This is done through communiques and by an Analysis Conference held about ten days after test.

Within approximately 21 days after launch, a substantial technical recap and interpretation of the test is published. Analysis and interpretation continues, in each design area affected, to insure maximum use of all data.

Meanwhile, the task force operation is being repeated with subsequent launchings. On occasion, LMSD says, there have been three task force teams operating simultaneously.

Special Report

Bigger, Better Subs Are Coming

Bigger and faster nuclear-powered *Polaris* submarines are now on the ways.

They belong to the new Ethan Allen class, 410 ft. long and displacing 6900 tons. This compares to the George Washington class, 380 ft. and 5600 tons.

The Ethan Allen being built at the General Dynamics Corp.'s Electric Boat Division, Groton, Conn., the first of four of the "new" class, is actually the first true *Polaris* submarine designed from the keel up to carry 1200-mile-range missiles. It will have a different hull configuration and will be roomier inside than the first Fleet Ballistic Missile subs.

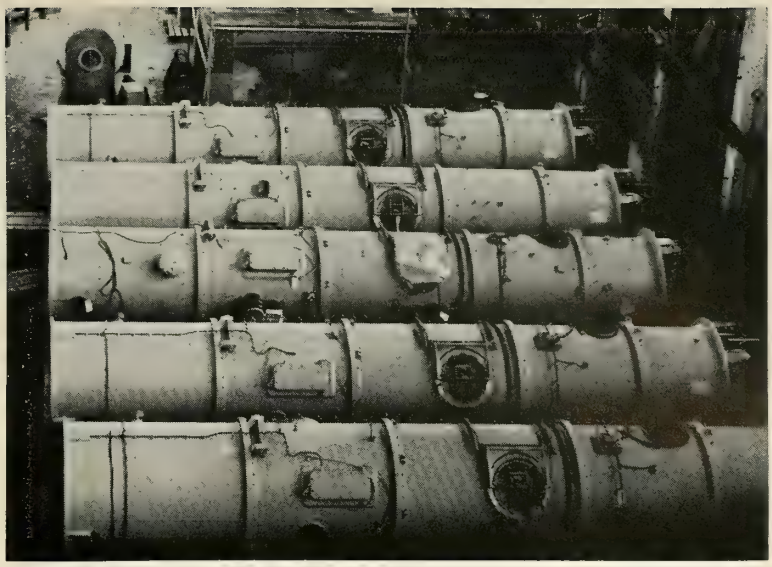
The George Washington and its four sister ships constructed during the past two years have Skipjack-type hulls modified to include a 130-ft. missile section amidships. The GW itself—under the *Sputnik*-forced acceleration of the *Polaris* program in late 1957—actually was created out of a keel already laid at Electric Boat for the Skipjack-class submarine Scorpion. The keel was cut amidships and the missile section was inserted, giving the completed vessel a slightly humpbacked silhouette.

Modification of the hull proved to be a tremendous timesaver. The George Washington was completed in a record two years—against three years normally needed to bring in the prototype of a new sub.

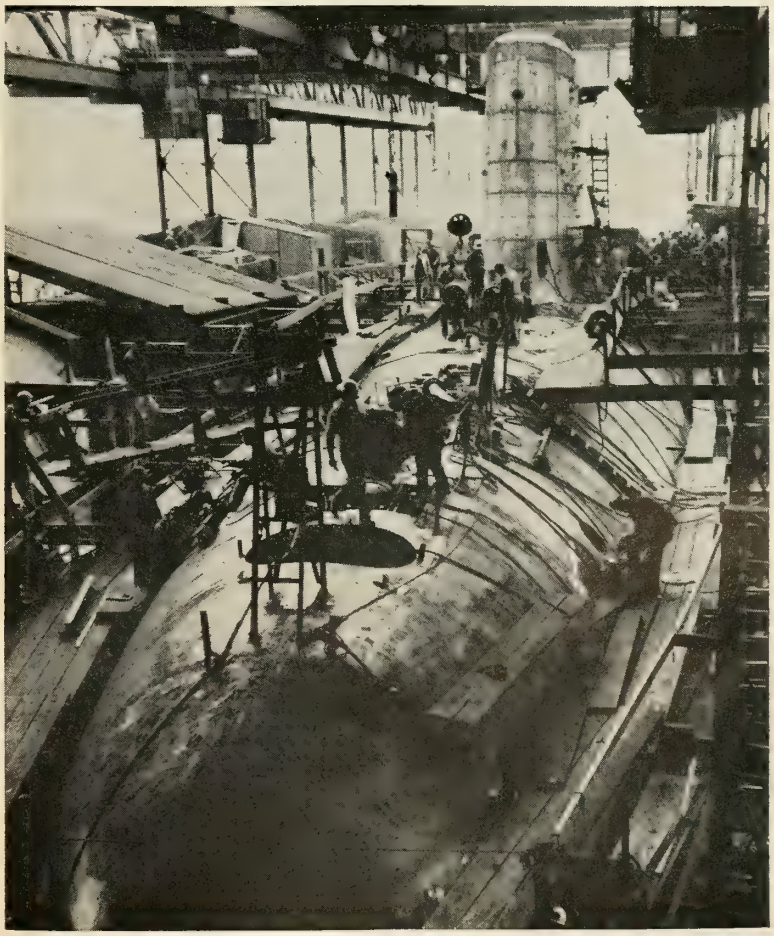
Speed and diving capability of all the FBM subs is classified. The Navy says they will travel "in excess" of 20 knots underwater and can go down farther than conventional subs, which have about a 650 ft. limit.

The Ethan Allen's extra weight will go largely into a thicker pressure hull, to make it even more deep-diving than the George Washington. It also is expected to be a little faster than its predecessors.

Down the line—starting at about the 15th FBM sub—the Navy is planning to go to a third, more advanced class. No details of this new design have been made public.



MISSILE LAUNCHING tubes move along the production line at Westinghouse-Sunnyvale. Note access hatches which open on *Polaris* first- and second-stage hydraulic section (for jetavator control) and on the guidance section.



FIRST POLARIS submarine, George Washington, as she was being constructed in a record-breaking two-year period at Electric Boat.

Special Report

Assemblin

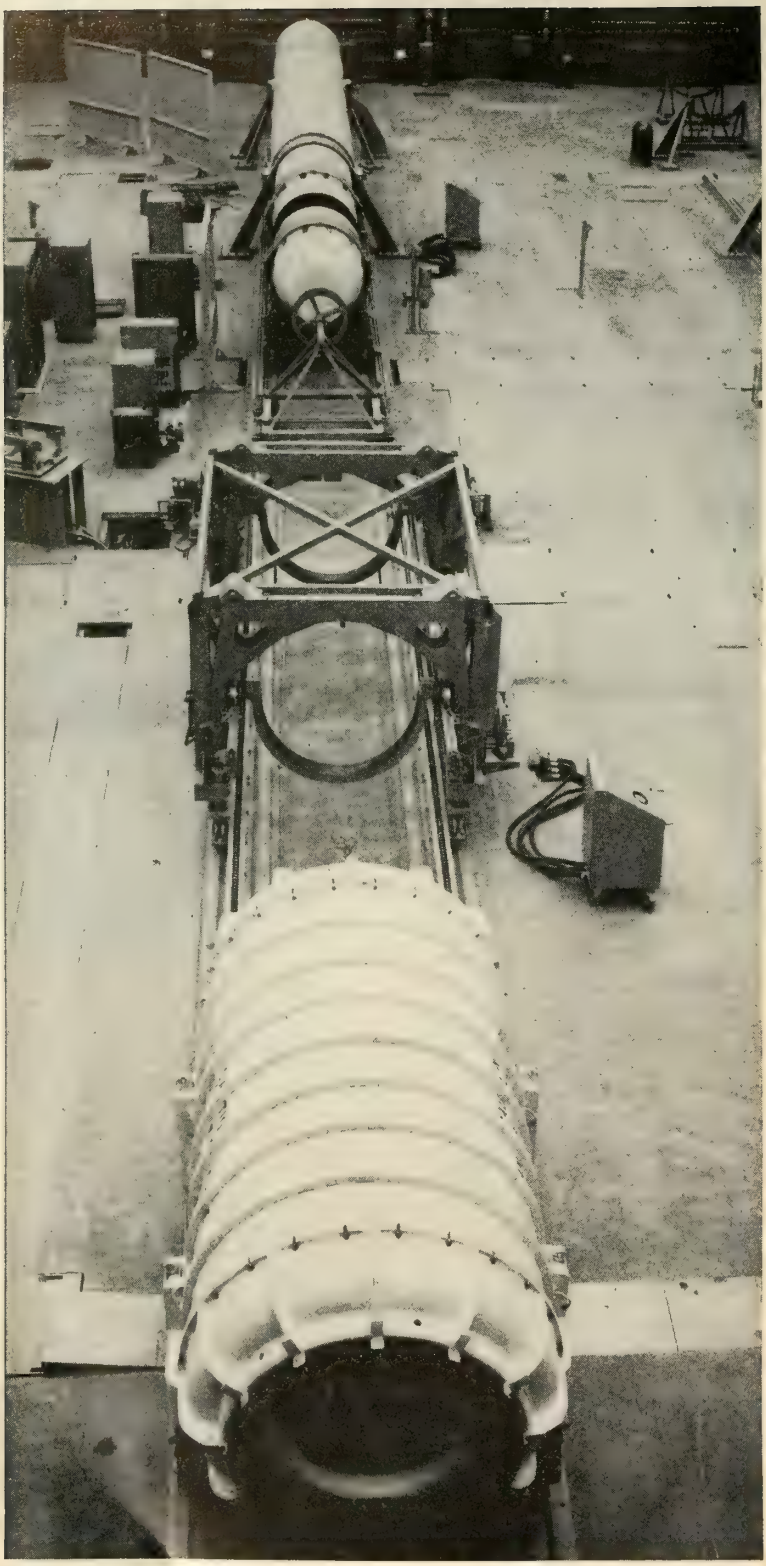
Operational *Polarises* are already being assembled at the *Polaris* Assembly Depot near Charleston, S.C.

From here all *Polaris* submarines will pick up their missiles before going on station. A similar facility may be constructed later on the West Coast.

The depot is operated by more than 200 officers and men. They are assisted by more than 100 Lockheed engineers, about 15 from General Electric and five from Aerojet-General.

Components are shipped to Charleston by air and individually checked out in other specialized buildings at the depot before being assembled into operational birds in the 1500-square-foot Assembly Building.

Submarines and sub tenders take on their missiles at a pier several miles away on the Cooper River. The missiles



THREE LINES in Assembly Building can operate simultaneously to turn out operational *Polarises* for the fleet. Another depot may be built on the Pacific.



EMPTY LINE in the facility awaits arrival of missile components, flown in

nd Loading



MAIN BUILDING where operational *Polarises* are being assembled. The entire area is under heavy security. Its Navy personnel alone totals more than 200.

are shipped from the Assembly Building to the pier in doubled containers on railroad flatcars.

The missiles are lowered into the submarines' tubes directly from the containers. A half-million-dollar crane is used for the delicate operation. Initially, the loading of a single submarine is expected to take more than a week.

Loading time is expected to be much faster, however, as familiarity with the system increases.

All loadings by the first tender—the Proteus (see artist's conception)—will be in port. A converted merchantman, the Proteus can handle a score of missiles. It will replace missiles that are in need of major repair work which cannot be carried out by crews aboard the submarines.

• **Three assembly lines**—The 880-acre depot—called the Navy Weapons Annex—went into operation in March of this year. Built at a cost of $27 million, the sprawling installation includes facilities for checking out and servicing missile components before they are fully assembled, for inspecting the two-stage motors, and for installation of nuclear warheads.

Combat submarine crews which must tend the missiles preside over the final checkout of the assembled birds before they are gingerly lowered into the subs.

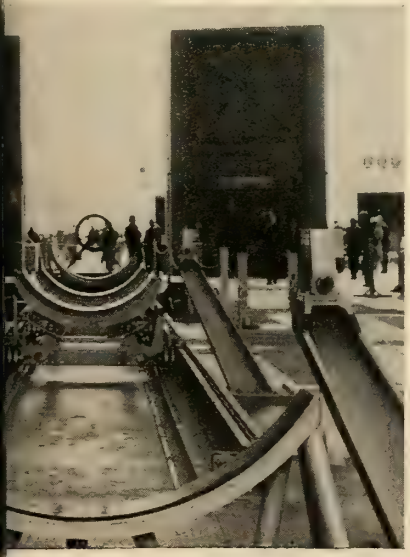
The Missile Assembly Building contains three assembly lines which can operate simultaneously. The missiles roll off the lines into special liners—to guard against possible adverse environmental effects—and then are placed in shipping containers for handling and stowage.

For the next several years, the Charleston depot will be the focal point of operational *Polaris* missiles in this country. And for this reason, the depot is now a maximum security area—with barbed wire fencing and Marine Corps patrols.

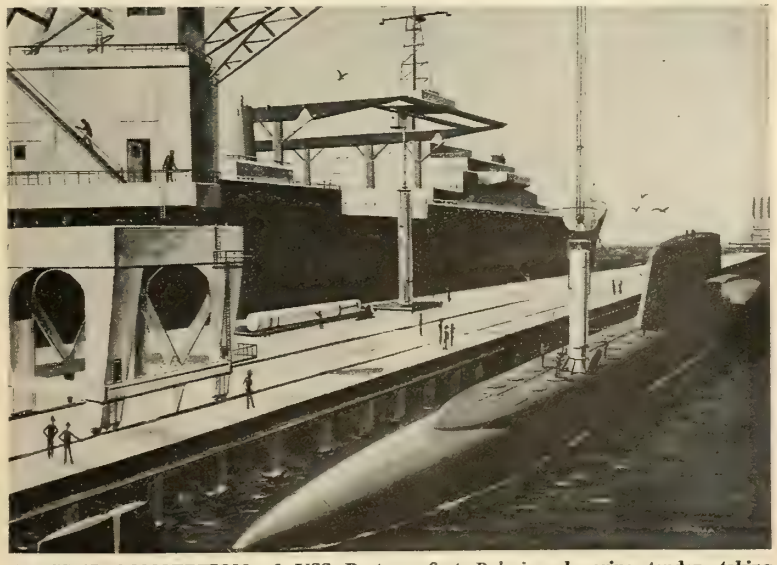
Selection of Charleston, which means that Fleet Ballistic Missile subs will be operating in the Atlantic, hinged on both economic and geographic factors.

The port is ice-free and well protected, and has easy access to the sea. It is also near the Charleston Navy Yard, which in the next year will be the home port of some of the *Polaris* submarines.

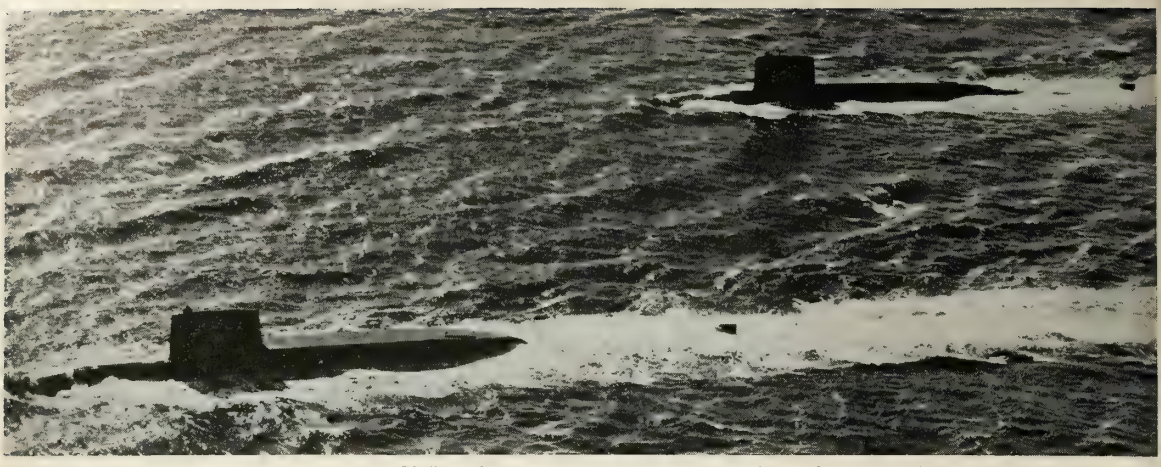
(The Charleston Depot was described earlier in M/R, April 4, pg. 12.)



and checked out in other specialized buildings at the Charleston site.

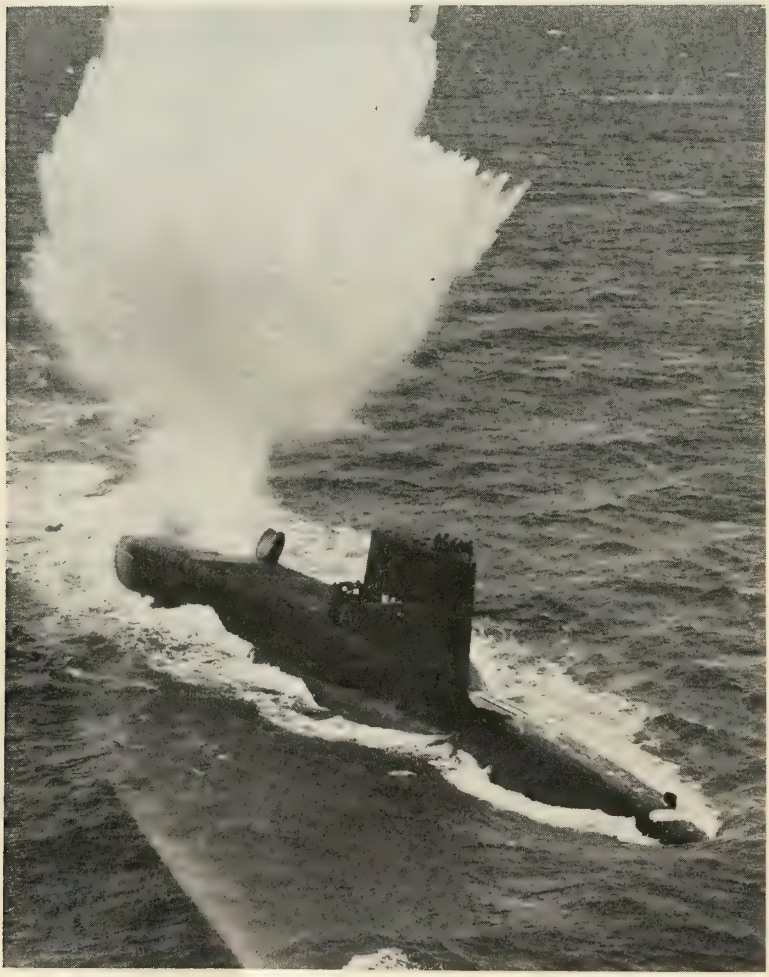


ARTIST'S CONCEPTION of USS Proteus, first *Polaris* submarine tender, taking aboard a missile in its container. In foreground, a submarine receives a *Polaris*.



USS George Washington, foreground, and USS Patrick Henry steam down to Long Island Sound on trial run this spring.

Polaris Submarines Train for Action



ONE-TON Sabot "slug" is fired from a port missile tube of the George Washington during a drill in Long Island Sound.

Polaris Deployment

Missile-launching nuclear powered submarines sought by the Navy: about 45. Submarines authorized in part or whole 21 Missiles per submarine: 16 Initially operational: Fall, 1960. Administration plans call for laying three more keels in FY 1961 bringing number of subs commissioned or under construction to 12.

Polaris Submarines

George Washington
380 ft., 5600 tons, commissioned 1960, Electric Boat

Patrick Henry
380 ft., 5600 tons, commissioned 1960, Electric Boat.

Theodore Roosevelt
380 ft., 5600 tons, commissioned 1960, Mare Island

Robert E. Lee
380 ft., 5600 tons, commissioned 1960, Newport News Shipbuilding

Abraham Lincoln
380 ft., 5600 tons, commissioned 1960, Portsmouth Naval Shipbuilding

Ethan Allen
410 ft., 6900 tons, launching 1960, Electric Boat

Sam Houston
410 ft., 6900 tons, launching 1961, Newport News Shipbuilding

Thomas A. Edison
410 ft., 6900 tons, launching 1961, Electric Boat

John Marshall
410 ft., 6900 tons, launching 1961, Newport News Shipbuilding

BENDIX ANNOUNCES NEW AND EXTENSIVE WEST COAST FACILITY



FOR CABLING USED ON GROUND BASED ELECTRONIC EQUIPMENT

Scintilla Division of Bendix has scheduled for September completion this new 30,000-square-foot plant at 1001 S. Grand Ave., Santa Ana, Calif. It will offer West Coast users the finest, most complete facilities in the area devoted exclusively to development and manufacture of cabling used on ground based electronic equipment.

West Coast missile industry producers, particularly, will benefit by having this new facility "on their doorstep," bringing them the latest and best in cabling for missiles and supporting ground equipment.

Sales and service for *all* Scintilla Division products—including cables and connectors—will continue to be handled out of 117 E. Providencia Ave., Burbank, Calif.

Scintilla Division
SIDNEY, NEW YORK

THE Bendix CORPORATION

Circle No. 5 on Subscriber Service Card.

Aerojet Group Takes Overall View

SACRAMENTO, CALIF. — An Advanced Developments Division has been established at Aerojet-General's liquid rocket plant to evaluate new engine design concepts in the context of overall weapon system and vehicle requirements, rather than as propulsion systems per se.

R. C. Truax, head of the new group, said ADD will concentrate on high risk, high payoff ideas. Recruiting of personnel has been proceeding quietly for a year—with such high standards that only ten vacancies of the available twenty have been filled.

The hand-picked group consists of specialists in the fields of thermo and fluid dynamics, chemistry, structures, operations analysis, vehicle performance analysis, rocket engine design, and other disciplines, Truax said.

Current projects underway in the ADD program include a liquid rocket system equal in simplicity to a solid rocket but having appreciably higher specific impulse and propellant fraction. Work includes greatly simplified pumping systems, combustion chambers, rocket nozzles and controls.

• **Reusable boosters**—Sustained reusability of liquid rocket boosters is another area of concentration, Truax said. Existing information on service life of liquid rocket engines in non-expendable applications is being compiled with a view toward determining life limiting factors. Ultimate objective is to produce designs with the capability of making hundreds or even thousands of flights.

"If we are to make large-scale space operations economically," he said, "we must have re-useable vehicles. These will be rockets, not air-breathing types." The large size, re-useability and simplicity of such systems will be the controlling factors in reducing costs of astronautic missions, he added.

Truax, retired Navy captain and former American Rocket Society president, expressed doubt that either electric or nuclear propulsion would be needed to lower such costs. He pointed out that the prime difference between travel by rocket and travel by other means is the large amounts of fuel required by reaction engines.

"When cheap liquid propellants are used, the cost of the propellant is small," he noted, "and if the cost of the vehicle is amortized over many flights, the cost elements unique to rockets do not compare unfavorably with other types of transportation."

• **50,000 tonners**—ADD is studying rockets as large as 100 million pounds weight, and which use only force due to gravity and acceleration to feed propellants into the combustion chamber.

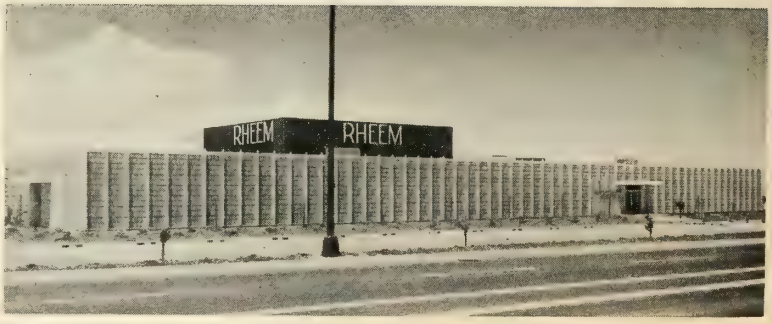
The Advanced Developments Division, headquartered at Sacramento, operates as an initiating, planning and management organization. Its concepts are expected to be put into practice by Aerojet's other operating divisions.

The liquid rocket plant, parent organization of ADD, was set up specifically to develop the engines for the *Titan* ICBM. With successful completion of this program in sight within a few years, LRP is increasing its efforts to round out its capabilities in the overall liquid rocket propulsion field.

mergers and expansions

CONVAIR DIV. of General Dynamics Corp. will build a space radiation facility in San Diego to study radiation effects on electronic components, guidance and control systems for nuclear propelled vehicles. An improved 3 million volt electron-ion accelerator will bombard test specimens with varying types and intensities of radiation in test areas with six-foot thick walls. The accelerator itself will be contained in room with four-foot thick walls. Dr. A. E. S. Green, chief of physics for Convair-San Diego is head of the program.

Radiation Dynamics Inc. of Westbury, L.I., New York will build the accelerometer. Installation date is set for March, 1961.



EXPANDABLE PLANT—Rheem Semiconductor's new $2-million plant near San Francisco can be expanded in any direction with almost no loss of materials. Manufacturing areas are constructed of easily dissassembled concrete tilt-up walls, while the administration side (facing road) is built with Owens-Illinois-Thinlite curtain wall. The attractive glass-block panels can be unbolted and moved without destruction.

LINDE COMPANY, Division of Union Carbide Corp. has formed a Cryogenic Products Dept., with laboratory and manufacturing activities at Tonawanda, N.Y., and Speedway, Ind. Glenn A. Murray, former sales manager of Linde's Gas Products Dept. is manager.

GENERAL ELECTRIC will start construction in August on a $3-million plant for the manufacture of basic silicone intermediate chemicals in Waterford, N.Y. The facility, adding 15,000 sq. ft. to the Waterford site, will go into operation in late 1961.

LEAR, INC. has established a $300,000 customer service center at Harrisburg, Pa. The 33,000-sq.-ft. building purchased by Lear will be modified to include a dust-free "clean room" and other facilities for servicing gyroscopic instruments, electronic components, pumps, electro-mechanical systems produced by Lear and other firms.

VITRO CORP. OF AMERICA has opened a West Coast facility with electronic marketing, maintenance and service operation, product showrooms and administrative offices in Los Angeles.

financial

Westinghouse Electric Corp.—First-half sales increased to $953.8 million, 4% over the first half of 1959. Net income was $40.4 million, compared with $34.1 million a year ago. Second-quarter sales were $495 million and second-quarter income was a record $21 million.

Eight Major Shots Remain On Mercury's 1960 Schedule

by Jay Holmes

Eight major launchings, leading up to the first venture of man into space, will make up the Project *Mercury* schedule for the remainder of 1960.

If all goes well on a series of McDonnell production capsule launchings from a *Redstone* booster, the third will carry an astronaut 125 miles up and 200 miles down the Atlantic Missile Range from Cape Canaveral.

Officially, the National Aeronautics and Space Administration will say only that the manned *Redstone* shot is scheduled for the last quarter of this year. However, it appears unlikely the shot will take place before December. And there is a chance it may slip into January or February.

The increased *Mercury* firing rate comes just as NASA goes into the 1961 Fiscal Year with an appropriation of $108 million for the project. Before completion, NASA expects to spend $350 million on this first major effort to get man into space.

The first *Mercury Redstone* launching—designated MR-1—is to take place next month. It will be a test of the capsule alone—with a dummy astronaut aboard.

If no hitches develop, the second *Redstone* shot—MR-2—is scheduled for early in the fourth quarter. This one will carry a monkey.

MR-3—according to present planning—will be the first manned shot.

• **Proceeding with caution**—NASA officials emphasize that slippage is entirely possible on such a series as this. Each shot depends on a complete success of the previous launching. And an extra degree of reliability is demanded of every component in a vehicle that will carry a man.

The entire *Mercury* program is supervised by NASA's Goddard Space Flight Center—a team of scientists and engineers built around the men who developed *Vanguard*. *Vanguard* experience is the key to the entire philosophy of the Goddard group. Their first aim in life is to avoid another humiliation like the first *Vanguard* failure—before the collective eyes of the world's press.

"If you think that *Vanguard* shot was a colossal flop," a Goddard spokesman remarked, "picture what will happen if we kill off an astronaut on the launch pad."

• **Number of shots undermined**—Concurrent with the *Mercury Redstone* shots is a series of launches of the McDonnell production capsule atop an *Atlas*. The first of these vehicles—the MA-1—is now on the pad at Cape Canaveral and will be launched soon.

MA-2 and MA-3 are scheduled to follow in September and October. And if this series goes well, MA-4 will carry a monkey into orbit before the end of the year.

No one—not even the engineers in charge of the project—knows how many *Mercury Atlas* shots will be necessary before a man is fired into orbit. The target for that shot is sometime in 1961. But the date is by no means settled.

Testifying before the House Space Committee last February, George M. Low, NASA chief of manned space flight programs, said there would be a sequence of *Atlas* ballistic shots, instrumented capsules in orbit, capsules containing an animal, and finally manned orbital flight.

At the February hearing, NASA Associate Administrator Richard E. Horner summarized the NASA approach to the *Mercury* launch schedule when he said:

"I had shaken my head at your suggestion that the primary purpose of the Project *Mercury* was one of national prestige and psychological advantage. We are not approaching the project in that manner. The primary purpose is to determine the feasibility and the utility of manned space flight, and this is in fact a prerequisite for most of our follow-on space program."

Liquid Ozone May be Safe as LOX

COLUMBUS, OHIO—Liquid ozone is as safe as LOX for rocket oxidizer applications when mixed with LOX in relatively low concentrations, an Armour Research Foundation specialist declared last week.

Charles K. Hersh of Armour told an American Rocket Society conference that liquid ozone-LOX mixtures are safe outside of the two-phase temperature and pressure region. Eventually, he said, he believes ozone concentrations up to 90% will become safe to handle.

At the ARS Propellants, Combustion and Liquid Rockets Conference at Ohio State University, Hersh said the major safety consideration in dealing with ozone is thorough cleaning of the system and avoidance of contamination. Hersh said he does not believe ozone will ever be practical for use in military rocket systems. But he said it should be practical for use in manned rockets used by NASA.

The Armour researcher, in a review of the properties of liquid ozone and liquid ozone-oxygen mixtures, recalled that specific impulse rises upwards of 5% when liquid ozone is substituted. He gave these examples for frozen equilibrium, chamber pressure of 1000 psia and exit nozzle pressure of 15 psia:

	Specific impulse, sec.	
Fuel	Ozone	Oxygen
JP-4	302	282
Ammonia	304	284
Hydrazine	315	301
Hydrogen	419	388

Liquid ozone and oxygen are not completely miscible over the entire composition range, Hersh said. Below –292°F, the mixture forms two layers, one ozone-rich and the other oxygen-rich. At the consolute temperature of –292°F, the ozone concentration is 41.3 mole percent.

Other differences between oxygen and ozone listed by Hersh included:

• Ozone's boiling point is –169°F, compared with –297° for oxygen.

• Ozone's liquid density (at –297°F) is 1.57 g/cc, compared with 1.14 for oxygen.

• Ozone has somewhat higher thermal conductivity and latent heat of vaporization than oxygen.

In other papers:

• Frank J. Hendel of Aerojet-General reported that specific impulse of a solid-propellant grain was raised from 225 to 246 seconds by injection of 18 to 19% by weight of liquid oxidizer in a hybrid system. A hypergolic slug between two burst diaphragms was used for ignition. The solid grain was one that would support combustion but was fuel-rich.

• Ernest Mayer of Rocketdyne Division, North American Aviation, reported studies showing that a refractory coating will improve the performance of a nozzle of a liquid rocket in the million-lb.-thrust range. He showed also that performance improves on shifting from stainless steel to Inconel X, and improves again on shifting to F-48, a columbium-based alloy.

• Dean Walter H. Bauer of Rensselaer Polytechnic Institute reported identifying an unstable partial oxidation product, $H_2B_2O_3$, in the oxidation of diborane, the same as in the oxidation of pentaborane. Dean Bauer declared that much more research on borane oxidation is necessary before the new propellant family will be understood.

Technical Countdown

ELECTRONICS

World's Largest Radio Telescope Planned

The largest radio telescope antenna ever built is being planned by the Benelux countries. The antenna will be built in the form of a cross, measuring almost two miles square. Each arm of the "Benelux Cross" will be made up of thousands of small individual antennas. Planned frequency is in the 300-600 mc range. The beam will have a half-power width of about one minute of arc.

Monstrous Magnet for MIT

The world's most powerful magnet—rated at 250,000 gauss—will be part of a new magnetic research laboratory planned at MIT. Construction of the research center—to be built and operated under a $9.5 million ARDC contract—is scheduled for completion in 1964.

Coiled Antennas for Canadian Satellite

Thirty-foot radio antennas which uncoil after orbital injection are being developed for the first Canadian satellite. The polar-orbiting vehicle will be launched by a *Thor-Delta* in 1961 to measure galactic radio noise and the influence of the aurora on the ionosphere.

GROUND SUPPORT EQUIPMENT

Automated Control for Missile Instrumentation

A real-time control console being built by Computer Equipment Corp. for ARDC will automatically program missile instrumentation to conduct an automatic countdown. The console will also provide monitoring displays, including a three-dimensional chart of the missile trajectory.

Faulty Radar Signal Scratches Scout

A spurious radar signal was blamed for the failure of a *Scout* satellite launch vehicle to reach its assigned altitude on July 1. The faulty—and unexplained—signal indicated a violent change in the vehicle's trajectory and led the safety officer to cut out fourth-stage firing.

Journeyman to Use Digital Telemeter

"Digilock" telemetry systems will be used in the AF *Journeyman*, four-stage 30,000-mile sounding rocket. The two-pound digital system built by Space Electronics Corp. will use a quarter-watt transmitter to telemeter radiation data and other measurements from space.

Automatic Checkout for Terrier/Tartar

Complete automatic checkout of six missiles can be accomplished in three minutes with system being built by Hycon Mfg. Co. for the Navy's *Terrier* and *Tartar* missiles. Production of the equipment will continue under a recent $6-million contract.

Big Ovens for Inertial Units

Three elaborate ovens developed by Sperry Gyroscope will protect temperature-critical inertial elements aboard *Polaris* sub tender Proteus. Replacement accelerometers and gyros for SINS will be stored at two temperatures. The ovens hold 16-18 elements each. An alarm on the ship's bridge rings if temperature varies as much as three degrees.

PROPULSION

New Aerobee Sounding Rockets

The *Aerobee-150A*—a four-finned modification of the *Aerobee-Hi*—is now in use for stellar and solar observations with sounding rockets launched from Wallops Island. Seven rockets have been launched to date. Each carries a 160-lb. payload to an altitude of 150 miles.

Javelins Boost Sled to Mach 3.5

Another record was set at Holloman AFB last month when a cluster of three Grand Central Javelin motors boosted a Northrop monorail test sled to 2688 mph in about two seconds. Braking fins brought the sled to a safe halt less than three-quarters of the way down the 35,000-ft. test track.

Free Radicals Excite Tremendous Disinterest

According to the Air Force, basic research in chemical kinetics has shown that attempts to trap hydrogen atoms on solid hydrogen are doomed to fail—a result that has hastened disinterest in stabilized free radicals as a fuel.

ADVANCED MATERIALS

Plastic Minuteman Booster Case?

A fiberglass-resin case is under consideration for the big *Minuteman* first stage. Young Development Division of Hercules Powder filed a recent bid with Thiokol to build 50 cases at a unit cost of $25,000. Hercules would set up facilities at Bacchus, Utah.

Spherical Powder Particles

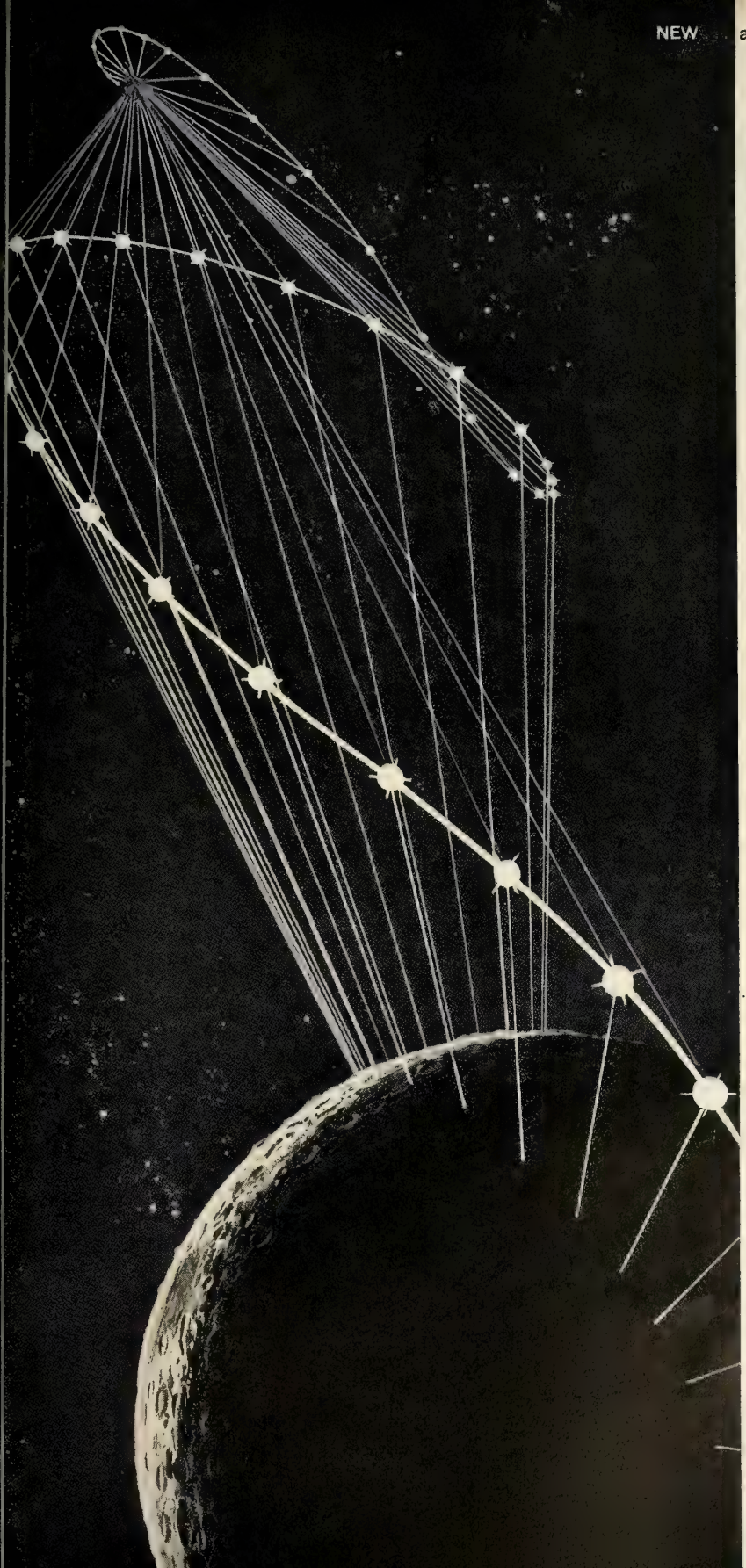
Particles ranging in size from 20 to 150 microns and produced as tiny spheres by Linde Co. Crystal Products Dept. may find application in propellants and sweat-cooled nozzles. Uniformity rates up to 98% are possible with copper, aluminum, nickel, 316 stainless, tungsten, and nichrome powders.

20 Gals. of Oxygen in ¾-gal. Can

Columbium modified steel from National Steel Corp. is being used in a miniature, controlled-flow oxygen breathing dispenser. The four-in.-diameter sphere holds an hour's supply (20 gals.) of oxygen at 1790 psi. The apparatus may find application as an emergency breathing source for astronauts.

Pedigreed Single Crystals

Each refractory single crystal produced by the Materials Research Corp. carries a "breeding sheet" noting its crystal orientation, dislocation count, hardness measurement, and chemical analysis.



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- Coding—Decoding Techniques for Satellite-borne Equipment
- Upper Atmosphere Physics
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TI Moves Toward Standard Telemetry

by Hal Gettings

DALLAS—Off-the-shelf telemetering systems may well be the answer to one of the many problems plaguing the manufacturers of missile telemetry equipment.

Texas Instruments, operating on this premise, has made one of the first steps toward standardization with a company-sponsored program to develop an airborne PCM (pulse code modulation) system. Other standard units are in the works.

Although there is some reluctance on the part of missile makers to use standard equipment, short lead-time requirements make such a solution promising in many applications. Missile test programs have to be tailored to existing ground equipment; there is no really good reason why airborne systems can't be standardized, at least to a large extent.

• **Today's work aimed at future**—This is one approach that offers telemetry manufacturers a direction for future development. Other programed changes and expected logical advancements further broaden the target. In any case, progressive organizations in this field have something more than a crystal ball on which to base their R&D programs.

New frequency bands are already being assigned. New signal-to-noise requirements and increased information bandwidth will be necessary in the future.

PCM, for instance, is still a long way from general acceptance, yet the trend is undeniably toward digital techniques for their greater accuracy and information capacity. Most of the problems—weight, power, and reliability—have already been solved. Compatible receiving equipment—the major remaining problem—will undoubtedly follow as the benefits and necessity of digital data transmission are realized and accepted.

TI is one of those aiming present developments at future needs. The PCM system is but one example of such future-oriented projects. Other examples are also under development.

• **Telemetry overshadowed by transistors**—Although their work in telemetry has already been substantial, TI is not too well known in this field. In a recognition survey last year, they were rated number 12, well behind several other companies that have done considerably less. Based on volume of business in 1959, they should place well within the top four manufacturers of airborne telemetry equipment.

TI's achievements in telemetry have no doubt been overshadowed by its more widely known reputation as a top semiconductor manufacturer.

But the company's leadership in semiconductors has given it a definite edge in the design and development of airborne telemetering equipment. The small size and weight requirements for missile and space vehicle equipment naturally calls for the greatest degree of miniaturization and reliability. TI has capitalized on its background and knowledge in the art of making things smaller to produce the kind of equipment demanded for airborne telemetry.

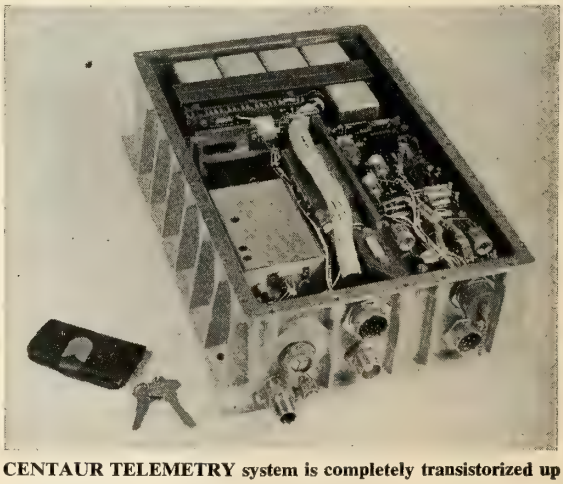
• **Approach to universal system**—The standard PCM system mentioned earlier is a solid-state package one-half cubic foot in volume weighing 25 lbs. It contains a high- and low-level multiplexer, analog-digital converter, programer, and output register. As an approach toward a "universal" system, input configuration and output format may be varied to fit specific needs.

The more flexible such a system is, the better its chances of acceptance. Mission requirements vary widely (see table) and a practical universal system must meet these requirements.

A high/low-level solid-state commutator—or multiplexer—built for the *Bomarc* represents another challenge met and conquered by TI engineers. This unit, which replaced a mechanical commutator already in the bird had to fit in the space assigned the previous



STANDARD PCM system is solid-state throughout, will handle both high- and low-level inputs. Built-in flexibility offers variable bit rate, and trade-off between number of channels and channel information bandwidth.



CENTAUR TELEMETRY system is completely transistorized up to the r-f power stages. Specifications required small size, extreme reliability, and 500-hour minimum unattended operating life.

unit and perform a bigger function and do it better. It was the first true low-level solid-state multiplexer to be used in an operational missile. Actual life tests have yielded over 1000 hrs. continuous operation without failure.

The multiplexer is transistorized throughout. It uses highly reliable low-noise transistor switches and has no moving parts, eliminating a major source of trouble in time-sharing telemetering systems. It will handle low-level inputs of 2-42 millivolts with an overall accuracy of ±0.5 percent.

The standard PCM system has a low-level accuracy of ±0.1 percent—referred to a 50 mv full-scale input range—and a bit rate of 200 kc. The company claims techniques have already been developed that will permit 350 kc, or higher, bit rates with this same accuracy. A current research project is aimed at the multiplexing and encoding of microvolt signals with bit rates up to one megacycle.

• **Deep-space poses critical requirements**—Instrumentation for deep-space vehicles presents even more exacting requirements because high accuracy and reliability as well as long life are required. Telemetering equipment for a lunar-orbit or interplanetary mission may have to function, continuously or intermittently, for weeks, months, or even years without adjustment.

An example of TI's work in this area is the telemetry system for the NASA *Centaur*. Here, extreme reliability was the design goal. The system is conventional 220-260 mc FM/FM with a medium power output of 48-65 watts. A 500-hour life with no maintenance or attention plus tight packaging and weight considerations were the requirements for this system.

• **More reliability goal**—TI engineers feel that the state of the art in transistor circuit design has arrived at a point where equipment can be manufactured and guaranteed to remain within close electrical tolerances throughout its specified life. For this reason, and for better reliability, all adjustments were designed out of the subcarrier oscillator and power supply circuits of the *Centaur* system.

The same principle was applied to maintain optimum distribution of r-f bandwidth by extremely accurate and stable pre-emphasis scheduling. For a given power level and signal-to-noise ratio, maintaining optimum r-f bandwidth is of much more concern in deep-space transmission than would be the case in R&D missile applications where relatively high signal levels can be expected.

• **Signal-conditioning subsystems**—In addition to systems, TI has done much in transistorized subsystems—particularly in the field of signal-conditioning equipment. They are currently building signal-conditioning modules for the *Titan* ICBM and *Pershing* missile. The low-signal level amplifiers for *Pershing* are unique in that they, unlike similar units, operate from an unregulated power supply.

Other units being produced for missile/space applications include transistorized subcarrier oscillators designed for high reliability and low power consumption. These SCOs eliminate potentiometers in the interest of high reliability. They require only five milliwatts of power.

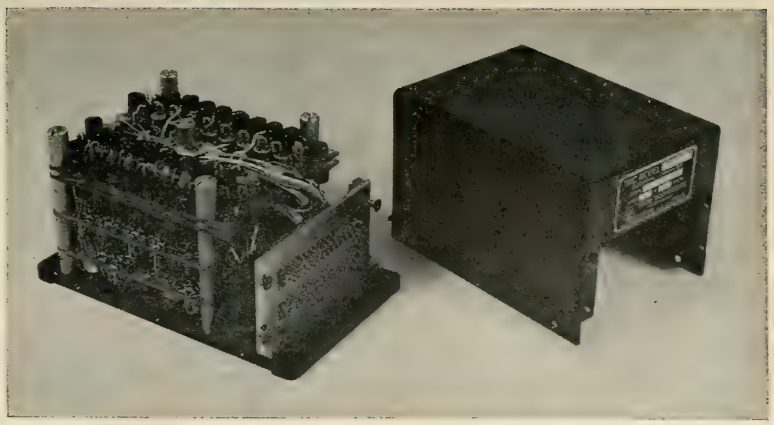
An example of one of the Company's unique high-accuracy components for an R&D missile is a true-RMS voltmeter. This discriminator is completely transistorized and is designed to produce an output of 0 to 5 volts dc for an input of 105 to 125 volts. It has a claimed accuracy better than 1.0 percent for any waveform which contains frequencies between 25 and 20,000 cps.

TI has built a large number of miniature telemetering transmitters. These have flown in the *Bomarc, Corvus,* and *Green Quail* missiles. Some models feature an integral power amplifier that combines small size with large power outputs. One such unit developed an output of 150 watts—well beyond normal telemetering requirements.

• **Functional semiconductor circuits**—Carrying miniaturization a big step further, TI's Semiconductor-Components Division has developed microminiature functional circuits on semiconductor wafers only 1/32 x 1/8 x 1/4 inch in size. One such tiny circuit introduced last year—a bi-stable multivibrator—combines all the functions of assembled transistors, diodes, capacitors, and resistors in the conventional circuits at component densities of up to 30 million per cubic foot.

Advantages of this development include not only the size-reduction benefit but the reliability jump—in part, from an 80% reduction in the number of solder joints—and manufacturing simplification as well. In developing airborne applications of "Solid Circuit" networks, the company has evolved welding techniques said to be more reliable than soldering.

TI's Apparatus Division is active in many areas of the missile/space business. In addition to telemetering systems and components for *Bomarc, Corvus, Titan, Minuteman, Mercury, Centaur, Pershing, Saturn, Atlas,* and *Thor,* the Division has done considerable work in other aspects of missile/space electronics. They have developed and built 10-ton radar systems and advanced equipment for combat surveillance and ASW. Their synthetic antenna and side-looking radars are probably the most advanced produced to date.



SOLID-STATE electronic commutator for *Bomarc* replaced mechanical unit and fit same space. Unit will handle 43 high/low-level information channels plus two sync channels, at a rate of 20 samples/sec. PCM version has sampling speeds up to 100 kc.

Varying Requirements

Vehicle	No. of channels	Accuracy	Sampling speed
MINUTEMAN	128 hi-level	0.1%	12 kc and all submultiples
	96 lo-level	0.2%	down to 33 cps
TITAN	90 hi-level	0.1%	900 cps
ADVANCED TITAN	64 hi-level	0.05%	8640 cps
BOMARC C-2	36 hi-level	1.0%	900 cps
	7 lo-level	1.0%	
BOMARC C-4	45 hi-level	1.0%	900 cps
CORVUS	(2) 45 hi-level	0.5%	900 cps

Mission telemetry requirements vary widely as shown above. A universal system must be flexible to meet such requirements yet be standard in other respects

debate among astronomers . . .

How to Contact 'People' in Space?

Those scientists who believe there is intelligent life on other planets are divided on the question of how to go about getting in touch with them; they agree that it's likely that other 'people' exist

If there is life out there, then where is everybody?

Dr. Edward Teller

by William Beller

There is a fight going on among scientists looking for ways to get in touch with intelligent beings outside our solar system.

The assumption is that people exist out there.

One astronomer right now is searching the skies for signs of extra-terrestrial life.

Another astronomer is informing him that he's not looking in the right places.

Both men are fully convinced that somewhere, somebody may be searching for us.

A third astronomer asks why all the fuss. "We'll know soon enough if anybody's out there. Meanwhile, are there lichens on Mars?"

Other scientists are entering the fray.

The fight going on is a velvet-gloved one but is nonetheless intense. If life, the extra-terrestrial type, is actually trying to locate earthlings, then the results of this local conflict could affect the beings' chances of finding us, and vice versa.

• **The division**—The scientists involved divide into three major factions. These reduce to two if disbelievers in extra-terrestrial beings are eliminated.

In the first faction, the members say that intelligent beings are sitting on their planets passively attending to about one thousand transmitters all beaming electromagnetic signals into likely areas of the universe.

Partisans of the second faction affirm that if these beings are truly intelligent they won't be waiting around hoping somebody will hear them. Instead, they'll be sending out probes and satellites. These will be actively querying every solar system within reach, hoping to get an answer back.

Unofficial leader of the first faction is Dr. Frank D. Drake, associate astronomer of the National Radio Astronomy Observatory, a facility perched near a mountain top in Green Bank, W.Va. Last April he began pointing his 85-ft.-diameter dish radio-telescope in the neighborhood of two nearby stars for a sign of life.

Heading the second faction, also unofficially, is radio astronomer Professor Ronald Bracewell of Stanford University's Radioscience Laboratory.

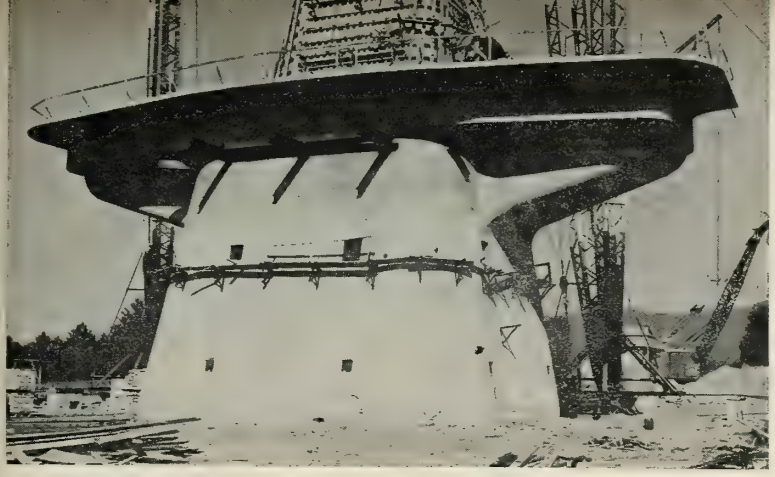
Both groups begin with the premise that somewhere in our galaxy there is a community at least as advanced as earth's. This is done with communities to spare in the following logic:

There are a vast number of stars in the Milky Way that have low angular momenta. One instance is our sun, which has given 98% of its momentum to its planets. Thus there are probably millions of millions of planets existing, thousands of millions of them standing in the same relation to their stars as the earth is to its star.

Life therefore would have evolved and be abounding in the Milky Way. Chances are that it would be incredibly more intelligent than our own. Although our sun is young, earth's civi-



SEARCHING FOR extra-terrestrial life, 85-foot diameter radio telescope listens for artificial signals emanating from stars 11 light years from earth.



INCREASED SEARCH range will come from 140-ft.-diameter radio telescope whose foundation is shown rising from a field in Green Bank, W.Va.

lization has already advanced technologically amazingly far, up to controlling atomic energy.

Imagine then the progress that would be made by communities on planets born out of the mature stars, millions maybe billions of years older than ours! Of course, such progress occurred only if the communities did not destroy themselves by their discoveries.

Whether such advanced civilizations would want to trouble themselves to get in touch with "dark age" societies like ours has been questioned. Bracewell thinks they would because "the prospect of catching a technology near its peak might be a strong incentive for them to reach us."

• **The Milky Way Club**—Except for a month taken out for conventional radio astronomy work, Drake has been monitoring Tau Ceti and the Epsilon Eridani, two suns about the size of our own but 11 light years away. These are said to be the only nearby stars that might have life-bearing planets. Double stars were not considered.

Double stars are two suns linked by their gravitational fields. Even if the suns have planets, the orbits would be so eccentric that the climate would most likely be too variable and extreme for life to evolve.

Drake is calling his search "Project Ozma," a name derived from Frank Baum's queen of Oz who lived in "a place very far away, difficult to reach, and populated by strange exotic beings."

It may be that nobody is trying to get in touch with us from there, Drake says. After all, the probability that a given sun will have a planet like earth is an extreme long shot. Still, our radio talk over the years could have been heard by some advanced community; or such a community might have a program to explore "outer" space.

Another possibility, according to Cornell University scientists Drs. Philip Morrison and Giuseppe Cocconi, is that there might be some sort of Milky Way Club composed of advanced societies in communication with each other. Random spacings could have placed such societies not too many light years apart.

The MWC may have agreed to query star after star in an effort to find new members.

What signals would these advanced societies use to get in touch with earth? Chances are they would operate on some very common electromagnetic radiation. What is a better choice than the emissions of ionized hydrogen, asks Drake? It is everywhere in the cosmic vacuum. Intelligent beings on a distant planet would presumably know that we had discovered this universal hydrogen line. And this is where Drake is listening, at 1420 megacycles.

Since hydrogen is continuously sending out noise signals from space, as this gas is ionized by colliding particles, the trick is to separate the noise from the artificial signals being sought. Through an ingenious technique, Drake is able to do this without resorting to months of tiresome correlation calculations.

Using a wide and narrow band detector simultaneously, he first focuses his telescope on the star under surveillance. Then he determines and eliminates much of the background noise by focusing on an area in space near the star.

• **Large dish holds more stars**—The work at Green Bank is being supported by the National Science Foundation, which has a second telescope under construction at the site and a third one about to be started. Both these new instruments are similar to the one already operating but have larger diameter dishes, 140-ft. for the second, 300-ft for the third.

The distance over which a signal can be detected is directly proportional to dish diameter. Specifically, if a signal emanating from a point in space were as strong as the strongest electromagnetic radiation an earth station could put out today, the 85-ft. dish telescope could perceive it up to about eight light years away.

Though the range increases linearly with dish diameter, it is important to remember that the number of stars available to the telescope increases as the cube of the diameter. This is one of the prime reasons for building larger dishes.

Drake estimates that the requirements of conventional radio astronomy will leave only about 10% of the Green Bank telescopes' time free to look for extra-terrestrial life. He commented that regardless of how much time is devoted to the task, luck is going to play an important part. "It's going to take a lot of patience and effort because we know so little about where to look and what frequency to try."

Contrary to pronouncements made by Bracewell, Drake stressed that he knows of "no emanations past or present that could be construed as coming from other intelligent beings."

In his writings, Bracewell has referred to signals coming in from space, which seemed to be echoes of those sent from earth and "were reported 30 years ago by Störmer and van der Pol and never explained."

• **Computers that talk**—Taking issue with Drake, Bracewell wrote in a recent *Nature* magazine article that he doubts that intelligent beings would waste their time beaming signals to us from their home bases, even if these beings knew where we were. "Remember that throughout most of the thousands of years of the earth's existence such attention would have been fruitless!"

Instead, Bracewell sees such beings "spraying" a thousand or so nearby stars with satellites. Each satellite would be put into a circular orbit around a star, would then be powered by the star's radiations, and would be at a distance from it that would place the satellite in a habitable zone. Bracewell believes that this method would be far more economical of time and energy than having to power a thousand transmitting stations on a given planet for an extended period.

On board each satellite or probe would be radio receivers, transmitters, and computers. Through these instruments, the probe would listen for signals, then echo them on the same frequency they were received. "To notify the probe that we had heard it, we

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laser will be used heavily . . .

would repeat back to it once again," explains Bracewell. "It would then know that it was in touch with us." From here on, earthlings would be teaching the probe their language for transmission back to the superior community somewhere out in space.

Out of this Bracewell concludes that "we might better devote our efforts to scrutinizing our solar system for signs of probes sent here by our more advanced neighbors." Later, as we advance technologically, we can send out our own probes to explore and interrogate the Natural satellites of more distant suns.

Objections to Bracewell's thesis come from one of his colleagues. He notes that space probes are extremely expensive and undoubtedly fragile over extended periods because of meteorite bombardment. "Besides," the critic observes, "if a society can build the computers that Bracewell asks for, let's not have the devices waste time orbiting around us. Let them come right down to earth, have a couple of drinks, and talk things over man to . . . ah . . . computer."

• **Capture a star**—Intelligent beings may ultimately find themselves short of space on their home planet, says Freeman J. Dyson of the Institute for Advanced Study, Princeton. He expects Malthusian pressures to be driving the people to new habitats.

He envisions such people using their own star's energy to help them chop up what had been previously an uninhabitable planet. Such a one could have been in the relative position and of the size of our Jupiter. Chunks of the planet would be used by the people as the building blocks for a biosphere, a spherical shell completely enclosing a sun and at a life-sustaining distance from it.

The biosphere would be capturing all its sun's radiating energy. The hollow planet is seen having a diameter roughly equivalent to the earth's orbit and a surface temperature of 200° to 300°K. The most plentiful radiations would be in the far infrared, at about 10 microns wave length.

Dyson suggests that a search be made for sources of these infrared radiations along with the search for artificial radio signals. Unlike many other scientists, he sees the double stars as being particularly advantageous for supporting life. In effect, the weaker star would be surrounded by the spherical shell of a destroyed planet. The inhabitants would then be warmed from below and above.

Drake calls Dyson's scheme scientifically and economically sound.

The laser after further development will be playing an important part in infrared radiation detection (see M/R, July 18, p. 54). Such a light-amplifying device would be mounted in an earth-circling satellite in order to be above our atmosphere's noise, says Paul Johnson, Air Force Office of Scientific Research physicist. First the laser would look for high intensity, narrow band signals from space.

Failing to get these, and as the laser art progressed, the device would search for broad band emanations. It would try to detect "characteristic infrared signatures associated with life processes." Lastly, it would attempt to extract signals buried in a high background noise.

In the final analysis, probably the best way to attack the problem of searching for life in space is to look at as many areas as we can, near and far. At the same time, as one astronomer avers, "we should find every possible means to communicate available to us by the laws of physics and try them all."

ARPA Puts Real Money Into Research

The first real attempt at scaling the materials barrier is under way.

Project *Pontus,* a long-range basic research funding program, was initiated by the Advanced Research Projects Agency with a $14-million broadside.

Specifically aimed at providing needed basic knowledge in the several disciplines of the materials sciences and increasing the number of Ph.D.-caliber scientists, initial contracts were recently awarded to Cornell University, University of Pennsylvania and Northwestern University.

The program is the result of a recommendation of the Federal Council for Science and Technology that progress in materials could best be assured by setting up laboratories at qualified universities where separate scientific and engineering capabilities could be used collectively.

An added boost was supplied by the Committee on the Scope and Conduct of Materials Research set up by the National Academy of Sciences. This group, after a similar year-long survey, suggested that universities be strengthened in the dual role of training personnel and engaging in basic research.

The funding support levels are as follows:

• **Cornell—$6.1 million:** A materials research center will be established combining the efforts of portions of five departments in two colleges. Cornell will construct a $4 million building housing the administrative offices of the center, several common technical facilities and graduate research of the Laboratory of Atomic and Solid State Physics.

ARPA will reimburse Cornell for construction costs over a 10-year period. A larger building may be added later.

Disciplines covered include solid state physics, chemistry, metallurgy, mechanics and materials. The ARPA contract will run four years. Funding for the fifth year will be discussed next fall and further support annually.

• **U of Pennsylvania**—$4.4 million: The four-year contract will result in the erection of a three story building to house research activities in solid state physics, structural chemistry, inorganic chemistry, ceramics and all phases of metallurgy.

There will be substantial increases in the teaching staff and in the number of full time students.

• **Northwestern U**—$3.4 million: A materials research center wing will be established housing 18 specialized laboratories. Materials researchers will double in the first five years to 55. Graduate students in the materials sciences will be increased by a factor of 2.5 to 175.

Special equipment will be purchased by the three universities to aid in the program. Both Northwestern and Pennsylvania will obtain high power magnets—50,000 and 100,000 gauss respectively. Cornell and Northwestern will pick up new electron microscopes.

But the most valuable equipment will be the highly trained researchers.

In each case the contract runs for four years. Additional funding will be supplied as the program progresses. In some instances, private funds will funnel into the project.

The three universities were selected from among thirty interested institutions. ARPA has indicated that additional laboratories at other universities are being contemplated.

Chamber Simulates 250-mile Height

A huge ultra-high-vacuum chamber capable of simulating pressures equivalent to an altitude of 250 miles went into operation last week at the San Diego facilities of Convair Division of General Dynamics.

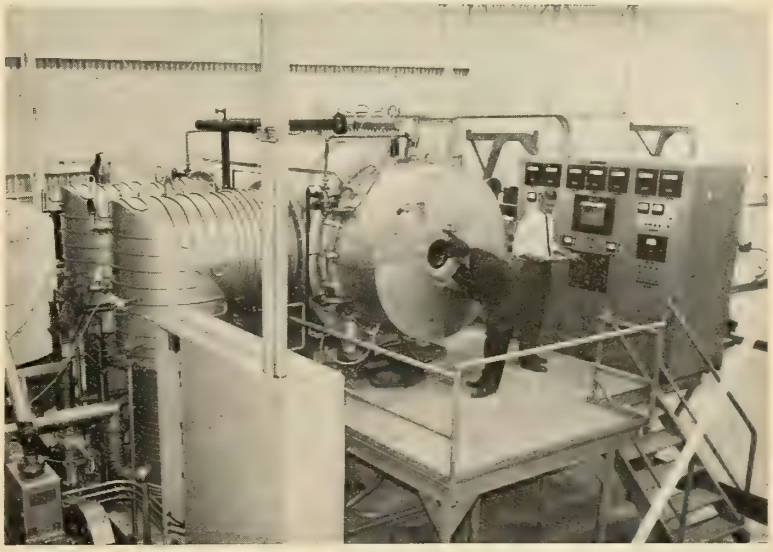
The installation will be used to test electronic components and pressure units for adaptability to space vehicles. Problems such as fluid leakage, lack of heat transfer and explosive decompression are also on the agenda.

The stainless steel chamber, 10 ft. long and 5 ft. in diameter, has a temperature range from −300° to 700°F. Full opening doors at either end facilitate test object handling. A 10-in. glass port permits visual observation during test runs.

The vacuum is created and maintained by a high-capacity oil-diffusion pumping system. Special liquid nitrogen traps and baffles freeze-out any undesired air or water vapor.

Company spokesmen said the chamber will probably be used almost entirely at its maximum pressure of 1×10^{-7} mm Hg. Two other high-performance vacuum tanks are now being tested at Convair.

The chamber was built by NRC Equipment Corp., Newton, Mass.



ULTRA-HIGH-VACUUM research at Convair will be performed in this stainless steel chamber. The installation simulates altitudes up to 250 miles.

NASA

RCA Communications, Inc., for a portion of the global communications network for Project *Mercury*. Amount not disclosed.

$806,500—**Southwestern Engineering Co.**, Los Angeles, for vacuum system for heat transfer cooling and aerodynamic facility, Moffett Field.

$86,850—**Radiation Dynamics, Inc.**, Westbury, N.Y., for ion source system.

$70,270—**Linde Co.**, San Francisco, for liquid oxygen storage and dispensing facility installed at 3.5 ft. hypersonic wind tunnel, Moffett Field.

$69,910—**General Electric Co.**, San Francisco, for services and materials for dismantling, cleaning, rewinding and reassemble rotor for 45,000 HP motor No. 4 unitary wind tunnel, Moffett Field.

NAVY

$6,000,000—**Hycon Mfg. Co.**, Pasadena, for continued production of automatic checkout equipment for *Terrier-Tartar* missiles.

$2,000,000—**Thiokol Chemical Corp.'s Reaction Motors Division**, Denville, N.J., for continuation of the development of a liquid-rocket engine for the *Corvus*.

$1,500,000—**Arma Division, American Bosch Arma Corp.**, Hempstead, N.Y., for compact anti-submarine missile systems.

$782,576—**Republic Aviation Corp.**, Farmingdale, L.I., for building automatic guidance system for the *Bullpup*.

$105,000—**Task Corp.**, Anaheim, Calif., for pump motors for use in the *Polaris*.

AIR FORCE

$40,763,711—**IT&T's Federal Electric Corp.**, Paramus, N.J., for operating and maintaining 60 DEW lines spanning the northermost American continent.

$19,200,000—**Westinghouse Electric Corp.**, Pittsburgh, for new high-powered, long-range search radar systems for the continental air defense network.

$15,625,000—**General Electric Co.'s Heavy Military Electronics Dept.**, Syracuse, for production of AN/FPS-24 frequency diversity search radars.

$5,600,000—**Massachusetts Institute of Technology**, Cambridge, for design, construction and operation of a quarter-million gauss magnet installation for the conduct of a high-magnetic field research program.

$5,478,696—**Douglas Aircraft Co., Inc.**, Santa Monica, for components, ground support equipment, spare parts and engineering data applicable to MB-1 rocket—*Genie*.

$1,400,000—**General Electric Co.**, Syracuse, for work on a major silicon transistor reliability program in connection with the *Minuteman*. Subcontract from **Autonetics**.

$1,198,576—**Collins Radio Co.**, Cedar Rapids, Iowa, for additional single-sideband radio communication equipment.

$400,000—**Northeastern University**, for design and evaluation of energy conversion storage system.

$291,500—**The Martin Co.**, Baltimore, for 50 missiles and miscellaneous support requirements.

$248,946—**General Dynamics Corp.'s Convair Astronautics Division**, for design, development, fabrication and test of ultra-lightweight storable liquid-propellant tankage.

$107,185—**Norair Division, Northrop Corp.**, Hawthorne, Calif., for research, development and fabrication of a rotational flight simulator for use in support of studies in bioastronautics.

$106,372—**University of Illinois**, Urbana, for conducting research into some of the basic physics of shock wave phenomena.

$95,030—**Aerojet-General Corp.**, Azusa, for design and development of a rocket-borne attitude-sensing device.

$92,481—**Thompson Ramo Wooldridge Inc.**, Canoga Park, for research on "Ion Beam Neutralization."

$90,377—**Electro-Optical Systems, Inc.**, Pasadena, for research on materials exhibiting photovoltaic phenomena.

$70,000—**Radio Corp. of America**, Princeton, N.J., for continuation of research on "Plasma Acceleration by Electric Field Gradient."

$62,642—**Texas Nuclear Corp.**, Austin, Tex., for research and reports on cellular bombardment.

$54,954—**Stanford Research Institute**, Menlo Park, Calif., for research investigation of the interaction of electromagnetic waves with a plasma.

$44,580—**Aerojet-General Corp.**, for one thrust chamber assembly for sled runs in support of WS-133A and WS-107A programs.

$43,356—**Ling Electronics Div., Ling Altec Electronics, Inc.**, Anaheim, for vibration test system applicable to the IM99A weapon system.

ARMY

Computer Equipment Corp., Los Angeles, for construction of two radar quantizers for the *Pershing* altimeter ground station. Amount not disclosed.

$10,000,000—**Western Electric Co.**, New York City, for *Nike-Hercules* components.

$3,940,851—**North American Aviation, Inc.**, Columbus, for target missile, type III-IV, supersonic, low and high altitude.

$2,000,000—**ITT, Federal Division**, for *Nike* missile support equipment.

$1,500,000—**The Marquardt Corp.**, Van Nuys, for the design and fabrication of a ramjet propulsion system for a supersonic target missile system.

$1,030,255—**Cubic Corp.**, San Diego, for performance and development, engineering design, fabrication and testing of necessary satellite payloads and associated equipment for mobile ground stations to be used for obtaining geodetic data.

$500,000—**Instruments for Industry, Inc.**, Hicksville, N.Y., for research and development of electronic countermeasures equipment.

$323,464—**Sperry Rand Corp.**, Salt Lake City, for furnishing and delivering repair parts for the *Sergeant* missile (three contracts).

$308,356—**Westwood Construction Co.**, Denver, for construction of nosecone facilities at Lowry AFB.

$269,514—**Thiokol Chemical Corp.**, Elkton, Md., for standard *Cajun* rocket engine, model III.

$191,679—**Grand Central Rocket Co.**, Redlands, Calif., for research and engineering investigation of solid-propellant grains and methods of effecting thrust level control of solid-propellant motors.

$126,235—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* ground handling and test equipment.

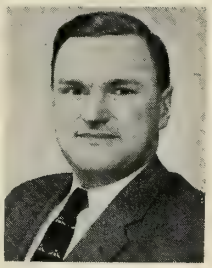
$116,284—**Telemeter Magnetics Inc.**, Los Angeles, for a high-speed digital memory system with clear control circuits.

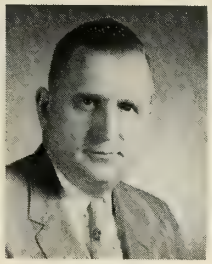
Testing Minuteman Car



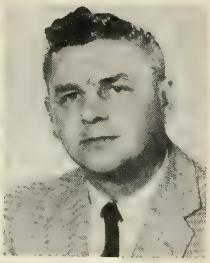
PRE-PROTOTYPE MODEL of the *Minuteman* rail car is getting shock-impact and checkout tests at American Car and Foundry's plant in Berwick, Pa. The car is designed to cushion the missile from transverse, longitudinal, and vertical shocks during rail transportation. After these tests are completed, it will be joined to an Air Force train for road testing.


BULLOCK


BLACK


SCHILLING


ADAMS


WOODHAMS

Col. E. T. Bullock (USA-ret.): Deputy Commanding General of the U.S. Army Electronics Proving Ground at Fort Huachuca, Ariz., joins Cook Electric Co. as director of planning for its new TransDigital Systems division.

Paul B. Black: Appointed marketing manager of the Systems Engineering and Management Operation of Sylvania Electronic Systems. Previously served as manager of the B-58 Hustler program at the Buffalo operations.

Dr. Martin Schilling: Elected vice president-engineering and research for Raytheon Co., succeeding **Dr. I. A. Getting,** who has resigned to become president of the newly-formed Aerospace Corp. Prior to joining the firm in 1958 as program manager of the Missile Systems Division, Dr. Schilling was chief of the project management staff of the Army Ordnance Missile Laboratories' Research and Development Division, Huntsville, Ala.

Donald K. Adams: Former project engineer for the U.S. Army Electronics Environmental Test facility joins Cook Electric Co.'s TransDigital Systems division as director of liaison engineering.

Ed Woodhams: Former measurement standards engineering specialist with the Measurements Standards Laboratory at Lockheed Missiles and Space Division, appointed laboratory director of National Astro Laboratories, Inc.

O. E. (Pat) Tibbs: Former Martin Co. chief test pilot and more recently head of the activation division in Denver, takes over the general manager's post of Martin operations at Cape Canaveral. He replaces **George E. Smith,** who will go to Martin-Denver.

Arthur S. Davis: Former sales manager for Westinghouse Electric Corp.'s Gearing Division, named customer relations manager of Elgin Micronics, a division of Elgin National Watch Co. He will be in charge of all marketing and sales for the division's plant in Elgin as well as the plant being built in Rolling Meadows, Ill.

N. S. Hopkins and **E. W. Bode:** Elected chairman and vice chairman of the executive committee of Holloman Test Directors' Council. Hopkins, manager of the Lockheed Missile Space Division AFMDC, succeeds **Thomas Bean** of Telecomputing Services, Inc. Bode is currently chief of the AFMDC Field Test Group of Radioplane.

John A. Garman: Named research and development director of Food Machinery and Chemical Corp.'s Chemicals & Plastics Division, succeeding **Sherman K. Reed,** now director of research for the Chemical Divisions.

Robert Seal: Former executive vice president named president of RS Electronics Corp., a subsidiary of Regan Industries, Inc. **Robert B. Parks,** former vice president named executive vice president and **Clinton O. Lindseth,** chief engineer, appointed vice president-engineering.

Dr. Joseph Rosenberg: Joins Tracerlab as head of the Organic Chemistry Dept. Was previously an organic chemist at the General Electric Laboratory, Schenectady and the G. E. Advanced Projects and Laboratories Operations, Erie, Pa.

Jerome L. Strauss: Budd Electronics, Inc.'s vice president for marketing, elected vice president and general manager.

Myron A. Tracy: Manager of The Garrett Corp.'s Washington sales office, appointed manager of military relations. He will conduct all prime military sales and contract negotiations for The Garrett Corp. and its AiResearch Manufacturing Divisions.

Leslie L. Alt: Joins the General Electric Advanced Semiconductor Laboratory as a physicist concerned with research in surface properties of semiconductor materials and devices.

W. E. Giberson: Named chief of the newly organized Guidance and Control Division at the California Institute of Technology Jet Propulsion Laboratory. Supporting Giberson will be: **Howard H. Haglund,** deputy chief; **Henry A. Curtis,** chief of electronic devices section; **Garth E. Sweetnam,** chief of space craft secondary power section; **Norri Sirri,** chief of guidance and control systems section; **John R. Scull,** chief of electromechanical devices section; and **Dr. John H. Laub,** chief of guidance and control research.

James W. Flynn and **Dr. Russell N. Clark:** Appointed vice president and director of marketing, and vice president and technical director, respectively, of Celanese Polymer Co.

Edward J. Querner: Named vice president and general manager of Daystrom, Inc. Transicoil Division. Was formerly Transicoil manager of manufacturing.

John P. Gaty: Vice president and general manager and director of Beech Aircraft Corp. will resign as of Sept. 30.

James V. Bitner, Jr.: Former technical director in charge of all engineering of the *Mace B* program at Martin-Baltimore, appointed assistant general manager, Instrument Division, of Lear, Inc.

Bernard R. Garrett: Former chief engineer, elected vice president, engineering and research, at Loral Electronics Corp.

Robert C. Boe: Former marketing manager and assistant vice president and general manager of Cook Technological Center, appointed marketing manager of the Buffalo Operations of Sylvania Electronic Systems.

William W. Pleasants: Appointed manager of the RCA BMEWS installation at Clear, Alaska.

Richard Cook: Joins the engineering staff of Technology Instrument Corporation of California as an electronic component engineer.

George J. Sbordone and **John Van Putten:** Named division general manager and manager of customer liasion, respectively, in the Military Products Division of Tempo Instrument Inc.

Lt. Col. Glenn Crane: Named project officer in charge of the Army's *Nike-Zeus* program, succeeding **Col. John G. Zierdt,** now commander of ARGMA.

Huntly P. Briggs: Appointed advertising and public relations director in the Military Products Division of Hoffman Electronics, succeeding **William H. Herrmann,** who has resigned.

Temperature Calibration

Conrad, Inc. announced the availability of a production model temperature-coefficient calibration chamber for thermistor and capacitor tests. The equipment capability is for stabilizing within plus or minus 0.005°C stability. The equipment is also available with additional controls to permit stability of plus or minus 0.001°C.

The temperature range available is from +250°C to –75°C. Instrumentation for recording the controlled condition can be supplied together with automatic temperature conditioning.

Circle No. 225 on Subscriber Service Card.

Solid-State Tape Rec/Rep

An all-solid-state magnetic tape recorder/reproducer has been developed by the DataTape Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

Up to 14 channels of direct-record or wide-band FM analog data can be recorded and played back bi-directionally. Head assemblies for two record and two reproduce heads of seven channels each can be plugged in. An accessory erase head is also available.

The Type PR-2300 records and reproduces at speeds of 60, 30, 15, 7½, 3¾, and 1⅞ in./sec. Speeds are changed in pairs by changing drive belts. Choice between the two speeds in each pair is made from push-button controls. Tape speed is held constant to within 0.25%.

Circle No. 226 on Subscriber Service Card.

Ultrasonic Spot Welder

An ultrasonic spot welder with a high-temperature, high-efficiency transducer construction and a unique self-tuning circuit has been announced by International Ultrasonics, Inc., an affiliate of Aero Supply Mfg. Co., Inc.

The spot welder is used for joining similar or dissimilar metals, of equal or different thickness. The top piece may be up to 0.006 in. in thickness. There is no limit on thickness of the bottom piece. Materials as thin as 0.00025 in. have been joined. Typical applications include joining leads to capacitor foil, joining foil tape for foil-wound transformers, attaching leads to transformer tape, making lead connections to transistors and diodes, and making attachments to copper and aluminum printed circuit boards.

Circle No. 227 on Subscriber Service Card.

Universal Circuit Cards

Development of a universal circuit card which can be prefabricated and adapted to different circuit requirements has been announced here today by Librascope, Inc.

The stock card contains a universal etched pattern which can be modified by interconnections to form any desired circuit function.

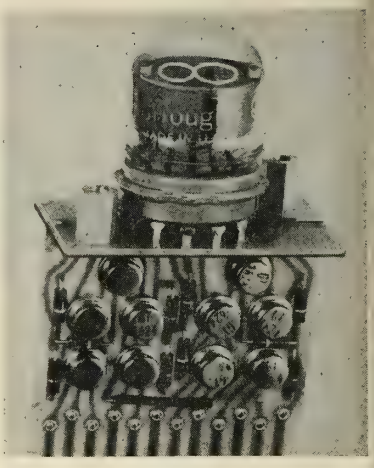
On the stock cards components may be added to form logic modules before the final design of a computer is ready, and then, when the design is firmed, these modules may be interconnected to form the required circuits.

Such a technique is particularly adaptable to short-run and prototype production, where lead time between design and actual start of production is usually excessive.

Circle No. 228 on Subscriber Service Card.

Low Power Visual Readout

The Burroughs Corporation's Electronic Tube Division has announced the addition of two low-cost transistorized driver modules to their TRIXIE driver line. The TR-40 has been designed to operate the miniature NIXIE(R) indicator tubes, and the TR-57 has been designed to operate standard and super NIXIE indicator tubes.



The TRIXIE readout comprises ten medium-voltage NPN transistors in a common emitter configuration with each transistor driving one of the NIXIE indicator tube's 10 cathodes.

Circle No. 229 on Subscriber Service Card.

High Voltage Power Pack

Era Pacific, Inc., has extended its present line of HYPAC high-voltage supplies with the addition of the MICROPAC series of subminiature solid-state high-voltage DC power supplies.

Units are available for operation from a 60- or 400-cycle line, in addition to a 26-29 VDC line. Line regulation of ±.5% for 20-100% load changes. Ripple is 1% RMS. Standard voltages available are 1000, 3000 and 5000 VDC at a maximum load current of 100 microamperes. Also available are units having the same input and output voltages but without the regulating circuit. These supplies are more inexpensive than the regulated series and provide regulation of approximately ±5% over 20-100% load variations.

Circle No. 230 on Subscriber Service Card.

Circuit Switching Board

A new circuit-switching/component interposition is being produced by Sealectro Corp.

Sealectroboard allows instantaneous set-up, or programing of circuitry logic between X and Y axes of terminations, without the use of patch-cords, and at the same time permits interposition of diodes, or other miniature electronic components between any X and Y termination.

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Circle No. 6 on Subscriber Service Card.

Miniature Check Valve

Miniature in-line check valves, designed for applications too small to accommodate larger check and butterfly valves, are being produced by Barber-Colman Co. Available in sizes from 0.25 to 0.50 in., in-line check valves are designed for direct coupling into high-pressure, high-temperature air flow lines.

This check valve allows air to flow in one direction only and closes immediately upon air flow reversal. Maximum temperature is 900°F with a maximum internal leakage of 0.04 lb./min. at 300 psig. External leakage is zero. Weight is 0.12 lb. for 0.25 in. valve.

Circle No. 232 on Subscriber Service Card.

Wirewound Micropot

Borg Equipment Division, Amphenol-Borg Electronics Corp., has available a series of 7/8-in.-diameter, wirewound Micropots.

Designated the 2100 Series, this new Micropot will be available in ten-turn and three-turn models.

Assemblies of the 2100 Series can withstand more than 1,000,000 revolutions without exceeding total resistance of linearity tolerances. Total resistances to 100,000 ohms are offered.

Circle No. 233 on Subscriber Service Card.

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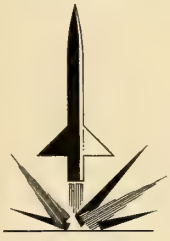
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editorial . . .

Khrushchev—How Long, Oh Lord?

SOME WEEKS BACK the dictator of the Soviet Union broke up the Summit Meeting, called the President of the United States back-alley names and revoked his invitation to the President to visit Russia.

Not long after that he proclaimed unilaterally a bit of international law little noticed in this country—his own mandate that any country suffering the overflight of a missile would forfeit its neutrality.

And he topped these outbursts, if topping them is possible, by openly admitting that Russian fighter aircraft had shot down an unarmed American weather plane—apparently over neutral territory.

Despite these events, our present Administration has indicated that the additional money voted by Congress for the U.S. military budget will not be spent—or at least the major part of it will not be.

The Administration's attitude is, to judge from the past, that our military programs are proceeding according to plan—that our deterrent posture is sufficiently strong without the extra money.

We should like to go on record as feeling that it is almost literally impossible to be *too strong* at this moment.

It is not so much that we are tired of Khrushchev's blustering threats, his insults and his overt armed terrorism; it is the fact that he is able to perform such acts with the complete sureness that nothing much will happen when he does.

Khrushchev respects only one thing and bends to only one thing—strength. And this is the thing we are lacking—visible, apparent, recognized strength. It can't be strategic alone, it must be tactical too. It can't rest alone with the Air Force or the Army or the Navy. It has to be inherent in all three services. It cannot be a strength capable of dealing with global wars only. It must be competent to handle limited conflicts as well.

One weakness is too many. The Russians will find it and exploit it, even as they are now concentrating on the nation's softest spot—the Administration.

Under Mr. Eisenhower we are living in an unreal and unrealistic climate where more cars must be built but not the roads to drive them on; where scientists are vitally important but not the schools to educate them; where space is recognized as the frontier of tomorrow but the exploration of it has a lower priority than preserving surplus grain; where military strength is a matter of survival yet we cannot spend the money to make us strong; where golf is more important than our political welfare.

And we continue to be pushed around, bullied and insulted by Nikita Khrushchev.

We cannot—looking back upon the U-2 incident, the summit collapse, riots in Japan, Cuba and the murder of the RB-47 crew—find one iota of hope for a lessening of the menace the Soviet Union holds for us and the entire free world.

WE see no reason to expect anything but a continuation or a worsening of the pressure Khrushchev will apply at every weak point he finds or suspects.

We as a nation don't want this menace and this pressure, nor do we have any desire to reciprocate. But when it becomes obvious that the menace and the pressure are something we must live with, then let's do everything we can to create a situation whereby we can live with it on our own terms.

There are many forms in which a nation can be strong; at the moment the one we are interested in first is the one the Kremlin recognizes—the brute variety. Let's be strong enough that an insult from Khrushchev will be a calculated risk and not merely a scornful gesture. This will take money, and don't think for a minute money can't be used to a good purpose right now. Money in military budgets buys hardware and time. It buys concrete strength. We can think of no better way to spend it.

Clarke Newlon



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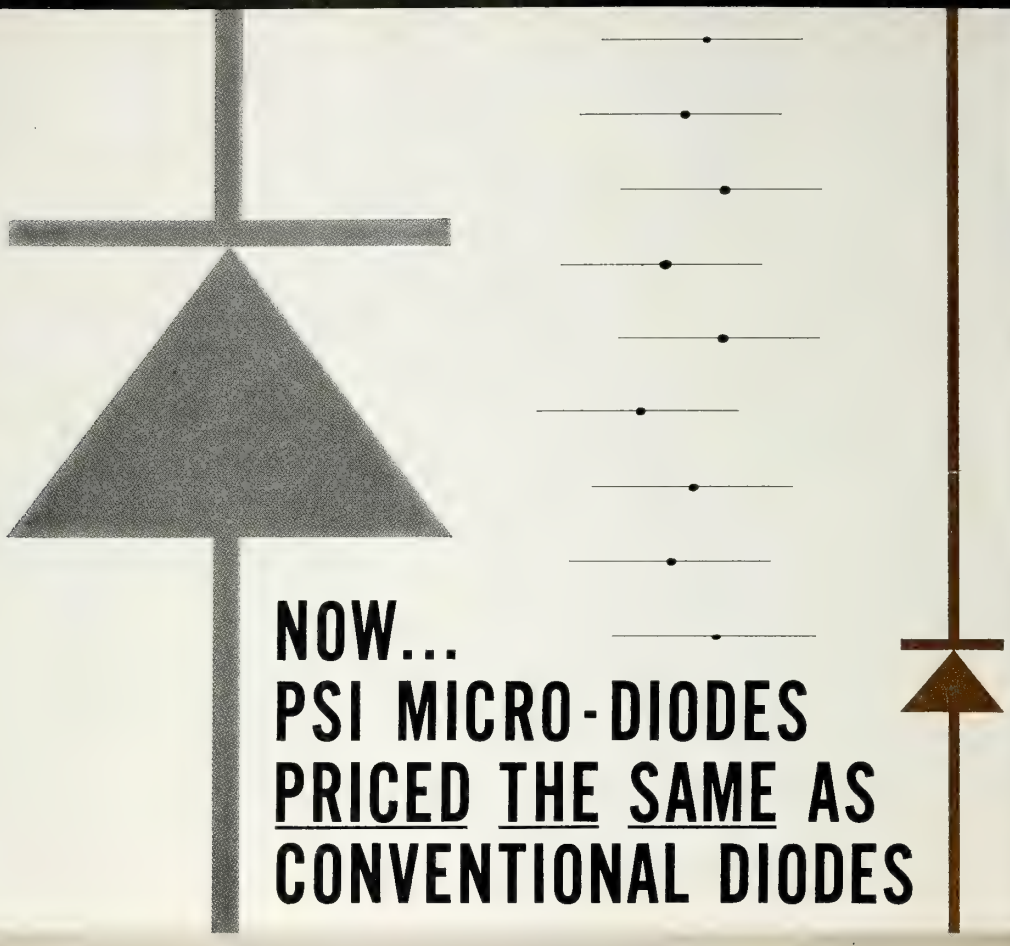
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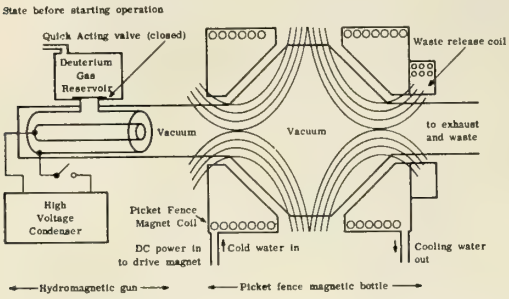
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non Science fiction at Los Alamos

Is this the shape of things to come in Sherwood?



The cusped geometry or picket fence was proposed back in 1954 independently by Grad at N.Y.U. and Tuck at Los Alamos, to get around hydromagnetic instability of plasma-magnetic field interfaces. Nobody did much about it at the time. The pinch effect seemed to hold more promise, so why bother about a leaky picket fence? A large magnet to produce a DC picket fence geometry was built but laid aside. For several years the stabilized toroidal pinch (called Perhapsatron at Los Alamos) held the stage. But as our measuring techniques got better, the pinches began to show a most sinister behavior. An apparently stabilized pinch which should have been radiating energy at the rate of several kilowatts, turned out to be losing it at a rate of hundreds of megawatts. As we got the impurities out of the system, the losses seemed to go down. One pinch (Perhapsatron S-5) has seemed so clean we are trying to raise its temperature to thermonuclear levels by pouring in more power.

Then there appeared the spectre of plasma oscillations and their evil effects on magnetic confinement. In principle, plasma oscillations can thrive on the interaction of a fast wind of plasma electrons moving through a slower cloud of plasma ions. This makes things look bad for the pinch effect, because the plasma has to have a large electric current in it, and therefore an electron wind.

The Russians delivered the next blow. Trubnikov and Kondryatsev predicted an enormous cyclotron radiation flux from a plasma containing a magnetic field. This would ruin the chances for DD reactors, and make things tough even for DT reactors. Among other complications, a nearly perfect mirror would have to be placed around the inner wall of the plasma container to reflect the radiation back.

Then Rosenbluth and Drummond argued that when the angular distribution is considered, the radiation isn't really so bad—say 1/50th of what T and K say. Now Trubnikov has come right back with another paper that says it is five times worse than R and D said it was. The above theories are pretty simple—the real problem is exceedingly difficult theoretically. It may be quite a while before there is anything new in this direction.

Anyhow, the point is that DD reactors with magnetized plasmas now seem to be out. But some people, like Tuck, claim that DD reactors are the only ones that make sense, since a DT reactor which must carry on its back a monstrosity of a tritium recovery plant could never compete with fission power anyhow.

This brings us to the point that if we want to have a DD reactor, it has to have no magnetic field in its plasma. So all right, don't put a magnetic field in the plasma. Unfortunately, there aren't any magnetic confinement systems stable enough to hold a pure plasma, except one. You've guessed it—it's the picket fence.

So we went back to the warehouse and dusted off the magnet we built long ago. Already it is going full blast, a second one has been built and a third one is on its way. Of course, we aren't alone any more in this field. Small cusped geometries are being studied at General Atomic, Livermore, Stevens, Harwell, Utrecht and Kharkov. Pretty soon we will have only picket fences and plasma guns at Los Alamos, aside from a few Scyllas to study plasma at thermonuclear temperatures, unless old Perhapsatron S-5 does something pretty spectacular.

The diagram of Picket Fence I (above), run by D. Hagerman and J. Osher, shows how plasma is injected as a slug, strong enough to push through the magnetic field and spread out inside. (This is called entropy trapping, but that's another story). Does it work? Well, that depends. It's a lot more complicated than we thought. At first, we nearly died of joy when the plasma was shot in and seemed to stay around for ages in our time scale (1000 microseconds), emitting light in the process. But when a magnetic probe was inserted, the harsh truth was revealed—the containment lasted only a few microseconds. In other words, the long time period we thought we had observed was merely cold plasma emitting light by recombination.

Just lately, however, Messrs. Hagerman and Osher have cleaned things up to the point that hot plasmas are pushing the field aside strongly and are keeping the inside field pushed aside for very satisfying periods, like 50 microseconds. Also, if we keep the magnetic probe out of the way of the plasma, it stays around longer, which is what it should do. This particular picket fence is a horror to keep a vacuum in, as it is completely overrun with O rings. The next one will be baked. Fun, eh?

What about the leaks in the fence? It is pretty leaky, but we think we have an answer to that too, so watch for the story on the TLC picket fence one of these days.

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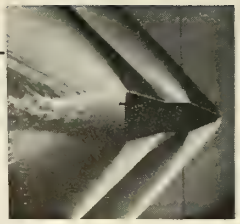
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THE COVER

An experimental Minuteman nose cone model is caught a fraction of a second after being fired from a light-gas gun at Avco's Ballistic Range. (Avco photo.)

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The Countdown

WASHINGTON

Polaris vs SAC

Chances are good the Eisenhower Administration will duck the prickly decision of whether to create a joint strategic command which would include control of the Navy's *Polaris* submarines (see p. 12). The Navy is understood to be deeply embroiled in a fight against such a move—on grounds such a command would be dominated by SAC. One of the key elements in the battle is money for more missile submarines. The Navy —to get the money—could be forced to capitulate.

ARM Becomes a Nose

The Air Force has dropped, at least for the present, plans to develop the ARM (anti-radar missile) into a full-fledged weapon system. Instead, just the anti-radar warhead will be developed and attached to the nose of such missiles as the North American *Hound Dog* and Douglas *Sky Bolt*.

B-70 Decision On Way

Insiders expect a decision from the Administration in short order on whether some or all of the extra $190 million to $290 million voted by Congress for the B-70 will be released. Any great delay now would make release of the money for the Mach 3 missile-bomber relatively meaningless.

Pershing's Secret Oomph

Despite what many say to keep within service "roles and missions" rules, the Army's *Pershing* has the power now to smack a target better than 500 miles away. Moreover, the *Pershing's* "350-mile range" is reported to be capable of being easily upgraded to 1000-miles.

Budget Thunderhead

Weather forecasting by satellite is in danger of being washed out by a budetary jurisdictional ruling. The Budget Bureau has turned down a Weather Bureau request for $5 million to capitalize on the *Tiros* program—claiming NASA should put up the money. But, NASA officials contend they haven't the funds—either—since the space agency's job is just R&D, not the establishment of an operational system for another government bureau. The Budget Bureau action has inspired top NASA officials to re-examine the agency's mission—with an eye toward changing FY budget requests due in October.

INDUSTRY

Super Sidewinder

Navy reportedly is developing a new, super version of *Sidewinder* at its China Lake ordnance test station. The new missile will have an improved rocket motor utilizing a graphite and phenolic-impregnated asbestos nozzle being produced by Horkey-Moore Associates, a subsidiary of Houston-Fearless Corp.

Giant Valves Installed

Elmco of Los Angeles is installing 11 of the largest cryogenic valves ever built at Edwards AFB Test Stand Bravo 2, which will be used to test the 1 and ½ million lb. thrust Rocketdyne F-1 engine. Made of stainless steel, the valves were designed by Vickery Co. of Oakland and manufactured under license by Pelton Co., San Francisco.

From Missiles to Cans

Reynolds Metals Co. is thinking of shifting operations at its Sheffield, Ala., plant—where *Redstone* boosters were produced—to the fabrication of either aluminum cans or automobile parts. Missiles frame manufacture shut down at the plant on July 1.

Help Wanted

NASA is seeking administrators for Project *Mercury* tracking stations in Faraway places: Zanzibar, Nigeria, Canary Islands and Mexico. Qualifications lean toward administrative, missile/space background and understanding of foreign relations. Salaries will be in $8000-$9000 bracket plus overseas pay benefits, according to NASA Langley Field Space Task Group Personnel Office, which is accepting applications.

INTERNATIONAL

French Put Up IRBM Money

Extra funds are being allocated the Service Des Poudres in the FY '61 French budget for facilities to develop solid propellant motors of 5 tons. There also is R&D money for 22-ton solid motors—indicating a serious backing of its IRBM program.

Fairey Selling Malkara

Australia has licensed Fairey Engineering Ltd. To sell the *Malkara* anti-tank missile in western countries except the United States, Britain, Australia and New Zealand. Fairey also has rights to sell the Australian Jindivik target drone in Europe.

Missiles in Portugal

There is some serious talk of stationing NATO intermediate range missiles in Portugal in the event France balks at allowing them in more preferable North African sites.

Navy Eyes $100 Million Range

Plan for '62 budget encompasses huge new ASW missile test range in Atlantic—AUTEC—and satellite-launching ship for orbiting Transit

by James Baar

The Navy is seriously weighing proposals to make two major additions to the nation's vast missile range empire.

One would be the construction of an ASW missile test range—possibly in the Bahama Islands.

The other would be the conversion of a Navy ship into a mobile satellite-launching platform.

The cost of the ASW test range is estimated at about $70 million. The cost of the ship is estimated at about $35 million.

Both programs are under consideration for inclusion in the Navy's FY 1962 budget which is now being put together.

Navy missile experts regard the building of an ASW test range as a basic requirement for the future development of anti-submarine missiles.

Firms already are making proposals for the range—called AUTEC, the Atlantic Underwater Test and Evaluation Center.

Present methods for fully testing ASW missiles are considered crude compared to the instrumentation available for the testing of missiles designed to fly in the atmosphere and space. An ASW test range would be equipped with instrumentation capable of providing minute data on the performance of a missile as it seeks and attacks its target underwater.



THE BAHAMAS are regarded by the Navy as an ideal possible site for a $70 million ASW missile test range. The range's center could be Exuma Island.

• **Exuma Sound site**—The ASW test range needed also must be large enough and deep enough to enable the simulation of tactical conditions. A range of this size is particularly desirable so that a missile's target can take normal evasive action.

Other ASW range requirements include the need for stable water and temperature, clear water and a minimum of current.

Some experts are understood to regard two sea areas southeast of Nassau in the British-owned Bahamas as particularly well suited for AUTEC, although there are a number of other possibilities.

The two Bahama areas—Exuma Sound and Tongue of the Ocean—flank the Exuma Cays and Great Exuma Island. Both the Sound and Tongue of the Ocean extend about 90 miles and have an average depth of about 5400 feet.

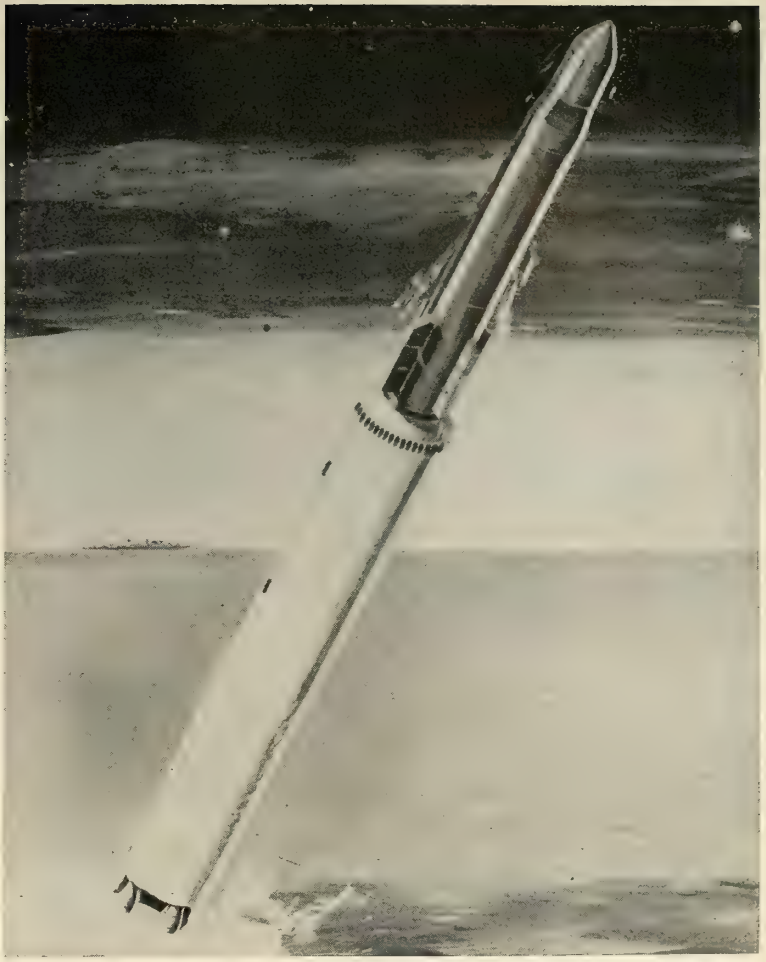
Such an area would be ideal for full-range testing of such an ASW missile as Goodyear's *Subroc* and its more advanced successors. *Subroc*, is undergoing late R&D testing, is reported to have a range of more than 20 miles.

The use of Exuma Sound and Tongue of the Ocean would call for negotiations with the British.

The United States already operates tracking stations including one on nearby Eleuthera as part of the Atlantic Missile Range and a now closed naval base on Great Exuma was leased to the United States by Britain for 99 years as part of the 1941 Destroyer Deal.

• **Transit launcher**—The proposal to build a satellite-launching ship is advocated on the grounds that such a ship would provide a platform from

Additions



SUB-KILLING SUBROC, a nuclear-tipped ASW missile in advanced development, is depicted in the first Navy-released artist's conception.

which sizeable payloads could be placed in any desired orbit. U.S. space programs would no longer be limited by the trajectories that can be obtained from Cape Canaveral and the Vandenberg AFB-Point Mugu pads on the East and West Coasts.

The launching ship would first be employed in firing operational *Transit* navigation satellites.

The operational *Transit* system in late 1962 calls for four 50-pound satellites: Two in an orbit with an inclination to the equator of about 70° two in an orbit of about 27°.

However, an orbit with an inclination of about 22 degrees for the second two *Transits* is considered preferable for obtaining maximum coverage of the earth's surface. *Transits* could be launched into the preferred orbit from a launching ship.

The Navy is considering construction of the launching ship by converting either an Albemarle or somewhat large Currituck Class seaplane tender. This has already been done once. A 9000-ton Currituck Class seaplane tender was converted into the Norton Sound which has been used for a number of missile tests including Project *Argus*—the high altitude nuclear blast tests in 1958.

The satellite-launching ship would have the capability of putting into orbits payloads up to about 200 pounds. It also might provide facilities for testing anti-missile missiles.

Both the ship and the ASW range are seen by many in the Navy as vital additions to U.S. missile and space programs in the decade of the '60's.

Institute of Space Law Up for IAF Consideration

The 11th International Astronautic Congress of the International Astronautical Federation is expected to attract more than 500 delegates to four lecture symposia. The Congress meets in Stockholm, Aug. 15-20.

Lecture series will include:

–A Space Law Colloquium dealing with international control of outer space and damages to third parties on the earth's surface caused by space vehicles.

–An Astrodynamics Colloquium covering orbit determination, perturbations and orbit optimization.

–A Space Medicine Symposium will feature lectures on man-machine systems in space vehicles, biodynamics of manned lunar landing and return, telemetering of physiological data from space capsules, and biological significance of space ambient radiations.

–A Small Sounding Rockets Symposium will discuss range and launching problems and instrumentation.

More than 80 papers are due to be delivered at the Congress which this year is expected to approve a constitution setting up an International Academy of Astronautics and a International Institute of Space Law.

Formation of the International Academy of Astronautics to provide world technical leadership for the peaceful conquering of space and to serve as a clearing house for astronautic information was proposed at the London Congress last year. Since then the Daniel and Florence Guggenheim Foundation has agreed to provide $75,000 for its operation during the first three years. After that the Academy is expected to support itself.

The International Institute of Space Law would replace the Permanent Legal Committee of the IAF. Former IAF President Andrew G. Haley of the American Rocket Society has pledged $35,000 to aid in the operation of the Institute for the first five years.

The Missile Week

GE Wins Titan II Nose Cone Contract

Missile and Space Vehicle Department, General Electric, Philadelphia, will develop the big Mark VI ablative-type nose cone for *Titan II*. This is a switch from Avco, which built the Mark IV re-entry vehicle used on *Titan I*.

Development of Mark VI, the biggest re-entry vehicle yet, will net GE many millions of dollars. The exact sum has not been disclosed. A contract is expected to be signed shortly.

$28 Million in Polaris Work to Northrop

Nortronics Division, Northrop Corp., last week received Navy contracts totaling $28 million for design, development and production of electronic components for the *Polaris* system. The work includes automatic checkout systems, gyroscopes, periscopes and radiometric sextant. Checkout system on the missile is produced by Northrop Systems Support Department, Anaheim, Calif. Submarine components are produced at Precision Products Department, Norwood, Mass.

Boeing Seeks 1000 Engineers

Boeing Airplane's Aero-Space Division is putting up a "help wanted" sign for 500 electrical and electronics engineers, 300 mechanical engineers and 200 structures engineers.

The new talent, said Stanley M. Little, division director of industrial relations, will be used on the *Minuteman* and *Dyna-Soar* projects and on Boeing's search for new products. Last year, the division added 1200 scientists and engineers to its current employe roll of 8200.

Nike-Zeus Component Work Authorized

Contracts totaling $18 million to establish pilot lines for manufacture of components for the Army's *Nike-Zeus* antimissile missile were awarded last week to Western Electric.

One contract, for $11,341,510, is for development and proofing of high-volume manufacturing and inspection techniques, special tooling, test equipment and facilities needed for critical components. Four other contracts, totaling $6,658,490, are for development of advanced techniques in producing vital electronic components.

Goodyear Aircraft and Douglas Aircraft will participate with Western Electric in work under the contracts, awarded by Army Signal Supply Agency, Philadelphia.

Minuteman Assembly Plant Construction to Start

Construction will begin late this month on the Boeing-operated *Minuteman* assembly plant at Hill Air Force Base, Utah. Although no expected completion date was announced, it was understood the plant is to be ready in about a year.

Atlas-Able Has Understudy Twin for Fall Shot

NASA has two backup payloads and one backup *Atlas-Able* available for its fall moon orbit shot. If the first shot, scheduled for around Oct. 1, should fail, the second *Atlas-Able* will be set up on the same pad at Cape Canaveral. This would take from a month to six weeks.

Paul F. Glaser, project engineer for Space Technology Laboratories, payload manufacturer, said last week that if the first shot is successful the second may be launched as an identical twin to double-check the measurements from the first shot. Glaser spoke before the American Electroplaters' Society in Los Angeles.

NASA spokesmen said no decision has been made on the idea of a twin shot.

ICBM Slippage

Industry Top Brass Called to Pentagon

The mass summoning of top ICBM contractors and labor officials to the Pentagon this last week underlined the serious affect of recent slippages in *Atlas* base construction.

Delays in completing ICBM launching sites at three missile bases—Vandenberg, Offutt, and Warren—put the first sizeable deployment of *Atlases* back nearly a half year. More than 30 *Atlas* sites are involved.

As one insider put it: "With the numbers of missiles we're building we just can't afford that sort of thing."

Defense Secretary Thomas Gates summoned the heads of 49 companies holding contracts connected with the construction, installation and checkout of ICBM bases. He also invited AFL-CIO President George Meany.

The meeting—aimed at preventing further slippages and seeking possible ways to regain lost ground—was called against the background of preparations for the presidential election campaign in which U.S. missile strength is certain to be a major factor.

Gates' action followed a series of moves by the Air Force and Army Corps of Engineers designed to tighten schedules for ICBM base construction.

The Air Force transferred from the Air Research and Development Command to the Air Materiel Command the management responsibility for ICBM base construction except Vandenberg, Offutt and Warren.

The Army Corps of Engineers announced the establishment of a Ballistic Missile Construction Office at Los Angeles under command of Brig. Gen. Alvin Welling. The Army said the new office "is being established to further streamline, strengthen and expedite" ICBM base construction.

Missile Price List

Latest official cost figures on the *Atlas, Titan, Minuteman* and *Polaris* programs show:

Hardened *Atlas* squadrons will cost $152 million each.

Hardened *Titan* squadrons will cost about $138 million each.

Hardened *Minuteman* squadrons are expected to cost about $58 million each. (All of these figures cover for the most part the bases and production-line missiles, not R&D.)

Total cost of a fleet of 45 *Polaris* submarines equipped with missiles is placed at $8.6 billion. (This figure includes R&D.)



HOUSING PROBLEM in Los Alamos, where millions are spent to make rockets, but little is spent to house rocket makers.

Housing Shortage Hamstrings Rover

Los Alamos Director fears loss of key personnel because of substandard living conditions

by Frank G. McGuire

LOS ALAMOS, N.M.—The U.S. effort to build a nuclear rocket is threatened with serious delay because of a failure to build a few houses.

This is the opinion of Dr. Norris E. Bradbury, director of the $270 million Los Alamos Scientific Laboratory where the *Rover* nuclear rocket is being developed.

Dr. Bradbury's 3200 charges—some of the best nuclear rocket experts in the world—are living in substandard housing, all of it hard-to-get. They are beginning to heed private industry's offers of higher pay and better living conditions elsewhere.

The problem will become worse because of LASL's need to acquire 600 to 900 more personnel. The Laboratory has tentatively hired 300 new employees who can't start work because they have no place to live.

• **Source of difficulty**—According to LASL officials, the government doesn't want to build houses because that might hurt private enterprise. Private contractors don't want to build houses in Los Alamos because the buyers can't get government loans. So the housing doesn't get built and the Laboratory's turnover increases.

The *Rover* nuclear rocket is presently scheduled to fly by 1965. Some LASL optimists believe this can be done by 1962. But the project will be seriously delayed, LASL officials believe, if they can't hold onto all of their present personnel as well as hire new talent.

"We have the technology, the facilities, and the potential funding," one LASL official said, "but we're hamstrung by as incredible a reason as housing."

"All I can predict now with certainty," Dr. Bradbury warned, "is trouble for the future, accelerating with passage of time; avoidable only by prompt and possible drastic action in the form of extensive housing construction and maintenance."

"We must have action on this program, anywhere we can get it, from anyone who will listen, and at the earliest possible moment."

• **How bad is it?**—Presently LASL employees are housed in everything from modified WW II barracks to trailers.

The rare house that becomes available is rationed on a point system. An employee gets one point for each dollar he makes per month and two points for each month of service up to ten years.

For example, a Ph.D. who was employed recently makes $750 per month and has 750 points. This puts him in 526th place on any waiting list for a single three-bedroom house.

Many who have been with LASL for several years have piled up over 1000 points. There are now 300 of these people—and six vacancies.

Furthermore, recent surveys show that almost every lucky LASL member who has some place to lodge his family is living in housing far below what he could afford in any other area of the country.

All attempts to interest private contractors into building new houses have failed.

In February, the Atomic Energy Commission invited bids from over 250 private contractors to develop a housing area near the Laboratory.

Not one bid was received.

When asked why, the contractors replied that the Federal Housing Administration had refused to guarantee home loans in the area, thereby making the enterprise too risky.

• **Four years in making**—The government on the other hand, refuses to build the houses because they don't want to deter private industry.

This situation was predicted by LASL over four years ago in a set of recommendations to the AEC. But only one of the four recommendations—the modification of existing housing—was achieved.

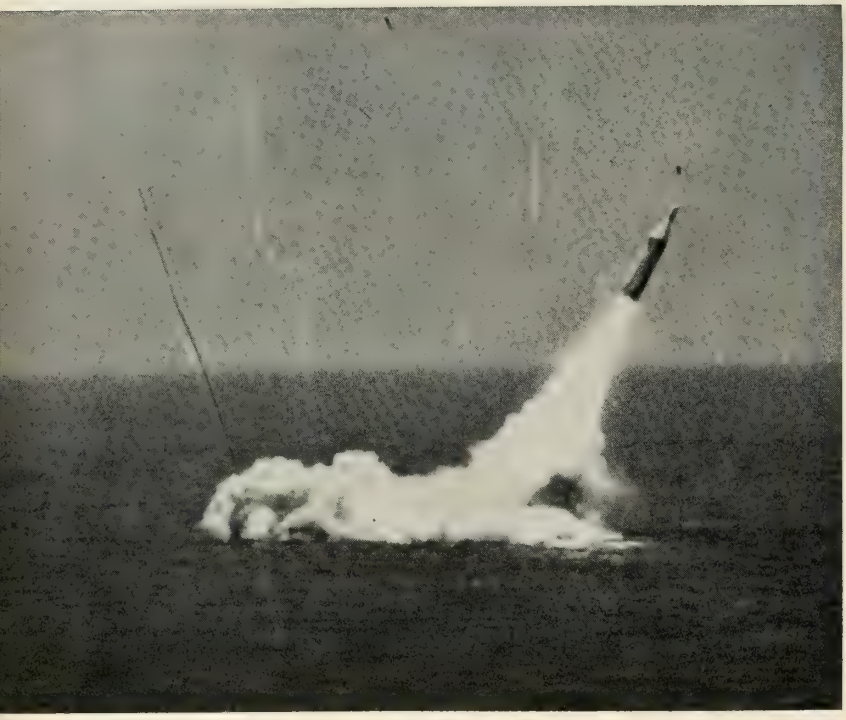
LASL has proposed that $2 million be spent annually for ten years, or $20 million be appropriated in a lump sum to remedy the situation.

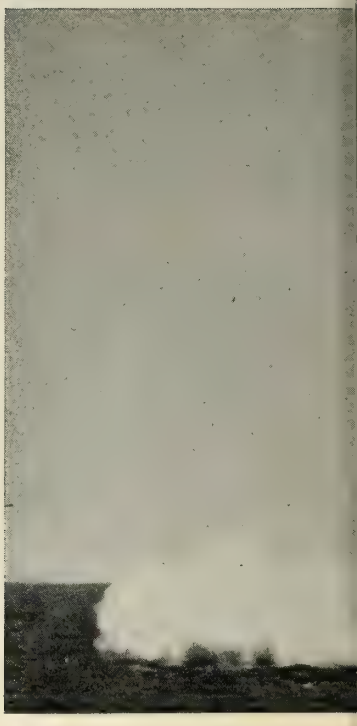
The government has refused to appropriate the money, and so far has only agreed to make some modifications in the barracks-type housing now in use.

In other words, the government is willing to pour $270 million into a facility, $60 millions into its programs annually, but refuses to spend $20 million to house its employees.

As one LASL employee bitterly put it, "Los Alamos may become the most expensive and best equipped ghost town in the West."

Next Administration May Inherit Polari





Polaris: Up from the Deep

The first Polaris to be launched from a submerged submarine ripped through the surface of the sea off Cape Canaveral at a sharp angle, ignited and swiftly righted itself. Shot No. 2 the same day—July 20—burst straight up through the surface (far right). Both landed in the target area more than 1100 statute miles downrange.

One of the hottest bequests that the Eisenhower Administration may leave for its successor is the decision whether all U.S. strategic missiles should be placed under a joint command.

The issue is being debated in the Pentagon in the wake of the complete success of the Navy's "proof of the pudding" launchings of *Polarises* from beneath the surface of the Atlantic by the nuclear-powered sub George Washington.

The Air Force has been pressing intermittantly since last year for the creation of a Joint Strategic Command which would control SAC's bomber fleet and ICBM bases as well as the Navy's fleet of *Polaris*-launching submarines. The Navy has fought the proposal at every step.

So far the Navy has succeeded and is continuing to push for the creation of a 45 ship fleet of *Polaris* submarines that would operate as an integral part of U.S. Naval forces. This last week the Navy took several new steps toward its goal:

–Contracts were awarded for three more *Polaris* submarines. A $60,113,000 contract went to Electric Boat for two ships; a $32,405,000 went to Newport News Shipbuilding for one. That brought to 14 the total number of *Polaris* subs built, under construction or for which contracts have been let.

–The Navy disclosed that there would be no delay in constructing the two extra *Polaris* subs that Congress authorized and the Administration finally approved despite earlier objections. Long lead time items had not been previously procured for them—a possibly delaying factor. But the Navy said it planned to use the long lead time items ordered for two nuclear-powered attack submarines previously planned but later scratched by the Administration.

–Testing of the George Washington continued at Cape Canaveral. The George Washington and her sister ship, the Patrick Henry, are expected to launch more than a dozen *Polarises* from underwater before going on station later this year. The Patrick Henry, which has been undergoing testing at New London, sailed to Newport, R.I., to launch a Sabot slug as President Eisenhower watched.

• **Targets at issue**—One of the principal issues involved in the Air Force-Navy fight over a possible Joint Strategic Command is the so-called targeting issue. In effect, this is who is to be assigned to hit which target.

The Air Force contends that a Joint Command is needed to make these assignments and to make certain that targets will be covered when forces assigned to them are knocked out in an initial attack. The Navy contends target assignments can be made by the Joint Chiefs and that the *Polaris*

Control Issue



submarines can only operate at peak effectiveness as part of the overall fleet.

The Air Force is seeking to resolve the issue before the first *Polaris* submarine goes on station. This is scheduled to happen in October.

But even if the Defense Department were to reach a decision there is some question whether it would be upheld by the next Administration. Therefore, the chances that the decision will be allowed to slip are considered good.

The new Secretary of Defense and the White House probably then will face the question in January.

Pressing for Polaris Funds

Rear Adm. William F. Raborn said last week the Navy could develop a 2500-mile *Polaris* by 1964 if given the money. He said the increased range could increase *Polaris* submarines' hiding area from 3 million to 9 million sq. mi.

Asked whether he is seeking *Minuteman* money, Raborn replied; "The Navy is a poor service. We'll take money wherever we can get it."



international . . .

Germany Bankrupt in Space Scientists

Migration of Rocket Talent to U.S. and Russia puts Bonn 10 years behind in space exploration

by Clarke Newlon

BONN, GERMANY—West Germany cannot make an important contribution to space exploration now and will not be able to for another ten years in the opinion of both government officials and the scientific community here.

While none were willing to be quoted by name, there was a general unanimity of opinion that West Germany had neither the scientific manpower nor the equipment essential to space exploration. Said one government official:

"There isn't a man in West Germany—not one—with the training and knowledge necessary to achieve any success in the space field. We had them once but now they are all either in Russia or the United States."

Asked whether any of the young German scientists who have migrated to the U.S., including some who have joined the Von Braun team at Huntsville, might return to form a space cadre, the official shook his head.

• **U.S. years ahead**—"They will stay in the States," he said, "because there is more opportunity there. Your country is 10 years ahead of us—even if we started now. And there is always the question of money—we do not have it."

England recently announced that she intended to enter the space exploration field, using the *Blue Streak* as a basic booster. The announcement said that Australia and Canada would merge their efforts with Britain and that probably France and West Germany would be invited to join the combine.

There was considerable doubt in the minds of German scientists that such an invitation would be accepted. Said one:

"Certainly we could build something for a space exploration vehicle. We could build, perhaps, a piece of guidance equipment or something in the electronics field.

"But it would be a hand-made article and the same device could be bought off the shelf in America much cheaper. We have not the tools. We have not done the research. We do not have the techniques.

"These things come with time, with study, with experience. Germany has none of these things and if we started now to acquire them it would take years and a great deal more money than our government has to spend on space."

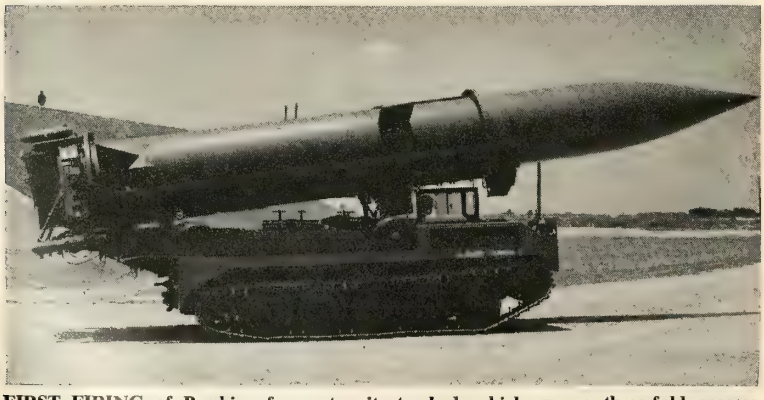
England's announcement indicated that she expected to spend 10 to 15 million pounds yearly on her program, for a total of perhaps 150 million pounds ($420 million). Presumably both Canada and Australia would contribute either money or equipment to the program.

• **French uninterested**—Political observers in Paris expressed doubt that the French government would be very interested in joining a combined space program headed by Britain and made up of Commonwealth nations.

"Any time Britain proposes a deal with the Continental nations she wants to control 51 percent of the stock," said one French politician. "France today is not in the mood to be a junior partner."

Notwithstanding these sentiments on the part of both France and Germany, there is little doubt that both governments would like to enter the space field in some manner. For, as the British government expressed it, any nation which does not must inevitably find itself a second class power eventually. Neither France nor West Germany is prepared to face this.

Launch from Tracked Vehicle



FIRST FIRING of Pershing from atop its tracked vehicle was a three-fold success. Selective range missile weathered "wind" variables thrown at it and TAPCO transporter-erector-launcher functioned successfully. 17-ft. long tracked carrier can travel at 40-mph over any terrain. Known as XM 474, vehicle is product of Food Machinery & Chemical Corp. of San Jose, Calif.

DOD's Secret Files Just Grow and Grow

A House Subcommittee has charged the Eisenhower administration with manipulating the "secret" stamp to its own advantage and creating a monumental pileup of classified documents.

Congressman John E. Moss (D-Calif.), chairman of the Government Information Subcommittee says the Pentagon has been a prime offender in withholding information vital to the public.

Summing up a five-year study of classification procedures, Moss found that "in too many cases, 'secret' was stamped on Pentagon information until the appropriate moment that the announcement would have the greatest propaganda effect on the American people."

He cites a case in which unclassified *Titan* ICBM pictures were withheld by DOD, claiming it wanted to avoid "ballyhoo" of untested missiles. However, the pictures were released "with political effect just before election."

In another instance unclassified *Nike-Zeus* photos were refused to the press with the explanation that no official pictures would be released until it was certain the missile would work. Result: pictures were released with "publicity fanfare 5 months after military declassification."

The committee's report came on the heels of Democratic Convention accusations that the Administration had purposely withheld non-security information which might discredit it in the eyes of the public.

Moss' committee studied 174 cases of classification by the Executive branch which were protested by outside agencies—mostly by Congressional committees and the press. In more than half the cases, the classified status was found to be unnecessary and harmful. These cases included the withholding of information to bidders on an unclassified *Nike* site for "security reasons;" and the refusal to release unclassified reports of conflicting testimony on DOD projects.

Classified documents are being stockpiled at the rate of 1373 feet a week, Congressman Moss found. A one million-cubic-foot stockpile of classified documents has been created since W.W.II—three times as much as that created from the inception of the system in 1907 until 1946.

PENTAGON DEFENDS CPFF CONTRACTS

The running battle between Congress and the Pentagon over the merits of negotiated contracts continued last week with DOD issuing a defense of its present procurement policies.

The DOD statement was precipitated by recent moves in both the House and the Senate to restrict the use of negotiated and incentive contracts in defense spending. Presently, about 85 percent of all defense dollars are spent through negotiated contracts.

Basically, the DOD argument was that:

–Competitive, formally advertised contracts are impossible in most cases;

–Negotiated contracts are the most effective and practical way to procure defense components;

–There is a great deal of competition in the negotiated contract method which Congressional critics have overlooked.

"Formal advertising," the DOD argument contended, "is inappropriate because it would require static specifications which would yield obsolete equipment. It would preclude placing contracts with companies offering the most advanced design."

The DOD argument also contends that competition is present in about 88 percent of all DOD negotiated contracts —usually at the design or technical level.

Cited as an example of the competitive quality of negotiated contracts was the procurement of *Mauler*, where the DOD statement points out that ninety-seven firms were briefed on the project, and thirty-one submitted proposals.

After intensive technical and military evaluation by defense agencies and non-government consultants, according to the statement a committee was formed which eventually picked four of the thirty-five companies to do feasibility study contracts.

Only after this entire process during which competition was present, was further evaluation and review conducted "which resulted in selection of a single contractor to handle the project."

Gas Generator Eliminated From Turbo-Fed Engine

Rocketdyne engineers have succeeded in eliminating the gas generator in turbo-fed liquid propellant engines.

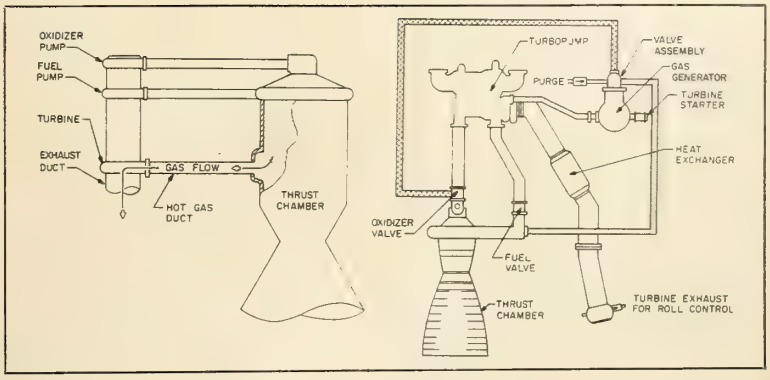
The simplification is obtained by tapping the main thrust chamber to get hot gases needed to drive the turbo pump.

Sixty-four tests with a modified MA-2 sustainer engine using liquid oxygen and RP-1 demonstrated the feasibility of the tap-off system. Performance of the modified engine was found to be comparable to a conventional propulsion plant.

The Rocketdyne system uses a solid propellant spinner to start the pump. After starter burn-out, the tapped gases take over.

The main benefit derived from the development is increased reliability. Removal of the gas generator is the equivalent of a 60% reduction in potential problems.

The work was performed under contract to the Ballistic Missile Division of the Air Research and Development Command.



SIMPLIFIED gas tap-off (at left) needs a solid-fuel starter.

Right Road to Rocket Reliability

Expert decries reliance upon flight testing—says 'Destructive thinking' dominates test philosophy

by Kermit Skeie*

With the tremendous expense of R&D and production of a missile or space system, why do we deliberately destroy it to prove that one inexpensive component will fail?

I understand this is called failure analysis. Broken down, it would be defined as "let something fail," then go back and find out what went wrong.

We spend millions on telemetry test equipment, so that after a $5 million missile explodes on the pad we can find out what went wrong. Then often we repeat the process for another part.

It appears that destructive thinking dominates our Space Age test philosophy—with destructive testing and failure analysis concepts.

• **Earlier tests needed**—under present design methods, certainly some failure is bound to result when 100,000 and more components must operate together. But isn't there some way that many of the failures can be predicted and prevented *before* flight tests?

In a recent issue of an industry publication, a reliability engineer in one of our largest missile companies wrote:

"Failure is the measurement of reliability—you cannot get any measurement of a device's reliability without some record of the number of failures as compared with the number of successes."

On the other hand, in a current issue of a trade journal, an advertisement by a leading component company caught my eye. It stated that destructive testing was the only sure way to determine fatigue characteristics. "Testing must be ceaseless . . . ruthless," the ad explained. "We must destroy enough of each lot so that we can be assured of the fatigue strength of the others . . ."

The paradox in these two viewpoints is quite fascinating. We can only insure absolute reliability through destructive means, but if we get "absolute" reliability—and we all know we won't—how can we get the failures to measure against the successes, to measure "absolute" reliability?

• **Development costs could drop**—The stated policy of the U.S. Air Force is to bring down the high costs of missile development, much of which is caused by the breakdown of individual components of individual parts. Justifying a $5 million explosion to prove the reliability of a part worth a fraction of the total cost of the weapon, is hard to swallow. I'm all for flight testing of the nondestructive type that accomplishes the planned objective. The announced Air Force policy and intent to bring down the fantastically high cost of missile development is extremely gratifying.

A flight test program should be planned to prove the concept of the design. Once a weapon system reaches the launch pad, the dependability of the components should already be established. The launch should be the final step to find how all components will work in relation to each other, as a system.

Component failure appears to be the principal cause of launch fiascos. These tiny failures—an airframe becoming unsoldered, a leak in a fuel hose, a cracked connector, a leak in a glass to metal seal that can turn a well adjusted guidance system into a neurotic circuit—cause the obliteration of thousands of man-hours, millions of dollars, and months of precious time.

These tiny failures do not suddenly develop on the launching pad. They may be designed into the individual components from the first line on paper. They may be born in the materials, passed on into the structures and explode in the system.

A concept is fine but it will never be a reliable system as long as basic defects are perpetuated. A concept is only as good as the sum of its parts.

• **Planned to fail**—Let me give you an example of how to design in failure. In this instance the engineers had actually designed in structure failure. The detail design had two guaranteed, built-in defects that could not fail to fail. In order to insure "reliability," the design called for far too much weld metal to be deposited, causing lack of fusion in the weld—a carefully engineered, man-made crack.

Not only that, but the design of this structure was such that it was virtually impossible to apply any known means of non-destructive testing satisfactorily at that late date—the only possible way to assure the absence of relevant defects.

The reliability engineer I quoted before would have ample factors for measuring reliability—he'd have more than enough failures for his measurements.

• **Specs a real goal?**—Is it possible we are more anxious to get past a component test requirement in a specification, rather than to assure ourselves that the part will perform its ultimate function?

The design engineer wants satisfactory performance—the military assurance of reliability—but both at any cost?

The designers take these failures to get performance, too often with reliability shelved until the goal is achieved. Then, with a lack of cost consciousness they try to design the reliability back into the system after performance is attained.

The present schedule in developing a system seems to me to be, all too frequently, this: design, develop, produce and then prescribe the test methods to insure reliability.

Tremendous economies can be realized and reasonable reliability of components achieved by developing test processes concurrently, rather than after, the conception of a design.

Design and flight test engineers want dependability but don't know how to get it without sacrificing the predictable performance—their basic objective.

**Mr. Skeie is Director of Services for Magnaflux Corp., a General Mills subsidiary.*

• **Need real approach to materials**—All materials are imperfect, full of irregularities. For instance, it has been noted experimentally that a single crystal of pure iron has a tensile strength of one million psi. This is pure, unalloyed iron.

So engineers start out on a foundation of imperfection and those imperfections are perpetuated on into a missile or space system. The design compounds those defects by making inadequate provision for those inherent irregularities or too much provision. This is called a factor of safety, but I call it a "factor of ignorance."

It's inconsequential whether this ignorance factor is 1.01:1 or 6:1 since the concept is a protective one.

The Aerospace industry has few standards on type and extent of irregularity that can be tolerated and practically no standards for the new exotic metals and alloys in use today—nor do they have methods to establish a code of standards.

• **Impact test for steel?**—For example, a measure of toughness utilized, historically, is an impact test and it is still prescribed. What is the use of an impact test on high strength steels, which has no need for purely impact properties?

How much money do you think could be saved if test methods—nondestructive test methods—were developed along with the design? How much time would be saved if minor modifications were made at an early stage to accommodate such testing, rather than complete redesign after the system is assembled?

• **Solution offered**—Design engineers should never call out the type of tests. They shouldn't be expected to know enough about the theories, the methods, nor the limitations of these tests. The function of the designer should be to prescribe the objectives he wishes to achieve by such testing and leave it to the quality control or nondestructive test engineer to meet those objectives.

Space technology has advanced much too far, too fast, for handbook concepts. The test procedures must be tailored to fit the exploding technology. The design engineer has stated objectives in his design criteria; let him leave the assurance of achieving them to those who know more about the performance of the materials.

• **New design-team member**—I urge that a quality control, specifically a nondestructive test engineer be added to the design team. Two or three major concerns in this industry who have adopted such an approach.

The designer is not looking for trouble. He assumes the homogeneity of the structure because the published or lab data are all he has to go by. But there may be trouble in the materials. We try to accommodate rigid test procedures from obsolete MIL Specs to a rigid design. We should expect inadequate performance.

The addition of a nondestructive test engineer to the design team might help fill that chasm between design, development and operational reliability. It would provide a system of checks and balances in the design of a space vehicle.

He can help bridge the communication problem. I have had conferences with high level design engineers who assured me they had no material problems. Then I met with reliability engineers who listed twenty-four acute problems in testing of materials and structures on the same missile project—existing hardware.

What can a mere nondestructive test engineer contribute to the knowledge of the designer? The answer may be nothing—but he does know something the designer doesn't—the design may be perfect on paper, but the materials aren't.

• **Not a new idea**—I confess there's nothing new about this concept. I've stolen it from the tractor industry, where test engineers have been kibitzing the designers for many years!

One manufacturer of steering parts inspects the same component three times, looking for one abnormality in 30,000. Why? One failure could result in a $500,000 law suit. One missile failure only costs $5 million, but then that's tax money.

I wonder what would be the result if DOD required just the same warranty you get with even a compact car—90 day or 4000 miles.

With 80% or so of a missile system on the ground, I should imagine that at least as much preventive maintenance is practiced on these facilities as is in the oil industry. Yet, I read this in the L. A. *Times:* "As the Atlas lifted off the pad the arm tore through the metal skin and ripped apart the pressure system tubing. Investigation disclosed two bolts in the arm had sheared from metal fatigue."

• **Thinking must change**—I've heard it said that we aren't interested in the measurement of moduli of materials dynamically because all our data and design criteria are based upon moduli obtained statically. Today it is possible to measure moduli dynamically on a structure itself, and survey the entire structure.

Or hardness testing—who needs it? Less than 5% of specs calling for hardness want hardness per se. Besides, it can't be nondestructive. Less than two months ago I encountered a requirement for hardness on a sintered beryllium alloy! The property this designer wished to measure was density, or homogeneity of structure. We stick to superficial hardness measurement of high strength fasteners because it's too much trouble to change the spec.

Or high strength steels for missile cases, thousands upon thousands are being spent in development of a repetitive destructive test to measure toughness on test sample of the material. All effort is put forth on developing the destructive test on samples and, to my knowledge, none on a nondestructive test on structures. True, no failure of a missile has been attributed to case failure, but how many thousands do they blow up on hydro test to achieve this record.

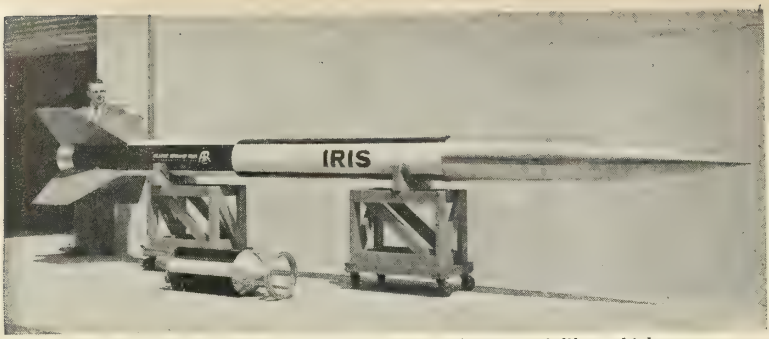
The hydrostatic test itself. Does this furnish the information we wish to know? Is it a liability in reliability? Most people say "it's the best we have." That's status quo thinking. One manufacturer of line pipe reduced hydro test failures from 15% to 0.3% by applying a nondestructive testing technique, that is not yet being employed as a production test to steel missile cases.

I feel that more than third of the failures can be prevented right on the design board. We know that nearly one-half of the missiles being fabricated, assembled and produced today can be counted out before the countdown.

Even if I'm half wrong—we'll still be 50% ahead of where we are today. Let's learn something from our biggest failure—the failure to recognize that we cannot afford failure analysis on complete systems.

Rules for Reliability

- **Develop test processes concurrently, rather than after the conception of a design.**
- **Stop trying to accommodate rigid test procedures from obsolete MIL Specs to rigid designs—tailor test processes to fit the design.**
- **Set up realistic standards for the new exotic metals and alloys**
- **Design non-destructive tests for structures.**



IRIS sounding rocket was developed at about ½ the cost of like vehicles.

NASA's Iris Rocket Lifts 150 pounds 140 miles

The National Aeronautics and Space Administration last week reported a highly successful first test of the Atlantic Research *Iris* solid-propellant rocket, a sounding vehicle designed to carry a payload of 100 lbs. to an altitude of about 200 miles.

In the test from Wallops Island, Va., July 22, the test *Iris* carried 150 lbs. of instruments to an altitude of 140 statute miles and impacted 210 miles from the launch site.

NASA said *Iris* was developed at a cost of about half of that for sounding rockets in its class used at present. The first shot in a series of three for the preflight rating test was a test of flight performance, acceleration, rotation, aerodynamic loading and aerodynamic heating of nose cone and fins.

Iris, which weighs 1216 lbs. exclusive of payload, is about 20 ft. long and has 12½ in. diameter, 46½ in. fin span and an 80 in.-long nose section. In the test, the rocket burned at an average thrust of 3800 lbs. for 62 seconds and lifted the payload to 28 miles altitude and a velocity of 6774 ft/sec at burnout.

Because of the slow-burning polyvinyl chloride propellant, a booster section was attached. The booster, which burned for about one second, gave an 18,000-lb. initial total thrust and then dropped off at burnout. The booster was a cluster of seven small rockets.

Iris was developed under a Navy contract, which was taken over by NASA last year.

Robert A. Wasel, acting chief of solid rockets, said NASA officials were surprised and pleased by the rocket's excellent performance on its first flight. He said the flight followed a series of six successful static tests.

The booster cluster was added to give enough initial velocity to overcome the problem of dispersion at Wallops, Wasel explained. The booster burns out before the *Iris* leaves the launch tower and drops off as a result of the continued thrust of the main stage.

Wasel said a low-thrust, long-burning rocket is preferred for sounding applications because the lower speed results in less atmospheric resistance and aerodynamic heading of the fins, and part of the burning takes place in a near vacuum, where the rocket is more efficient.

Scout Was Okay

Wrong Radar Signal Blamed for Failure

A sudden radar signal shift has been pinpointed as the reason for lack of complete success of the July 1 *Scout* launching.

The National Aeronautics and Space Administration said the all-solid vehicle did not actually change direction as indicated by the radar and the fourth stage could have been allowed to fire without danger.

The third and fourth stages reached an altitude of 860 miles and 1500 down the Atlantic Missile Range from the NASA station at Wallops Island, Va. With fourth-stage separation and burning, the instrumented payload would have gone to an altitude of 2300 miles and 4700 miles downrange.

Examination of telemetry data revealed three areas requiring detailed examination and possible modification in the *Scout* vehicle. They were:

- The protective covering of the third-stage motor, which normally would be jettisoned at third-stage ignition, came off as the vehicle passed through the transonic flight zone during first-stage burning. However, flight was apparently not affected by the premature loss of the shield.
- Vibration higher than had been anticipated was recorded toward the end of third-stage burning. No failures were known to have occurred as a result of the excessive vibration.
- Third-stage roll control was overpowered, probably by a torque just prior to burnout. The motor rolled beyond its limits during burning but roll, pitch and yaw control performed normally after burnout.

The July 1 test was the first powered flight of the third-stage *Antares,* a motor developed by Allegany Ballistics Laboratory, a Navy installation operated by Hercules Powder Co., especially for *Scout.* The three other stages are motors adapted from other programs.

NASA said the telemetry showed that performance of the first three stages was completely satisfactory except for the excessive third-stage roll. A spokesman indicated that the next *Scout* test will be held in the last quarter of the year.

General Electric Reduces Tunnel Diode Price 93%

The price of gallium arsenide tunnel diodes has been reduced 93% by General Electric.

At the same time, the company announced five new types of the gallium arsenide devices. The start of a volume market for the newly developed electronic components was cited as responsible for the price cut.

Two older GE gallium arsenide tunnel diode models previously selling for $55 and $85 are now $4.50 and $6 each in large quantities. Prices of the five new gallium arsenide diodes range from $7.50 to $18 each in large quantities.

GE predicted further price reductions as production volume picks up and estimated that tunnel diodes will be selling for under $1 each by 1962.

Production Run Completed For Canadian ASW Planes

The last of 33 Canadair CL-28 Argus antisubmarine airplanes built for the Royal Canadian Air Force under contracts totalling $170 million, rolled off the assembly line last week.

Argus airplanes have been in service with the RCAF Maritime Air Command since late 1957 and on July 1 had flown more than 4,700,000 miles.

On a recent routine mission an Argus was airborne for 26¼ hours and flew about 6000 miles. Developed to meet the increasingly serious threat of long-range submarines, the Argus mounts a highly sophisticated search and attack weapon system.

Dark Horse Douglas Wins 'Missileer'

Douglas Aircraft Co. emerged winner with the much sought-after Navy contract for "Missileer," launching aircraft for the *Eagle* long-range, air-to-air missile.

The award culminated a lengthy competition in which Chance Vought Aircraft and Grumman Aircraft looked by many to be prime contenders. Missileer is the only new military aircraft design proposed by the Pentagon this year.

Combined development costs for Missileer and *Eagle* have been estimated by Vice Adm. J. T. Hayward, deputy chief of Naval operations for development, to run as high as $3.4 billion. The development expert's figure differs with the official Navy forecast of $2.7 billion. Contract amounts for the Missileer development program has not been disclosed.

Missileer will be carrier-based, and although little has been made official, it is expected to fly a continuous air-alert around carriers and provide defense for Marines landing.

Two TF30-P-2 turbofan engines are now under development by Pratt & Whitney to power the subsonic aircraft.

Bendix is prime for the 100-mile *Eagle* missile. Subcontractors include: Grumman Aircraft Engineering Corp., air frame and propulsion; Litton Industries, computer; Bendix systems division, fire control system; Saunders Associates, missile seeker Aerojet General, propulsion and Westinghouse, radar.

mergers and expansions

CHANCE VOUGHT ELECTRONICS will establish a $3.5 million facility in the Great Southwest industrial district between Dallas and Fort Worth. An 80,000 sq. foot building to cost 1.5 million is now under construction. Special equipment costing approximately $2 million will be housed here.

GENERAL INSTRUMENT and GENERAL TRANSISTOR Corp. stockholders will vote on a merger agreement at separate meetings August 30. The agreement calls for the merger of General Transistor into General Instrument, with the issuance of .7 shares of General Instrument common stock for each outstanding share of General Transistor common.

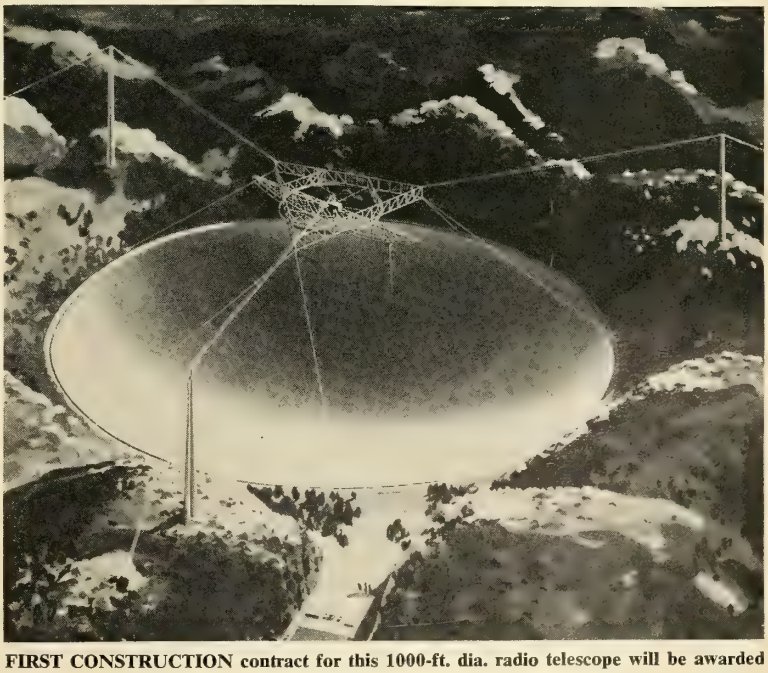
SYLVANIA ELECTRIC PRODUCTS—Advanced Device Research Laboratory of the Semiconductor Division has been moved from Northlake, Ill., to Waltham, Mass. The move was made to bring the laboratory closer to the Woburn headquarters of the Semiconductor Division, where it is expected it will be relocated by 1961.

UNITED CONTROL CORP. adds its third firm this year with the merger of Smith-Florence Inc., a firm specializing in the design and manufacture of laboratory and field-service instrumentation. Smith-Florence, located in Seattle's Commodore Industrial District, will remain a separate organization and be headed by Robert E. Florence, one of the founders of the firm.

A. O. SMITH CORP. has acquired 50% interest in the Bissett-Berman Corp. of Los Angeles. Bissett-Berman was organized by Thomas B. Bissett and Bernard Berman, research scientists who had been associated with Thompson Ramo Wooldridge. The firm will offer advanced electronic equipment for military requirements and some commercial applications.

MB ELECTRONICS, a division of Textron Electronics, Inc. has established a laboratory for calibrating and certifying transducers. The facility reports it is geared to calibrate and ship transducers within two weeks.

HUGHES AIRCRAFT CO. has changed the name of its Airborne Systems Group to Aerospace Group. Included in this unit are engineering and flight test divisions at Culver City, the El Segundo manufacturing division, the communications division and



FIRST CONSTRUCTION contract for this 1000-ft. dia. radio telescope will be awarded this month by the Air Force's Cambridge Research Center. Located below Arecibo on the north coast of Puerto Rico, the $3.2 million mesh reflector will be built within a natural sink-hole to minimize earth removal. An elaborate cable network will maintain the spherical surface within ±0.1 foot. Funded by Advanced Research Projects Agency, Cornell University is prime for the overall program. Total cost for the observatory will exceed $6 million. It is due for completion by July, 1961.

field service and support division at Los Angeles International Airport and missile manufacturing division at Tucson, Ariz. Some 16,000 persons are employed in these divisions.

UNIVERSITY OF MICHIGAN will begin construction on a $1.1 million Cyclotron Laboratory on its North Campus. The laboratory will house a $1.8 million cyclotron, financed by the U.S. Atomic Energy Commission, in addition to the University's present cyclotron.

ELECTRICABLE INC. a new electronic and instrumentation wire and cable manufacturer has been formed in North Hollywood. It will concentrate on bulk production of wires and cables to both military and commercial specifications and specialty material.

DACOM CORP., professional computing service for engineering, research and industry has been established in Buffalo, N.Y. Dacom offers services in stress analysis, shaft vibration analysis, test data reduction, table generation (fans, compressors), structural analysis (two or three dimensional), pipe stress analysis (three dimensional) electrical network analysis. President William H. Mestler reports that the complete staff of MIT is available to the company for support research.

DEVELOPMENTAL ENG. CORP. revealed plans for construction of a new laboratory at Boulder, Colo. DECO's main plant and laboratories are at Leesburg, Va., with executive offices in Washington, D.C.

COOKE ENG. CO. opened new offices last week in Alexandria, Va. The building contains 10,000 sq. feet.

A. T. PARKER & ASSOC. has been formed by A. T. Parker, former chief engineer for Stoddart Aircraft Radio Co., Inc. The Hollywood firm will offer consulting electronic engineering services for manufacturers interested in Radio Frequency measurement and control, especially for those interested in complying with military requirements.

VERNISTAT DIV. of Perkin-Elmer, producers of precision electronic components for space and defense programs, has established facilities at Los Angeles.

MINNESOTA MINING AND MANUFACTURING has purchased Revere Camera Co. of Chicago. The 21-year old firm is a supplier of movie cameras, projectors, recorders and related items. Wollensak Optical Co., Rochester, N.Y. is a subsidiary of Revere.

PORTLAND INDUSTRIES' new president Ira Kamen unveiled plans to develop the Portland, Maine complex into a scientific center for the production of products in space technology and sonar and nuclear fields. Goals of 30 million yearly volume and employment of 3000 people have been indicated.

HYDRO-AIRE CO., producers of controls for aircraft, missiles and trucks, has become part of the recently formed Systems and Controls Group of the Crane Co. Other divisions in the group include Chapman Valve Manufacturing Co., Indian Orchard, Mass., and Swartwout Co., Hooksett, N.H.

VECTOR MANUFACTURING CO. has broken ground for a 25,000-sq.-ft. Space Instrumentation Center in Trevose, Pa. The electronics components manufacturer also has facilities at Southampton and Churchville, Pa., and Grand Prairie, Tex.

financial

Douglas Aircraft Co., Inc.—A net loss of $1.8 million for the second quarter of FY 1960 ending May 31 was reported. Six months loss was $8.8 million, compared with a loss of $15 million for the first half of FY 1959. Total sales for the first half totaled $556.5 million compared with $447.9 million the previous year. Backlog stood at $1.3 billion compared to $1.4 billion backlog May 31, 1959. Missiles and space systems accounted for $503 million compared to $281 million a year ago.

National Research Corp.—Net profit for the first half of 1960 was reported at $99,290, compared to a net loss of $100,534 in the corresponding period last year. Profit for the full year 1959 was $17,356. Sales and income for the 1960 first half totaled $4.5 million, an increase of 43% over the same 1959 period.

Hagan Chemicals and Controls—Six months sales and revenues reached $20 million compared to $18.2 million the same period in 1959. Net income rose to $901,822 from $857,691.

Sparton Electronics Div.—A backlog of $7 million in defense contracts is reported by the division. Approximately $5 million was acquired during the month of June.

Clevite Corp.—First half sales and other revenues were $51.4 million, compared to $42.8 million the previous year's first half. Electronics divisions accounted for 40% of sales and almost half of pre-tax earnings. Combined electronics sales were up 60% from first-half 1959.

Titeflex Corp.—The company, with a history of loss, is converting into stock $5.8 million of indebtedness to Atlas Corp., at the rate of one share for every $25 of principal and interest now owned by Titeflex. Encouraging although small profits were reported by the company in April and May.

National Aeronautical Corp.—Net sales for six months ended May 31 amounted to $3.2 million, compared with $3.34 million for the same period last year. Net income amounted to $316,000 for the 1960 half-year, which falls under the $370,000 reported for the six months ended May 1959.

Aircraft Dynamics International—Aviation Investors of America offers for the first time 99,000 shares at $3 per share. The company sells aircraft spare parts, supplies and equipment to domestic and foreign airlines and air forces. The proceeds of the sale will be applied toward repayment of current liabilities and expanding inventories.

Aerojet to Earn $10 Million

Aerojet General will earn close to $10 million on sales of $425 million for the fiscal year ending November 30, according to vice president and general manager W. E. Zisch.

Zisch told a meeting of the Los Angeles Society of Security Analysists that the General Tire & Rubber Co. subsidiary would substantially increase its FY 1959 totals of $8.2 million income on $364.4 million sales.

Aerojet's six month's record showed a 29% increase in sales, but earnings rose only 16%. Zisch attributed this "profit deficiency" to the "closer competitive position into which all the companies in the aerospace industry are moving."

He marked the cost of sharing research and development work with the Government and emergence of many new companies into the missile field.



Out of today's space research come unexpected by-products—perhaps even space travel for the average citizen . . .

When only explorers dared cross darkest Africa, few foresaw it as a future vacationland. Outer Space now stands in a similar position.

What will Lunar vacations cost? When rocket development is written off and we have nuclear power, a traveler may go for about the present price of a tiger hunt or African safari!

At Douglas Aircraft, builder of the big DC-8 jets, practical steps to bring this about began 14 years ago when Douglas engineers designed and engineered a feasible space platform. Today, with more than 20,000 rockets under its belt—including the *Nike* series and *Thor*, reliable Space Age workhorse—Douglas is deep in a series of space age studies: the moon as a military base . . . compact space huts . . . how will man react to the space environment . . . what useable natural resources to expect . . . and, always, more efficient rockets for military, scientific, and peaceful needs.

The Douglas concept of a *complete* support system has resulted in space research ranging from nuclear rockets to nutrition for space travelers

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This is **Hipernas**, a self-compensating, pure inertial guidance system developed by Bell's Avionics Division. Designed for the U.S. Air Force, **Hipernas** is so versatile that a whole family of related systems has been engineered for application in any environment — sea, sky, or space.

The system introduces new Bell BRIG gyros. Its accelerometers and digital velocity meters are already operational in missile and space guidance systems.

Hipernas — and many other systems such as the Air Force GSN-5 and the Navy's SPN-10 All-Weather Automatic Landing Systems — typify Bell's capabilities in the broad field of electronics. This diversity of activities offers an interesting personal future to qualified engineers and scientists.

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BELL AEROSYSTEMS COMPANY

BUFFALO 5, N. Y.

Technical Countdown

PROPULSION

Phoenix Goes to 200 Miles

Rocket Power/Talco's *Phoenix* rocket carried an 11-lb. payload to an altitude of 1,067,000 ft. on its fifth flight from Point Mugu last month. The two-stage vehicle was developed at a cost of $150,000 in 3½ months. Operational shots from Wallops Island are scheduled soon.

New High-Energy Solids Show Promise

Three promising high-energy solid propellants have been developed by United Technology Corp. in a company-funded program. Although UTC will not disclose details, one of the three is a polyurethane which, while not a great improvement ballistically, represents a physical step forward. The other two, more exotic, are said to be considerable advances if tests now underway turn out as expected. (See story p. 32).

Polaris Energy 5 Megapound-seconds

Total energy released during full-duration operation of both motors in the interim tactical *Polaris* is more than five million pound-seconds, says Dr. Werner Kirchner, *Polaris* program director at Aerojet. This would indicate booster thrust of something over 80,000 lbs.

Start-Stop Feasible for Hybrid

Marquardt and Grand Central researchers believe they have demonstrated feasibility of instantaneous start and stop in a hybrid solid-liquid rocket. A nitrile rubber binder with aluminum powder and a heavy liquid oxidizer is used. Ignition is hypergolic and shutoff is complete with interruption of oxidizer flow, since there is no oxidizer in the solid grain.

Liquid Stand Tests Solid Nozzles

Aerojet saves money on testing nozzles for solid rockets by using a liquid-rocket test stand. Aluminum powder and other bits of solid matter are fed into the propellant mixture to simulate a solid-rocket flame—thus postponing the cost of casting a solid grain until later in the test program.

ELECTRONICS

IR to Measure Atmospheric Temperatures

Laboratory instrumentation to study the feasibility of a satellite-borne infrared spectrometer that would measure atmospheric temperatures is being developed by Barnes Engineering. The nine-month job, to be completed next March, will be done under an $80,000 contract with U.S. Weather Bureau.

Low-Noise TWT Developed

A 2.8 db terminal noise figure is being claimed by RCA for a modified production-line traveling wave tube. Such a noise performance improvement would significantly increase sensitivity and range of systems using TWTs.

Satellite Weathermen Sought

A new breed of meteorologist is being sought by the U.S. Weather Bureau to do research on interpretation of data from *Tiros* and future weather satellites. Positions open for meteorologists and physicists at Suitland, Md., will pay up to $10,635.

Doppler Radar Weather Techniques Developed

A method of using doppler radar data to extract meteorological information has been developed by Cornell Aeronautical Laboratory. Statistical formulas applied to the doppler spectrum from weather targets yield data on wind velocity, air turbulence, and precipitation rates.

GROUND SUPPORT EQUIPMENT

VERLORT Radars for Mercury

Delivery has begun on VERLORT (very long-range tracker) radars for Project *Mercury*. The Reeves Instrument trackers are reported to be capable of much higher precision than any previous long-range equipment.

China Lake Tracking to be Improved

Navy will streamline and modernize its EDP and missile-tracking equipment at NOTS China Lake under a new contract with Cubic Corp. Primary improvement is addition of a data digitalizing system to operate with present missile intercept data acquisition equipment and provide almost-instantaneous performance information.

ASW ENGINEERING

Raytheon ASW Center Begins Operation

Raytheon's Antisubmarine Warfare Center at Portsmouth, R.I., began operations last week with about 450 employees. Work of this integrated industrial facility, among other things, will be "triple-threat" sonars going on Tullibee and Thresher. Raytheon also is managing the 9 NATO nation ASW research center at La Spezia, Italy.

ADVANCED MATERIALS

Ti Scrap Recovered in Unique Furnace

Single pours of titanium up to 550 lbs. in weight have been achieved in a helium-cooled furnace at National Research Corp. The unique furnace combines the features of skull melting by permanent electrode with vacuum melting by consumable electrode.

Powder Metallurgy Boosts Tube Life

Electron tube cathodes fabricated by compacting metal powders of closely controlled composition have increased reliability, uniformity, and life span, according to Sylvania Electric. The procedure permits a high degree of control over the reducing agents.

Moly Drilled Without Crumbling

Picatinny Arsenal engineers have been drilling perfect 20-in. holes in molybdenum using commercial electrical discharge equipment and a copper-tungsten electrode. The cavity races through the moly at one inch per hour but generates little heat in the workpiece.

Hydrogen Embrittlement Eliminated

Forty-five minutes in a tumbling barrel containing water, a promoter chemical, an impact medium, and a specially prepared metal powder will result in corrosion-resistant metal-plated parts. The ingredients were whipped up by Minnesota Mining and Manufacturing and aimed at the plating of small complete parts and assemblies.

Parachute Recovery Systems Being Refined

Cook Electric leader in competition to recover big Saturn space booster

by Charles D. LaFond



FROGMEN ASSIST in first recovery of a *Jupiter C* nose cone. Cook's recovery package is attached to base of cone.

THE DEVELOPMENT and successful operation of parachute recovery systems represent an indispensable ingredient in missile/space technological progress.

By far the acknowledged leader in this field is Cook Electric Company's Research Laboratories, Morton Grove, Ill. Its record of accomplishment is difficult to refute since every ballistic missile nose cone recovered in the Free World so far has employed a Cook recovery system.

Among the many "firsts" chalked up by Cook are recovery of *Jupiter C* nose cone (1957), *Thor-Able* ICBM range re-entry cone (1959), full-scale *Atlas* cone, and instrumentation cassette from *Titan* nose cone.

An outgrowth of its early parachute research and development work, recovery systems research has also spawned a flock of test missiles at the Center: *Skokie, Hopi, Sioux, Cherokee, Portland* and *Cree*. Cook's Tomahawk supersonic test sled is another of its offspring along with five other special-purpose rocket sleds.

Employing FIST Ribbon parachutes, single and clustered, deployment inflated bags, and many other types of chutes (ring slot, solid flat, equiflo, airfoil, torus, etc.), recovery system configurations can vary, depending on the particular need. Retrorockets often provide extra deceleration capability, as does normal vehicle drag.

But, regardless of the configuration the essential requirement is that the system permit safe recovery.

• **Special test vehicles**—Early sled programs were started in 1950 to investigate sub-, trans-, and supersonic regimes. Later developments of a subsonic "whirl" tower and the unusual Tomahawk rocket sled contributed in no small measure to the division's rapid accumulation of parachute test data.

Located on a mesa, a unique monorail track permitted some of the first supersonic tests of parachute recovery by running the sled off a 1500-foot cliff before chute deployment. Track length is 10,000 feet.

The *Skokie* is a 32-foot near-sonic research vehicle loaded usually with cameras, electronic measuring and recording equipment. A free-fall missile, it is provided with a 3-in. diameter chrome steel spike on its nose to facilitate location and to minimize damage on impact.

Hundreds of B-29 dropped *Skokie* tests over the Mojave Desert have been

made from Edwards AFB during recent years to test parachute stability and performance characteristics.

Cherokee, a supersonic, rocket powered, air launched missile, is a special-purpose vehicle designed for pilot ejection and recovery systems testing. *Cree*, is a high altitude, high mach JATO boosted vehicle used to test clustered parachutes.

• **Past successes**—The variety of parachute-type recovery system applications handled by CRL has been very broad. These include:

–Re-entry nose cones
–Missiles
–Missile-dropped cameras (from *Navajo*)
–Instrumentation and equip. drops
–Bomb stabilization and deceleration
–High-mach stabilization and deceleration
–Pilot ejection
–Radiosonde rocket air-launch platform stabilization.

One of the first major nose cone recovery packages developed by Cook was for the Army Ballistic Missile Agency, Huntsville, Ala. This started with a test system for a *Jupiter* scale-model nose cone recovery and climaxed with the first re-entry nose cone recovery ever made—the *Jupiter C* cone and its instrumentation in August, 1957.

Another early recovery system was one designed to retrieve a camera and instrumentation package ejected from the *Navajo* ICBM. The system was deployed by an aneroid at a predetermined altitude.

Later, during the IGY, seven *Nike-Cajuns* were used for obtaining upper-atmosphere data photographically. Carried in the nose cone, the sealed capsule was recovered after 73.6 mile drop. A dive brake and parachute were used to recover the 85-lb. nose section. Six successes were recorded.

Other major recoveries include 1 *Atlas* ICBM, and 2 *Thor-Able* re-entry nose cones and 2 *Titan* ICBM data capsules.

Also included in this recovery record is the now famous *Jupiter* nose cone carrying the two primates, Able and Baker. Both were recovered in May, 1959, in fine shape following their 1500-mile ballistic ride.

• **Future hopefuls**—Cook will need all of its past experience and then some for the many future recovery tasks it hopes to tackle.

With proposals out for *Titan* and *Minuteman* nose cones and *Saturn* first stage booster recovery systems, CRL at the present time must concentrate on immediate needs.

It is designing a *Redstone* booster recovery package and one for the *Pershing* nose cone is in the early stages of development.

There is one recovery that still has never been made—the *Discoverer* stabilized space vehicle. Recovery system is a Cook product, but actual recovery involves an aircraft pickup in the air. After 12 attempts the score is still zero.

Probably the biggest system for the future will be that for *Saturn's* big booster. This will employ a balloon for initial stabilization, parachutes for deceleration and finally retro-rockets for zero-acceleration impact. It is not expected that the entire booster will be reusable, but that parts saved might make the effort worthwhile.

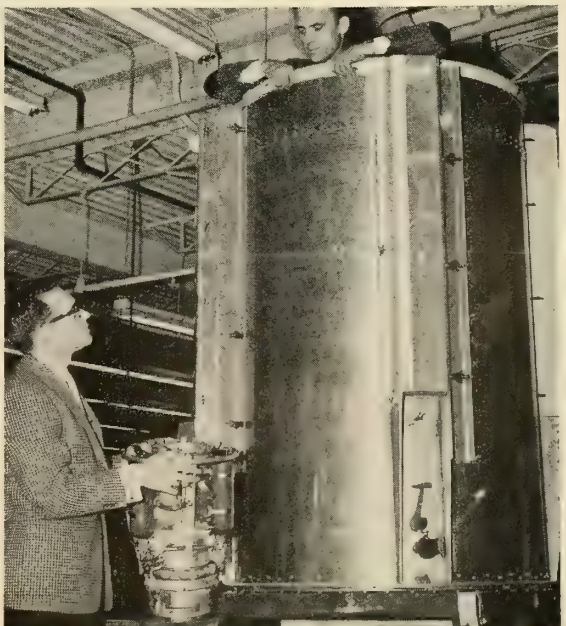
In NASA's *Mercury* project lies the toughest of all recovery problems—returning its human passenger safely. This is one recovery package that must function as designed. CRL has contributed much of its experience to development of this package.

A dual system is provided: one for ejection in case of malfunction during launch, the other for recovery after re-entry. Lift rockets will remove the capsule several thousand feet away before the drag and main chuts return the astronaut to Earth. Also included for recovery are retro-rockets for initial deceleration and a landing bag (inflated) for cushioning and buoyancy.

Primary drag for the capsule will be the capsule itself.

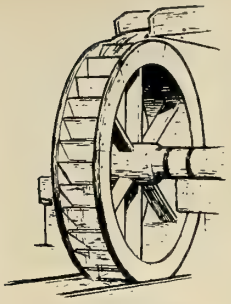


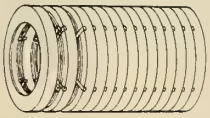
CREE RESEARCH missile is shown just after successful soft impact. The recovery chute is still attached.



A JUPITER C system (left) is dwarfed by container capable of recovering NASA's Saturn first-stage booster.







Solar energy conversion: Through recent advances in materials and electronics, we are on the threshold of a new era of energy utilization. By concentrating solar radiation into the cavity of a thermionic converter, electrical power is generated directly from sunlight without moving parts or circulating fluids. This freedom from earthbound energy sources promises far-reaching applications in space exploration. Artist's concept shows the unfolding of a solar collector mirror with its central power package which would be attached to various types of space vehicles. Lockheed's design of a thermionic converter operating model is shown at left. The water wheel depicts one of man's earliest known forms of energy conversion.

THERMIONICS

EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY

The development of new techniques in energy conversion is typical of the broad diversification of work at Lockheed Missiles and Space Division. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists.

Exploration into unknown areas such as Thermionics, provides endless stimulation to imaginative scientists and creative engineers. Research at Lockheed's Missiles and Space Division covers the entire spectrum — from pure basic research to development work, in support of current projects. Thermionics is but one phase of Lockheed's complete systems capability in missiles and satellites. To maintain this position of leadership calls for an extensive research and development program — ranging from electrical propulsion research to advanced computer research, design and development. Typical current projects are: Man in space; oceanography; fuel cells; space station; space navigation; solid state electronics.

Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. H-29A, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed

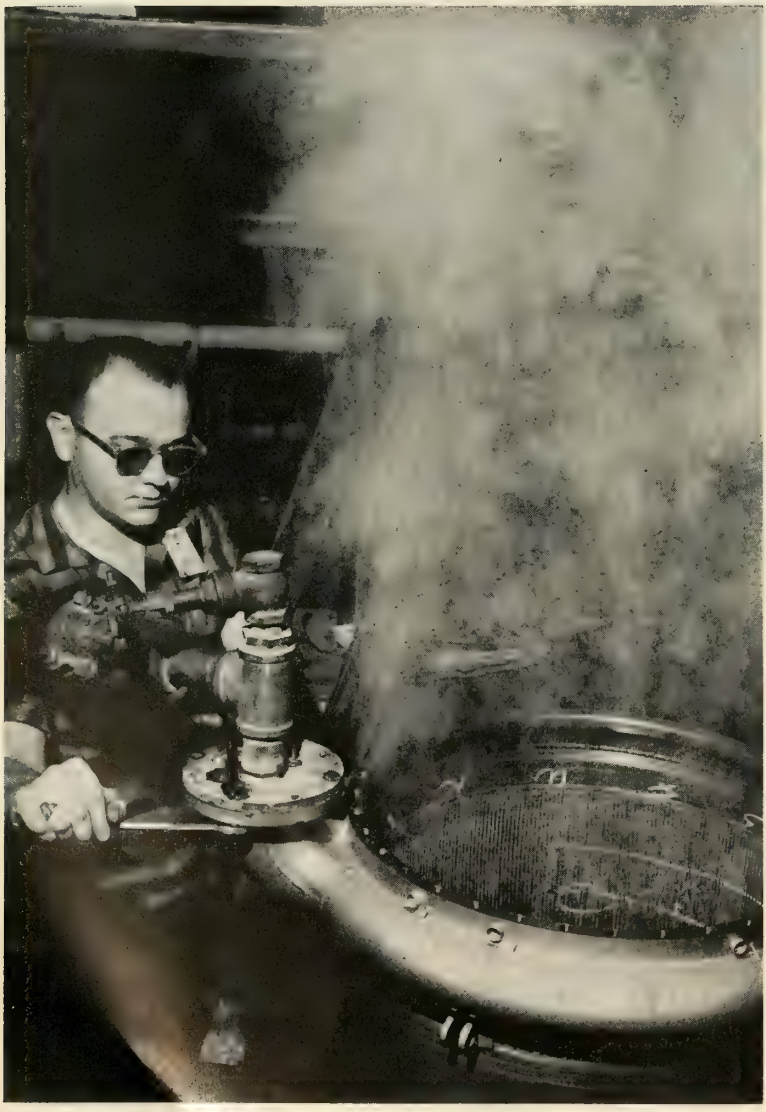
MISSILES AND SPACE DIVISION

Systems Manager for the Navy POLARIS FBM; the Air Force AGENA Satellite in the DISCOVERER, MIDAS and SAMOS Programs; Air Force X-7; and Army KINGFISHER

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA
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Missouri Town Makes Rocket Engines

Reliable Rocketdyne powerplant for Jupiter, Thor, Atlas produced at Neosho; plant employs 1100, purchases from 1500 suppliers; new alloy improves pumps



STEAM CLEANING of chamber is necessary to meet rigorous cleanliness requirements of Atlas engines. Workman tightens connection to chamber manifold.

by Jay Holmes

NEOSHO, MO.—One of the world's most reliable rockets, an engine without a name, is produced in undisclosed numbers at a plant employing 1100 persons outside a tiny community in southwest Missouri.

Rocketdyne Division of North American Aviation produces the liquid-propellant rocket that serves as powerplant for the *Jupiter* and *Thor* and as booster for the *Atlas* at a government-owned installation on the grounds of Ft. Crowder, a now inactive Army camp.

Military code designations are all the LOX-kerosene engine has for a name. As *Atlas* booster, the latest version is called XLR-89-NA-5. As engine for the Army *Jupiter*, it is the S3D.

Whatever the designation, it was rated originally at 150,000 lbs. thrust, with tanks for burning 160 sec. in the basic *Thor*. Recently, the engine has been upgraded to 165,000 lbs. to improve the *Thor* and give *Atlas* a longer range. A further modification, designated H-1, has been souped up to 188,000 lbs. thrust for clustering into the *Saturn* booster.

Rocketdyne performs research and development work on this and other engines at Canoga Park, Calif. When they go into production, activity shifts to Neosho. However, the 57,000-lb.-thrust, four-minute-burning *Atlas* sustainer is produced at Canoga Park.

Earnest A. Wright is manager of the Neosho plant, which has about 250,000 sq. ft. of floor area, a two-stand engine test area and a separate area for testing pumps, generators and vernier engines. Wright says the improvements developed in the engine recently have been introduced to production models, both of *Atlas* booster and *Thor* powerplants.

The improved *Thor* engine, which Rocketdyne designates "Block 2," will be used for space experiments. Further

improvements have been made in the *Atlas* booster. Rocketdyne calls the latest version MA3.

• **Ameliorations**—Wright said the *Thor* improvements include simplified valving, substitution of a pyrophoric igniter for a pyrotechnic igniter and the increase of pump capacity to increase thrust. He explained that the new igniter uses tri-ethyl aluminum in the fuel line with a cartridge on either side.

When the pumps start, fuel pressure breaks one cartridge, and the igniter fuel flames up on contact with air. Regular fuel following behind the second cartridge is ignited by the tri-ethyl flame. Meanwhile, LOX feed begins a few milliseconds later, at which time thrust has reached 90%.

The *Atlas* MA3 saves weight by using fiber glass wrapping instead of steel bands to reinforce the thrust chamber and reduces the number of components further. This is partly achieved as a result of a new control system that uses fuel from the missile itself to operate the engine sequences, instead of pneumatic and hydraulic sequences as in earlier models.

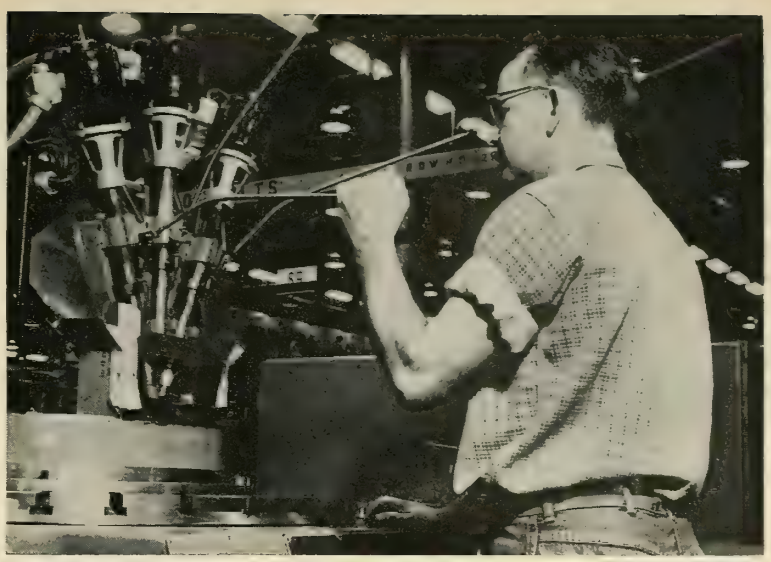
• **Many suppliers**—Production at Neosho begins in the receiving department. Rocketdyne bought $9,953,394 worth of parts, components and raw materials last year from slightly more than 1500 suppliers. More than one-third of the purchases were within an immediate four-state area (Missouri, Kansas, Oklahoma and Arkansas) within 150 miles radius. Of all purchases, 40.8% were from companies with fewer than 500 employes.

Much of the work given to subcontractors is on small metal parts, particularly when the plant machine shop is overloaded. Rocketdyne says many small machine shops in the area do extremely high quality work.

One example is Sibley Engineering & Manufacturing, a 19-employe firm in Sulphur Springs, Ark., whose chief product is a gizzard skinner used widely in the poultry industry. The owner, Milton Emanuel, is a former employe of a meat-packing company.

Another subcontractor, Claude Roderick of Monett, Mo., proprietor of Roderick Arms Tool Co., is in the rifle business, but does machine-shop, tool and die work for Rocketdyne.

A typical day's incoming shipments at Rocketdyne include: a lubricating pump from Pesco Products, forgings from Harvey Aluminum and American Brake Shoe, a valve assembly and an oxidizer check valve from Valley Bolt Corp., valves from H. W. Loud Machine Works, flex hose from Titeflex Inc., lubrication tank from Weldfab Inc. and servovalve and actuator from Moog Valve Co.



AUTOMATIC INDEXING machine used to drill holes in injectors, assures proper alignment, accurate angle. Tape control makes products identical.

Between 800 and 1000 different parts are manufactured in the Neosho plant machine shop, headed by General Foreman H. A. Eathorne. Many kinds of metal are machined.

• **New alloy**—One of the newest is an aluminum alloy developed by North American, called Tens 50. Castings of the new alloy are machined into the unusual shapes needed for the volutes in turbopumps. Tens 50 is harder and has greater strength than the aluminum alloy formerly used. This is a major factor in the uprating of pump capacity, which made it possible to increase thrust.

Another such change was a switch to Tens 50 from another grade of aluminum in the turbopump gear case. Also, the number of parts was reduced by switching from two pieces to one.

Hundreds of operations are involved in machining the complex gear case. The job takes weeks to complete. Work is programed so that different phases go on simultaneously.

"Tape-controlled machines come into their own on jobs like this," Eathorne says. "We get precision and repeatability. And we save on personnel costs."

In other changes in uprating the pumps, the inducer material went from plate 2024 aluminum to die-forged 2014 aluminum, and the impeller went to Tens 50 from another grade of aluminum. The inducer, which looks like a four-bladed outboard motor propeller, spins to maintain the flow of liquid into the pump. The impeller, inside the pump, does the main job. Alcoa supplies the aluminum forgings.

Other major parts machined in the Rocketdyne shop include a die-forged aluminum thrust chamber dome, the main injector of hand-forged 4130 steel, with its 3000 holes, and aluminum and stainless steel special fittings and crosses.

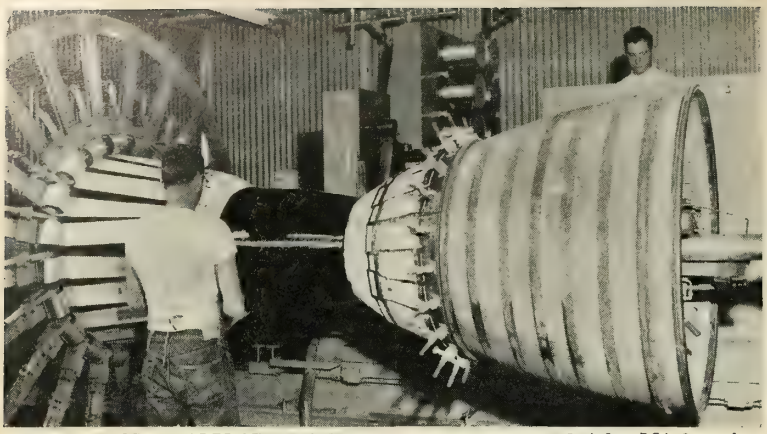
D. B. Gore, chief of engineering, says the Tens 50 alloy patented by North American was originally called T42. Variations of Tens 50 have 0.2% offset yield strength averaging 35,000 psi. Ultimate tensile strength averages 43,000 psi.

Tens 50 is the same as aluminum alloy 356-T6 except that it has 1% higher silicon content and a little beryllium. The composition is aluminum plus 7.6-8.6% silicon, 0.4-0.6% magnesium, 0.1-0.3% beryllium, 0.1-0.2% titanium and traces of several other elements.

The largest component of the engine, the thrust chamber, is produced in the metal fitting, welding and processing department, headed by General Foreman Frank Holkenbrink. This department also does all sheet metal work.

Assembly of the thrust chamber starts with 292 formed cooling tubes of pure nickel, chosen because it is very ductile and a good heat conductor. The tubes are stacked on a torch-weld jig and brazed together with silver solder. Silver was selected for its extremely high heat conductivity and relatively high strength.

In brazing, production workers start at the narrow throat and work both forward and backward, so that the combustion chamber and exit cone are reached simultaneously. To reinforce the tail cone, 4130 steel bands are used.



FIBER GLASS WRAPPING applied to the thrust chamber of Atlas MA-3 engines replaces heavy steel bands, reducing weight but keeping same strength as steel.

In the older design, 3/16 in. bands reinforce the combustion chamber and 11 bands 1/16 in. reinforce the tail cone. In the newer design, glass wrapping replaces all steel bands in the chamber area.

Holkenbrink outlined these subsequent steps in fabrication:

- Seal tube ends. At rear connect adjacent pairs. At front end, mill slot in every other tube and seal its end. Leave other tube open for feed to injector.
- Attach thrust ring to front end and machine it.
- Weld manifold on.
- Attach bands and ring to manifold.
- Pressure test to 1000 psi prior to glass wrapping.
- Insert expandable mandrel inside chamber.
- Paint seal coating on chamber to give good surface.
- Attach fiber glass strips, soaked in epoxy resin, lengthwise at 18° intervals.
- Wind fiber glass wrapping.
- Rotate 9° and attach another 20 lengthwise strips spaced between first set.
- Wind another layer of fiber glass.
- Cut off ends of strips.
- Attach fittings and wrap on with fiber glass.
- Bake in oven.
- Clean, paint and deliver to assembly.

In the assembly area, headed by General Foreman C. W. Bright, the first step is trimming impellers for the required power curve. Since thrust was uprated, the trim must be different from that in earlier models.

"From experience, we know within a few thousandths of an inch what the trim will be," Bright said. "One final trim is usually needed."

Bright listed these subsequent assembly steps:

- Mate impeller to gear case.
- Pressure-check and cold-check LOX line with liquid nitrogen.
- Hot-fire turbopump at test area.
- Leak-test and visually inspect pump on return.
- Test thrust chamber in water flow and calibrated for pressure drop.
- Calibrate and flow-check injector.
- Build up gas generator and test in hot-test area.
- Mount turbopump, injector and gas generator onto thrust frame.
- Link components with hoses and lines.
- Check out electromechanical connections.
- Test sequencing and for leaks.
- Hot-fire engine in test area.
- Make second electromechanical checkout at shop; optically verify that geometric center of thrust chamber is within prescribed tolerances.
- Inspect torque valves for leaks; verify complete procedures.
- Ship to customer.

A similar but less involved procedure is used in manufacturing vernier engines, the only other major item produced at Neosho. The vernier develops 1000 lbs. thrust that gives the *Atlas* and *Thor* their final velocity. Two engines are used on each missile; the *Jupiter* has none. The vernier weighs between 75 and 80 lbs.

The main difference between *Thor* and *Atlas* verniers is in the way the vernier is attached to the missile. In earlier models, designated Block 1, the vernier was ignited pyrotechnically. The Block 2 vernier uses a pyrophoric mixture of tri-ethyl aluminum and tri-ethyl boron.

Thor Engine Performance Data

Propulsion System	Actual (in qualification test)	Nominal
Thrust, lbs:	166,552	165,000
Specific Impulse, sec:	250.6	251.2
Mixture Ratio, o/f	2.308	2.300
Thrust Chamber & Propellant Feed System		
Thrust, lbs:	166,052	164,500
Specific Impulse, sec:	255.8	255.6
Characteristic Velocity, C*	5833	5848
Thrust Coefficient, C_f	1.411	1.406
Oxidizer Flowrate, lb/sec:	460.3	455
Fuel Flowrate, lb/sec:	189.0	188.5
Mixture Ratio, o/f	2.435	2.414
Chamber Pressure, psia	576	571
Fuel Pump Discharge Pressure, Total psia	879	830
Oxidizer Pump Discharge Pressure, Total psia	929	885
Verniers		
Total flow, lb/sec:	9.797	9.640
Mixture Ratio, o/f	1.725	1.800

Navy Builds Arc Furnace For Materials Research

Temperatures up to 27,000°F can be created with a new arc furnace being tested at the Naval Ordnance Laboratory, White Oak, Md.

The high-intensity arc will be used to study and develop new materials for missiles.

The furnace consists of a rod-shaped anode and a doughnut-shaped cathode surrounded by a plastic chamber. The plasma passes through the cathode. A stream of water whirled around the electrodes forms a core, or hollow vortex, which restricts the diameter and intensifies the electric arc.

The water also furnishes material to be heated and discharged through the hollow cathode as plasma. The hot gas is then directed against a material sample.

Noise levels up to 140 decibels are produced by the high-velocity movement of the plasma through the cathode orifice. Acoustic insulation will be used to reduce this to an acceptable level.

wanted:

engineers, physicists and mathematicians

FOR CAREERS WITH

GUIDED MISSILES RANGE DIVISION

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Pan Am's Guided Missiles Range Division (*GMRD*) is a technical organization with operations at Patrick Air Force Base, Cape Canaveral and the chain of down range tracking stations through the Carribean to Ascension Island.

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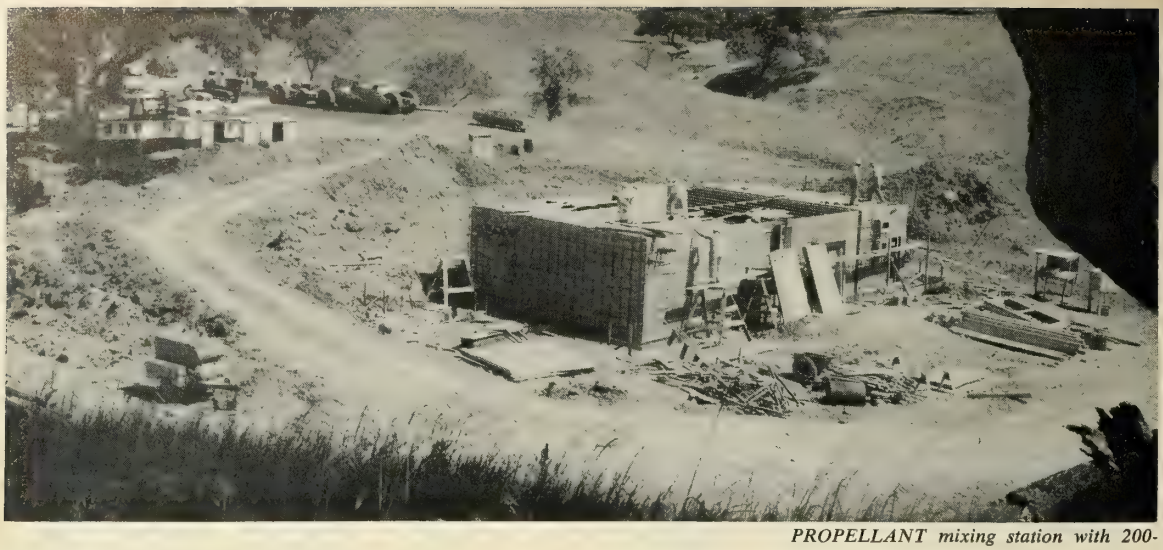
Dr. Gilbert S. Blevins
Dept. B-31, Guided Missiles Range Division
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PAN AM

GUIDED MISSILES RANGE DIVISION

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PROPELLANT mixing station with 200-gal. capacity goes up at UTC's Coyote Calif., center. Control center is at left.

propulsion engineering

UTC Aims for Big Rocket Competition

Test stand for 2-million lb. thrust engines being built; careful R&D planning is basis of new company's 'catch-up' program

by William J. Coughlin

SUNNYVALE, CALIF.—A test stand capable of handling solid rocket motors of up to 2-million pounds thrust is scheduled for completion by the end of the year on United Technology Corp.'s test site in the mountains south of here.

The stand will be one of four at the 3200-acre development center. Of these, at least one will be for liquid engines.

With work well underway on its first rocket engine contract, UTC thus is setting the stage for rapid expansion in the fields of solid and liquid propulsion.

The new company is basing its move on a carefully-planned research and development program which it is confident will create the basic strength needed to make the firm a major competitor in the field.

"We think we will be strong competition to some of the folks who got started ahead of us," says president Donald L. Putt.

United Technology was set up as a subsidiary by United Aircraft to extend that company's interest in propulsion to the rocket field.



PUTT



ADELMAN

"We realized it took a whole new breed of cat," says a United Aircraft official. UTC's function is described as a research and development and pilot plant operation.

• **Contract from NASA**—Its first contract was announced last month with the National Aeronautics and Space Administration for demonstration of the feasibility of a segmented, conical-shaped, solid propellant rocket motor. (M/R, June 6, p. 15; June 13, p. 35).

Design, fabrication and testing of three experimental engines will be carried out at UTC's new research and engineering center here and its development center some 13 miles southeast of San Jose.

The first unit at the development and test center went into operation this month, a 200-gal. propellant mixer station and its adjacent remote control center. More than 60 structures are to be completed there by the end of the year.

Testing of small liquid and solid propellant rocket engines has been underway at the site since the first of the year. More than 71 such tests have been carried out.

Although interested in liquids, UTC has concentrated to date largely on solid propellants and solid propellant propulsion systems. It has developed some extremely promising high-energy propellants, but declines to give details of these other than to say they offer much higher specific impulse.

One of the three whose development appears promising is a polyurethane which is not a great improvement ballistically but represents a step

forward physically. The other two are said to represent considerable advances and are more exotic.

"It's a big step from mixing these in the lab to mixing them for big motors," says executive vice president Barnet R. Adelman. "In four to six months, we may be justified in saying we have something pretty good."

Adelman says particular emphasis in the solid field is being placed on the synthesis of propellant ingredients, both organic and inorganic. In addition, he says, close attention is being given to development of advanced processing techniques.

• **Storable liquids**—UTC's interest in liquids is in other than cryogenic propellants, which will be left to Pratt & Whitney's Florida plant. Major attention in liquids is to storables and to systems using storables.

The effort in this field will include design and development of mechanical and electronic components for these systems.

According to president Putt, the firm will limit its work in storable liquid systems to those of not more than 25,000-lb. thrust. Larger applications will be handled by Pratt & Whitney.

"We think there is a market for motors of this size in upper stages, space boats and the like," says Putt.

The solid propellant plant at the test site, in addition to being a pilot plant, will also be what Putt calls a "manufacturing development" plant to work out manufacturing techniques.

This will give the company an incidental manufacturing capability of ½ to ¾-million lbs. per month of propellant. If a requirement for quantity propellant manufacture develops, present thinking is that it will be set up in Florida.

"But on large motors where the quantity is relatively small, say, one a month, we probably could handle that here," Putt says. The plant will have the capacity for casting and curing the largest rocket motors now contemplated.

• **Room for solids & liquids**—"We don't want to get typed as either a solid or a liquid outfit," the company president declares. "There are places for both of them. We want to remain flexible to propose and develop either one as needed."

UTC also is interested in other forms of propulsion and has carried out studies in the nuclear, ion and plasma fields. Efforts in these directions are expected to increase as the firm expands.

When United Aircraft made its move into the rocket propulsion field last fall, it lined up a top scientific and engineering staff to direct the effort, to be concentrated initially on research.

"We felt there was still a lot of fundamental research to be done and we wanted to have a strong research base," a spokesman says.

Putt, at the time of his retirement from the Air Force was Deputy Chief of Staff, Development, and a lieutenant general. He was chairman of the Scientific Advisory Board to the Chief of Staff and was president this year of the Institute of Aerospace Sciences. He was a former commander of the Air Research and Development Command.

Executive vice president Adelman was director of the Vehicle Engineering Laboratory at Space Technology Laboratories, Inc., before going to UTC. While there he had project management functions for development of the engines for the *Atlas, Titan* and *Thor* and was also responsible for establishment of initial solid propellant rocket engine development programs which led to *Minuteman.*

Chosen as vice president and director of the research division was Dr. David Altman, manager of the Vehicle Technology Laboratory for Aeronutronic Systems, Inc., at Newport Beach. He previously had served as chief of the chemistry and physics section of Cal Tech's Jet Propulsion Laboratories.

Herbert R. Lawrence, vice president and director of the engineering division, arrived at UTC from a position as associate director of the Astrovehicles Laboratory of Space Technology Laboratories, Inc.

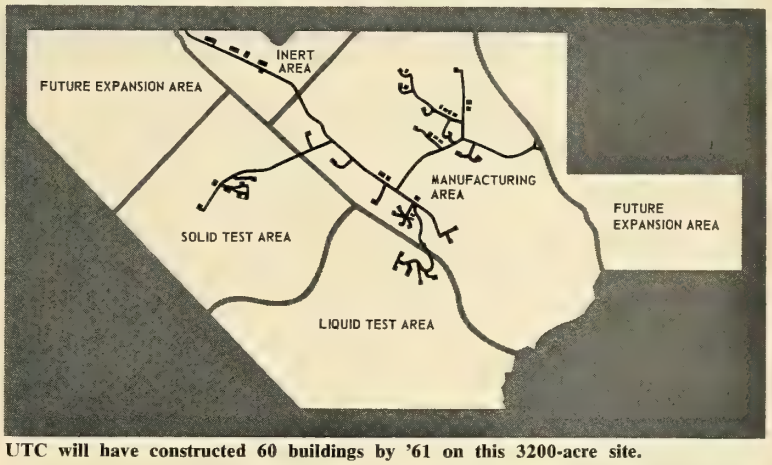
Around this team, UTC built its technical staff. Employment at the company now is approaching 300—more than half professional and technical people. Employment is expected to reach 1000 sometime late next year.

• **Initial research farmed out**—To get started quickly, United Technology contracted with Stanford Research Institute to do some of its initial propellant research. That arrangement still continues.

SRI has a 12-15 man group working exclusively for UTC on the development of new high-energy solids at its 14,000 sq. ft. Calaveras facility.

United Technology also is carrying out considerable basic materials research on nozzles, binders and other components of rocket propulsion systems. Extensive studies are being made of the physical properties of metal alloys, ceramics, plastics and plastic composites. Special basic research emphasis is being placed on thermodynamics and combustion of liquid and solid propellants.

The engineering division includes a strong organization for the analysis of complete weapon systems.



UTC will have constructed 60 buildings by '61 on this 3200-acre site.

"We probably will not be interested for some time in the development of complete weapon systems, if ever," Putt says, "but we need these studies to guide our efforts in the propulsion field."

In addition to its NASA contract, United Technology also backed its segmented concept with a bid on the Air Force's Project 3059 solid engine study which went to Aerojet-General.

The firm also has small proposals out in the research field, on materials, on new methods of vector control, and on new nozzle designs, particularly in regard to nozzle cooling.

From this relatively modest start, Putt and his colleagues are convinced United Technology Corp. will grow steadily, based on a combination of its own R&D capabilities with the hardware capabilities of United Aircraft's Pratt & Whitney division.

Data System Speeds Engine Development

Delivery of a new air/ground data acquisition and processing system to Edwards AFB, California, should result in a speedup of the Air Force's B-70 Valkyrie turbojet engine development.

Developed and installed by Radiation, Inc., Melbourne, Fla., for General Electric's Flight Test Center at Edwards, the new facility is expected to reduce significantly flight-test time and costs not only for the J93-3 engine but for other advanced GE jet engines.

With award of the contract to RI in early 1959, development was well underway by April and first elements of the giant complex were delivered in January, 1960. The installation although completed will undergo extensive testing over the next few months.



DATA PROCESSING CENTER developed by Radiation, Inc., for B-70 engine test and analysis is now completing test operation at General Electric's Flight Test Facility, Edwards AFB, Calif.

• **Mutt & Jeff contrast**—Size of the airborne data acquisition system is roughly 3.5 cubic feet and weighs about 180 pounds. It offers a startling contrast to its mate, the ground data processing center.

Occupying some 1600 square feet of floor space, the data processing facility is comprised of 26 rack mounted equipments and control consoles.

For high-speed and more accurate operation the system employs pulse code modulation (PCM) as the primary data recording mode.

A multiplicity of transducers will collect in-flight test data on magnetic tape. Critical fuel-flow, temperature, pressure, blade-stress, and engine-control-transient data are among the list of performance factors necessary to analyse GE's J93-3 engine.

During processing, selected data will be displayed visually at the ground complex. Others will be recorded for permanent readout on strip charts. Many of the data sequences will be translated automatically into formats for later analysis by the electronic computers.

Both analog and digital techniques are employed. Analog wide-frequency data above 200 cycles can be recorded to an accuracy of 1% using frequency modulation techniques.

• **Two-speed collection**—Digital data can be collected and processed at either of two rates—10,000 or 20,000 samples/sec. with even finer accuracies, said RI engineers. Nearly 80% of test data to be collected will fall in the 0—200 cycle low frequency range.

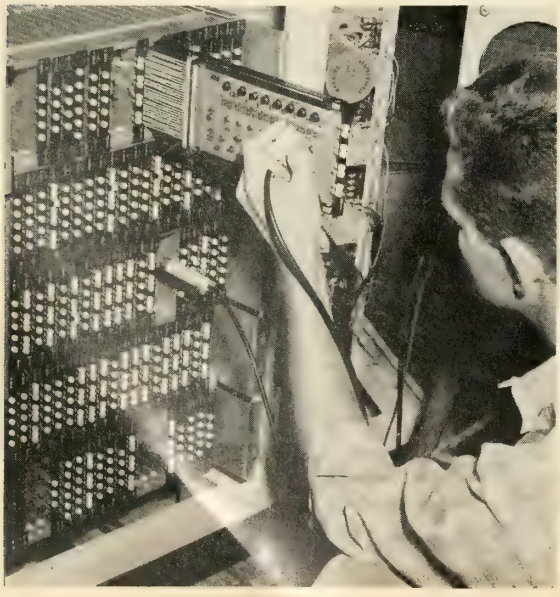
The recorder in the airborne unit can handle 14 analog channels across 1-in. magnetic tape. It also permits substitution of 16 digital channels for 7 of the analog channels.

To eliminate the need for preamplifying low-level outputs before multiplexing, RI's advanced multiplexer (see M/R, February 22, 1960) is included in the airborne system. (This subsystem accurately detects weak signals and requires only one amplifier behind it.)

Designed for flexibility, the system will also be used to test other advanced GE high performance engines. For in-flight tests GE's J79 and J85 jet engines will be among the first.

When the B-70 engines will be flight tested remains in doubt. However, it still will be installed in a pod beneath the fuselage of a B-58 jet bomber, but funding for flight-test program has been slashed.

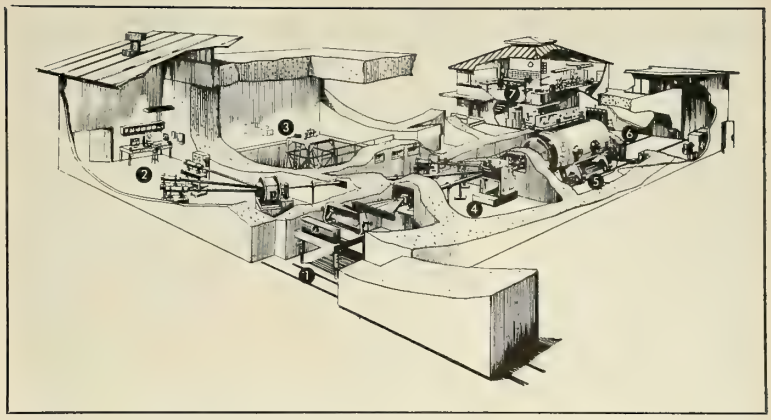
For the future, GE's new test system might readily be adapted to missile flight testing with the introduction of telemetry units, say RI officials.



SYSTEM FLEXIBILITY and reliability are achieved in ground facility equipment by the use of these standarized printed circuit cards and preprogrammed patchboards.

Industry Space Test Facilities Expanded

Convair, Boeing Sink Millions into Research On Space Hazards



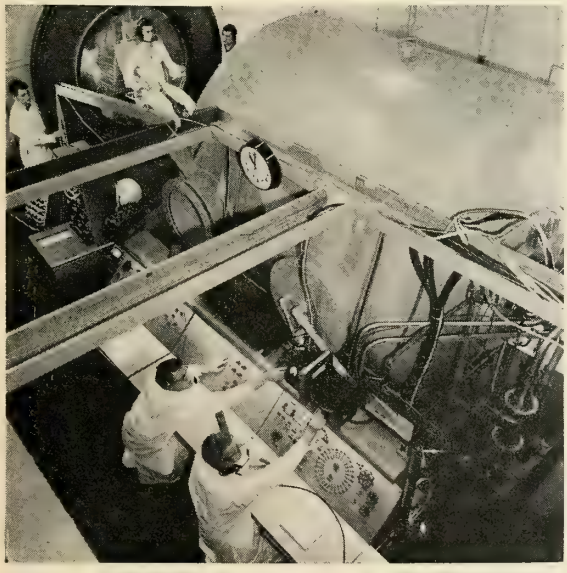
SPACE RADIATION research facility to be built by Convair will be equipped with 3-megavolt, 30-kilowatt electron/ion accelerator to study radiation effects on electrical components, guidance and control systems of nuclear propelled vehicles. Areas identified: 1) irradiation cell for conducting studies in radiation or structural damage to electronic components, and systems in nuclear vehicles; 2) nuclear physics experimentation area; 3) test area to investigate neutron interactions with nuclei; 4) steering magnet which directs accelerator beams to appropriate test cells; 5) accelerator; 6) accessory room for operation and maintenance of the accelerator; 7) control room.

NEW AND BIGGER space flight test facilities are the order of the day for the U.S. missile/space program. Industry and the military have recently announced several new facilities—much larger and of greater capability than anything previously available.

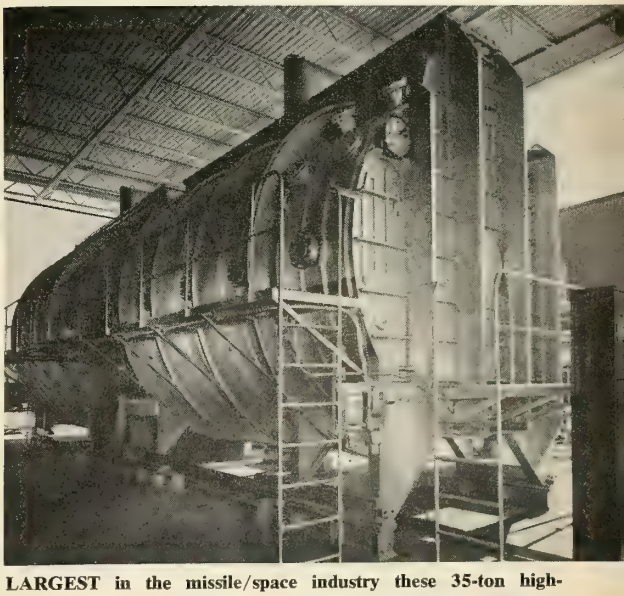
Convair has made two big additions to its space research facilities: high-performance vacuum chambers for simulated altitudes of up to 100 miles, and a space radiation research lab. A smaller tank capable of 250-mile altitude vacuum went into operation a short time ago (M/R, 7/25/60).

U.S. Steel will build for Edwards AFB an inertia-measurement platform capable of putting complete aircraft and missiles through yaw, pitch, and roll motions. Full-sized vehicles weighing up to 300,000 pounds can be tested on the 110 by 80-foot cruciform platform.

Boeing is near completion of a "multi-stress" chamber which will be used to determine human tolerances and equipment capabilities. The chamber can simultaneously simulate hypersonic flight conditions for *Dyna-Soar* and other manned-flight research.



BOEING'S "multi-stress" chamber will permit environmental control specialists to experiment simultaneously with six different space flight conditions: noise, intense light, vibration, and variations of pressure, temperature, and the composition of various gases.



LARGEST in the missile/space industry these 35-ton high-vacuum tanks at Convair Astronautics will be used to test small experimental rockets and satellite instrument packages. Tanks can simulate environmental extremes of heat and cold and altitudes up to 100 miles.

Heat

by Horace C. Knerr

Startling progress has been made in electronic controls and missile fuels in recent months.

But the men responsible for these singular achievements have been inclined to take too much for granted in the basic field of metallurgy, and in the most crucial aspect of rocket body production—heat treating.

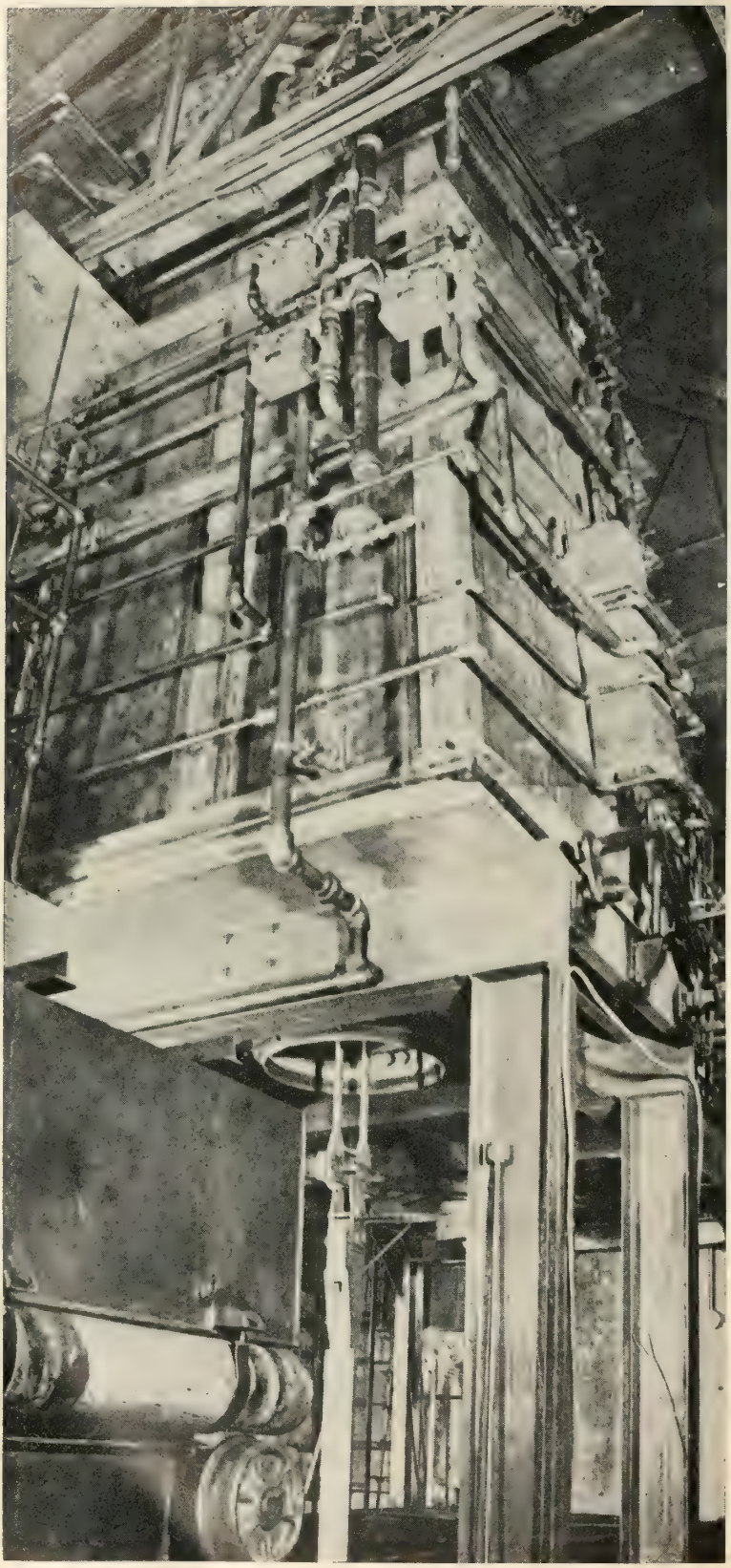
The control and prevention of deformation within intelligent tolerances is entirely within the province of the skilled metallurgist and heat treater.

Yet the whimsical tolerances insisted upon by rocket engineers make an already difficult task almost impossible.

• **Heart of the matter**—The higher the tensile strength or yield strength specified, the more difficult it is to meet close dimensional tolerances. The following actual cases will aptly illustrate the prevailing conditions.

A body approximately 2 ft. diameter calling for heat treatment to 160,000 psi minimum yield strength specified a maximum total indicator reading (TIR) of 0.060 in. in its length of 11 ft. This included ovality (D-d) and camber (bow). The latter was required not to exceed 1/32 in. Since this cammer in itself would create a total indicator reading of 1/16 in. or 0.0625 in., there would be less-than-zero allowance for out-of-roundness! Realistic? Yet this is a prime example.

However, by the exercise of extreme skill, ingenuity and care, with special fixturing, the bodies were actually held by the heat treater within a tolerance of 0.070 in. TIR. Items frequently arrived from the fabricator with a TIR of as much as 0.125 in. In addition to holding these extremely close tolerances, the fabricating deviations were actually corrected by the heat treater. After several hundred bodies were so produced by the heat treater, he was rewarded by having an additional 1000 parts placed for manufacture and heat treatment elsewhere. Will the new contractors be required to conform to the extreme specifications or is it that the tolerances were



← *METLAB's 14 ft. inverted pit heat treating furnace. Work area is 3 ft. wide.*

Treaters' Dilemma—Intolerant Tolerances

meaningless in the first place?

• **Excelsior**—A blueprint showing a body 6 in. dia., 8 ft. long, calling for 155,000 psi yield strength, specified bow and ovality to be less than 0.30 in. This seems to be generous but on further examination it appeared that ovality tolerance (D-d) was 0.190 in. If the fabricator so made the part, the heat treater would have to correct the ovality, or hold the body straight within 0.055 in. bow in its length—1 part in 1750.

A noteworthy instance, now understood to be obsolete, specified a spherical body 40 in. dia. with 0.048 in. wall made of 4130 steel to be heat treated to 180,000 psi minimum yield strength. For this high yield strength and thin wall a much more suitable steel would have been 4140, but even so the specified tolerance of ±0.010 in. in the diameter of 40 in. was clearly beyond obtainable limits.

First, the body could probably not be fabricated to such close dimensions even by drawing or hammering the two hemispheres over a spherical die and then very carefully welding and rehammering.

Second, no heat treater could assure this tolerance because volumetric changes in the metal itself due to heat treating transformations might exceed that amount.

Thirdly, there would be no further allowance at all for unavoidable deformation in the heat treating operation.

• **Teamwork needed**—Consultation by design engineers with a competent heat treating metallurgist might have avoided fruitless, costly and time consuming efforts to meet these requirements.

Another blueprint showed a body 14 in. dia., approximately 4 ft. long, calling for 180,000 yield point and demanding a bow less than 0.010 in. in 40 in. of body length, namely 1 part in 4000. Ovality was not specified.

More care and understanding in specifying strength values would be helpful. One blueprint submitted for

(*continued next page*)

Putting the Muscle in Metal

The heat treatment of metals is a very old art and a highly modern science, involving many variables depending upon the composition of the metal, the dimensions and shape of the work and the physical properties desired.

Basically, it usually consists of heating a metal part to a critical temperature range where profound internal changes take place, then cooling it rapidly to cause a transformation in the crystalline metal structure, and then a second reheating. For steels, generally known as ferrous metals, the quench hardens the material and the second operation, tempering, toughens it and sometimes softens it.

Aluminum alloys and certain others apparently reverse this behavior although the final effect, hardening and strengthening, is the same. They are soft after quenching (solution treatment) and then hardened and made strong during the second heating operating (aging).

• **Rocket application**—There are of course, many other forms of heat treatment for metals. The present discussion, for simplicity, is confined to the heat treatment of steels such as are used in rocket and aircraft manufacture.

Weight is the overriding consideration. By heat treating to high strength, steel is actually made "lighter" because less of it is required to support a given stress or load. By comparison, on a strength-weight basis, steels are actually lighter than aluminum or any other alloy.

Motor casings or containers for high pressure fuels, because of their extreme thinness, and lightness, present obstacles in the prevention of deformation during the hardening cycle. At the critical temperature, steel goes through certain plastic changes in addition to the natural softening caused by the high temperature—and is susceptible to deformation under its own weight. The rapid cooling or quenching operation unavoidably introduces further tendencies toward deformation because of thermal shock and severe contractional stresses. Small permanent changes in mass may result from metallurgical conversion, shrinkage may occur at welds.

The heat treater's principal task is to minimize deformation and thereby maintain the close dimensional tolerances required. In this respect the operation is as largely dependent upon the skills of the person as it is upon the character of the facilities.

• **Oils or nitrates?**—The quenching medium must be chosen with understanding and discrimination. No one is foolproof. Oil is usually preferable. Certain molten salts (nitrates, etc.) reduce the shock and tend to minimize deformation problems. But a salt bath is more sensitive to mass effects than oils—heavier sections do not fully harden. And we have consistently obtained the required high tensile properties with less deformation in oil quenching than with nitrate baths. Salt baths have their advantages—and we use them in other areas.

• **Treating styles**—The difficulties in quenching recalcitrant rocket bodies to high strength without disastrous deformation have led to the almost universal adoption of the "inverted pit" furnace.

Such a furnace consists essentially of a vertical, bottom opening heating chamber. A lifting device moves down inside the furnace and engages a spider supporting the charge. While heating, the charge hangs vertically, supported in such a way as to prevent sag.

When the heating cycle is finished, the charge is lowered directly into a quenching bath.

This system permits exact control of the quenching time and assures that every portion of the body has the same time of exposure from heat to quench. The bath can be made to circulate uniformly at a desired rate over the metal surface.

There are some disadvantages as to the idea of the gantry type furnaces. These travel back and forth over charging and quenching pits. It seems to be doubtful engineering to roll a tall hot furnace—made of refractory materials and carrying a delicate, suspended charge—back and forth during each operation.

(Continued from preceding page)

estimate to a heat treater specified "yield strength greater than 180,000 but less than 180,000 in." Plainly an error, but such mistakes in specifications can be wasteful and costly.

Another case demanded that yield strength should be held to 180,000 to 188,000 psi, in a body 5 in. dia., 5 ft. long. Any metallurgist will agree that, to hold yield strength within these limits, namely, ±2.25% would, if possible at all, require the most costly and protracted series of trial and error heat treatments for each individual piece. Steel varies in its hardenability from piece to piece in excess of this. A simple specification calling for a minimum of 180,000 yield with a maximum of 200,000 yield customarily specified would surely serve all practical purposes.

On this same body a TIR of 0.10 in. was called for, including both bow and ovality. A bow alone of 0.05 in. in 60 in. would require a straightness of 1 part in 1200—extremely close although obtainable with sufficient skill, care and time. In all probability, these were never achieved.

• **No decarburization**—Another "headache" presented to the heat treater is the requirement "no decarburization allowed". This is interpreted to mean zero decarburization. All rolled steel customarily has a slight amount of decarburization before it reaches the heat treater. A little more, making a total of 0.003 in. can be insured by special care, skill and good atmosphere.

To specify zero decarb required not only steels having this quality (practically unobtainable) but also very closely controlled artificial furnace atmospheres and sometimes the use of highly expensive special gases, such as helium, argon, etc. Such have even been called for.

But a prominent metallurgist in the rocket field (John M. Lynch, Aerojet-General, Sacramento, California) has shown that a small amount of surface decarburization, say 0.003 in. on a side, is actually beneficial since it reduces the surface tension, increases ductility and reduces the detrimental effect of surface notches.

• **"Ask the man who owns one"**—These comments are not made in a spirit of carping criticism but rather to illustrate the importance of closer collaboration between designers and competent metallurgists who understand the limitations of even the most skilled heat treaters with the finest equipment.

The metallurgist is only too glad to offer assistance and advice toward obtaining the very best performance in rockets, but requirements should not be set down unless they justify the expense involved in meeting them. But once such requirements are determined upon as necessary, they should be enforced.

In many cases, the dimensional tolerances are waived after it has been found that they are impractical and cannot be met. This is usually obvious to the skilled heat treater at the outset —before an expensive series of rejects. In some instances, stringent specifications are simply ignored and the purchaser does not receive as close tolerances as he might have, with consequently inferior performance. Obviously the heat treater who appreciated and allowed for the extra costs involved would lose out in the bidding.



Horace G. Knerr is the President of Metlab Co., Philadelphia, Pa. A veteran of 32 years in the heat treating of aircraft and missile parts, Mr. Knerr is the inventor of the inverted pit treating furnace (1928).

Furthermore, a certain cynicism regarding these "sacred little numbers" is generated.

Closer cooperation between the designer and the metallurgist would eliminate much of the retarding factors in such programs. Overemphasis on military secrecy in these areas add to cost, time and frustration, all out of proportion with intelligent security needs.

• **Are more furnaces necessary?**—The rate at which new and larger furnaces, capable of treating rocket bodies, are being built or planned is phenomenal. A short time ago there were scarcely six in existence.

At present there are more than twenty such facilities and more are anticipated. Seven of these are in the plants of commercial heat treaters, the rest belong either to the Government or to missile fabricators.

If all of these existing furnaces were to be utilized to their fullest extent, about 40,000 rocket bodies of all sizes could be handled annually. Yet more are planned!

Because there is little, if any, commercial application outside of the rocket industry for these specialized treating plants, the ultimate cost of this expensive equipment is borne by the taxpayer.

And the physical facility must be complemented with skilled personnel, possessing extensive metallurgical knowledge.

The practice of heat treating, while called a science, exhibits many of the characteristics of an art. Much of what happens to a metal being treated is only vaguely understood. The methods and techniques may be refined to a high degree but the understanding still lags behind.

One might suggest efforts toward a unification of specifications in the rocket field such as was carried out many years ago by the Army, Navy and Air Forces, including agreements as to steels to be used for certain strength values and other situations, the specification of tolerances within limits actually required and the question of surface decarburization, etc.

Furthermore, it would appear that more weight should be given to the value of experience and demonstrated ability in awarding contracts, especially repeat orders where a contractor has shown skill and resourcefulness in overcoming difficulties and meeting the highest requirements. Too often new orders are placed with a new source on price alone or possibly on local need for employment. A year's delay in production was reported in one such instance.

Other areas of endeavor also find this to be true. It seems that the business of defending the U.S. is just exactly that—a business, no more or less.

Travel Weary Electrons Measure Lowest Vacuum

Pressures down to 10^{-14} mm Hg can be measured with a cold cathode ionization gauge developed by P. A. Redhead, consultant to NRC Equipment Corp., Newton, Mass.

The instrument is reputed to be fifty times as sensitive as the current methods of measuring ultra vacuums. Its extremely high pumping speed will produce low pressures in small ultra-vacuum systems.

All ionization gauges measure pressure in terms of the very small current which is produced when gas molecules are ionized and attracted to a collector. The new gauge differs in the manner of ionizing these gas molecules. A few electrons traveling large distances form the ionizing medium. This offsets the usual X-ray background, which limits the effectiveness of current gauges.

Special models are being developed for inclusion in space satellites and probes to report on the densities and pressures of deep space.

Cornell Researchers Propose Flexible Space Radiator

Continuously rotating belt could be folded during launch to avoid high inertial loads; weight-saving a factor

LOS ANGELES—A thermal radiator for space vehicles which consists principally of a long, thin, continuously rotating belt to radiate waste heat into space has been proposed by two Cornell Aeronautical Laboratory researchers.

They suggest that such a radiator not only will weigh considerably less than conventional tube-and-header radiators but also will avoid the high inertial loads during launching which cause severe design problems. A belt radiator, they point out, can be folded or rolled into a cylindrical shape and allowed to flex harmlessly during launch.

Details of their proposal were presented by Roger C. Weatherston and William E. Smith at the recent meeting here of the Institute of Aerospace Sciences.

Although admitting that a number of developmental problems remain to be solved, the Cornell engineers said the new type of thermal-capacity radiator is simple in concept and promises to be reliable in operation because it is not endangered by meteroids.

"It has been found that, for power levels above a few megawatts, the conventional radiator is the heaviest single component," their paper says. "In such cases, considerations for reducing the radiator weight are of paramount importance."

Meteoroid penetrations do not impair the belt radiator because it does not confine a fluid, the authors assert. Consequently, it can be made thinner and much lighter than a conventional radiator. A spare belt also can be carried with small weight penalty.

• **Heated by waste heat**—The belt radiator depends upon the thermal capacity and radiative ability of a solid, belt-shaped member or members to replace the header-and-tube assembly. Each belt element is heated either directly or indirectly by the waste heat from the powerplant and then follows a closed trajectory through space until it is cooled to some designated temperature.

Since the belt moves continuously, the paper points out, the heat addition process begins anew for each element as the cycle is repeated.

For operation at the same level of radiative power and mean temperature, the belt radiator requires the same radiation exposure area as the conventional radiator, the authors admit. But whereas the interior tube surface does not contribute to the radiation area of the conventional design, all of the belt surface is external and radiates effectively.

No lengthly headers are required because the cooled belt elements are being continuously returned for reheat to a position close to the powerplant.

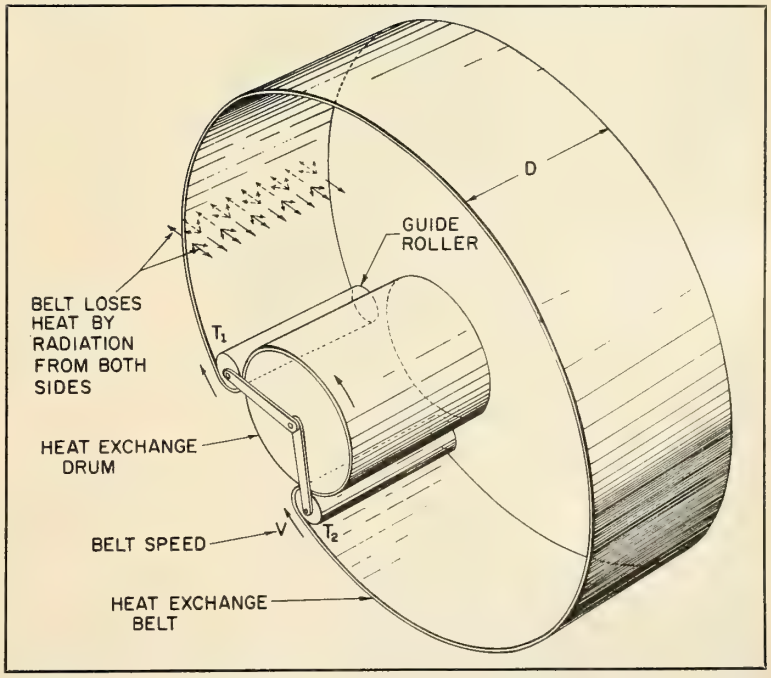
Two methods of transferring heat from the powerplant to the belt are suggested. One employs a long, flexible belt and a heat exchanger consisting of a rotating drum or other contact surface. The coolest portion of the belt contacts the hot drum to conduct heat from the surface of the drum.

In the other method, the contact surface is eliminated and the waste heat transferred directly to the belt by convection. In this method the powerplant working fluid, or another fluid if an intermediate heat exchanger is used, flows over the belt surface in an enclosed chamber.

The Cornell researchers note that the nature of the belt radiator is such that it can easily be driven by electrical power. They propose that an electric current be passed through the width of the belt. Pairs of electromagnets placed on each side of the belt at several different positions across the width then would drive the belt without the wear associated with a friction drive. Their preliminary calculations show that electrical energy in the amount of one-half percent of the heat rejected would be required to drive the belt.

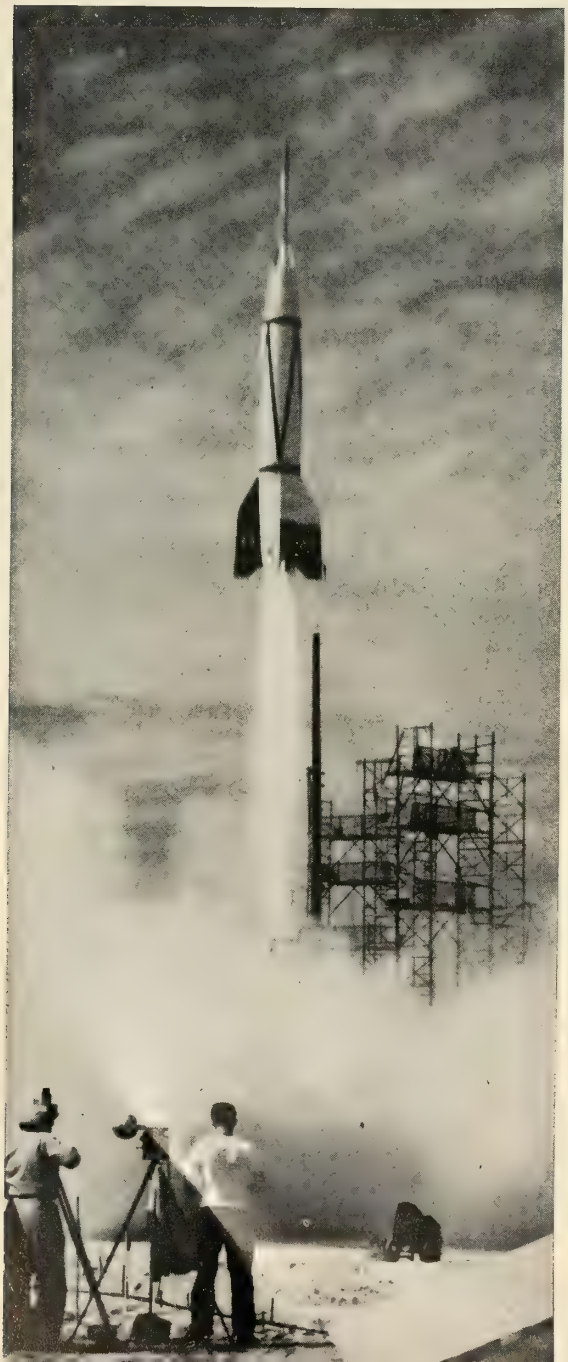
• **Low weight material**—While noting that the choice of materials or laminates for belt construction has not been extensively investigated, the two men suggest that stainless steel would represent a lower limit as far as temperatures are concerned. They suggest that use of beryllium might result in an extremely low belt weight.

For power levels in the megawatt range, the belt radiator might weigh only 15 to 25% of a tube-and-header radiator, it is estimated. The two researchers believe the problems involved in engineering a belt radiator appear solvable and would result in a big step forward in space propulsion.



POSSIBLE CONFIGURATION for a capacity heat exchange system for a space radiator.

Second Decade Begins at Cape



TEN YEARS AGO—At 9:25 a.m. July 24, 1950—the first missile was launched from Cape Canaveral. The two-stage *Bumper*—A WAC *Corporal* sitting on top of a leftover German *V-2*—programed as planned and impacted in the sea 250 miles down-range. Five days later a second *Bumper* was successfully launched from the Cape. In October, a third launch—a *Lark*—completed the schedule for 1950.

The first decade of the U.S. missile/space program was underway.

When this first missile was fired, the Air Force Missile Test Center—then called the Long Range Proving Ground—had little more than 800 persons. Its capital plant was valued at around $150 million and annual operating expenses were about $3.5 million.

Just four days before the first launch, an agreement was concluded with the United Kingdom for establish-

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A review of operational highlights during first decade of missile/space program at Air Force Missile Test Center (Cape Canaveral and Patrick Air Force Base, Florida.)

1950

24 July First missile launch from Cape Canaveral.
29 July Second missile launch from Cape.
1 Aug. Patrick Air Force Base, administrative headquarters for AFMTC officially dedicated.
25 Oct. First Lark missile launched by an Air Force Crew from Cape Canaveral.
Nov. Construction started at Grand Bahama Island for first downrange missile tracking station.

1951

1 Jan. The 4800th Guided Missile Wing established.
14 May AFMTC established, replacing Long Range Proving Ground Division, and placed under ARDC.
20 June First launch of the AF Matador from Cape.

1952

8 Dec. AF 1st Pilotless Bomber Squadron (Light) established at AFMTC for training on Matador.

1953

Jan. Construction of underwater cable from Cape Canaveral to Puerto Rico begins.

1954

Jan. Pan American World Airways takes over operation and maintenance of the Florida Missile Test Range.
9 Mar. 1st Pilotless Bomber Squadron (Light) transferred to NATO forces.
1 Aug. Maj. Gen. Donald N. Yates succeeds Maj. Gen. William L. Richardson as Commander of AFMTC.

1955

1 Jan. Four missile research and development flight programs underway at AFMTC: Matador, Snark, Bomarc, and Redstone.

1956

July X-17 test program begins at Cape to study re-entry problems by simulating re-entry velocities and conditions.
19 Sept. First Jupiter-C launched from Cape Canaveral. Modified Redstone carried 84-pound payload over 3000 miles.

1957

25 Jan. First attempted test flight of Thor IRBM. Flight not successful.
31 May First launching of Army Jupiter IRBM.
June First test flight of Atlas ICBM. Lift-off successful but malfunction in propulsion system occurred. Missile destroyed.
7 Aug. Nose cone from Jupiter-C test vehicle recovered from

←*FIRST launch was Bumper.*

lishment of the first tracking stations in the Bahama Islands for what was to become the more than 5000-mile Atlantic Missile Range.

• **Multi-million installation**—Today—over 800 missiles later—more than 20,000 persons make up the military-civilian team now working at AFMTC. The value of the capital plant, including Cape Canaveral, the AMR tracking stations, and Patrick AFB, now stands at almost $800 million. Operating costs for Fiscal Year 1960 were $230 million.

During the past decade, all of the long-range missiles of the Air Force, Army and Navy have undergone development flight tests at Cape Canaveral. The nation's major space experiments—except the *Discoverer* program—have used AMR facilities.

AFMTC's mission, under the Air Research and Development Command, is to operate and maintain the Atlantic Missile Range, conduct missile flight tests and collect and evaluate flight test data for the Air Force, Army, Navy, other governmental agencies, and missile contractors.

• **Space Age First**—Practically all the historic "firsts" in the nation's missile and space programs have taken place at Cape Canaveral—the first satellite, the first space probe, the first nose cone recovery, the first full-range ICBM flights, and many other significant achievements.

The second decade of missile launchings is off to a big start. Construction is being completed at the Cape on launch facilities for the *Minuteman* solid-fueled ICBM, the *Centaur,* and the *Saturn* 1.5-million-pound thrust space booster. And the first NASA Project *Mercury* man-in-space launchings are expected to begin in the near future.

CAPE CANAVERAL DIARY

the South Atlantic marking the first recovery of a re-entry body at long range.

20 Sept. First fully successful test flight of Thor IRBM.

Oct. Two Thor missiles successfully launched.

Oct. First full-range launch of Snark.

17 Dec. First successful launch of Atlas on 54th Anniversary of the Wright Brothers' first flight at Kitty Hawk, N.C.

1958

17 Jan. First launch of Polaris test vehicle in Navy's FBM test program at Cape.

31 Jan. Explorer I, Free World's first earth satellite, launched by a Jupiter-C.

5 Mar. Explorer II launched, but failed to achieve orbit.

17 Mar. Vanguard I, nation's second satellite, launched into orbit.

23 Apr. Thor-Able launched from Cape Canaveral to study re-entry problems at intercontinental ranges.

15 May Explorer III launched.

4 June Thor flight-tested for first time from a tactical-type launcher.

27 June All-Air Force crew successfully flight tested the Snark for first time.

June Recovery of the first data capsule at AMR after successful re-entry separation.

2 Aug. First full-power flight of Atlas using both sustainer and booster engines.

7 Aug. First launching of Bomarc interceptor missile on signal sent by SAGE control Center at Kingston, New York

17 Aug. First lunar-probe flight by Thor-Able ends when vehicle explodes 77 seconds after lift-off.

11 Oct. Pioneer I, nation's first space-probe, boosted by a Thor-Able launched. Re-entered earth's atmosphere on 12 Oct. after attaining altitude of 71,300 miles on a flight of 43 hours and 12 minutes.

28 Nov. First full-range (over 6000 statute miles) launch of the Atlas ICBM at AMR.

6 Dec. Pioneer III launched by a Juno II. Payload achieved altitude of only 63,500 miles before falling back to earth.

13 Dec. Jupiter carrying a live monkey in its nose cone launched.

18 Dec. Atlas launched into orbit. Known as Project Score, the experiment demonstrated feasibility of communications satellite.

1959

6 Feb. First test launch of the Titan ICBM from Cape.

3 Mar. Pioneer IV, a 13.4-pound satellite, launched into orbit around the sun by a Juno II. Signals were received from Pioneer IV at a distance of 416,000 miles from the earth.

8 Apr. Re-entry body of a Thor-Able recovered for first time after an ICBM-range flight.

23 Apr. First flight test of GAM-77 at AMR.

27 May First flight test of Bomarc-B long-range interceptor missile.

28 May Two monkeys, Able and Baker, launched in Jupiter to altitude of 300 miles and recovered alive.

5 June Start of construction at Cape Canaveral for Saturn 1.5 million-pound-thrust space vehicle.

2 July A Snark completed its third "round robin" flight at AMR.

21 July Full-scale Atlas ICBM nose cone recovered for the first time after a flight to far end of AMR.

7 Aug. Explorer VI, launched by Thor-Able III vehicle. "Paddle-wheel" satellite, measured earth radiation belts around the earth and carried scanning device to relay cloud-cover pictures.

25 Aug. First data capsule from Atlas ICBM recovered near Ascension Island.

27 Aug. First launch of Polaris test vehicle from the USS Observation Island at sea.

9 Sept. One-ton model of Mercury capsule launched on an Atlas to study design features of man-in-space capsule. Called "Big Joe I" the flight path of the missile carried the capsule to an altitude of about 100 miles to an impact point more than 1500 miles downrange. Capsule recovered.

18 Sept. Vanguard III launched into orbit to measure solar X-rays, environmental conditions in space and earth's magnetic field.

2 Oct. Major General Donald N. Yates, AFMTC Commander, appointed DOD Representative for Project Mercury support operations.

13 Oct. Explorer VII, a radiation-detection satellite launched into orbit by Juno II.

26 Oct. First AF Mace tactical missile test-launched.

26 Nov. Attempt to launch 372-pound satellite to explore space between earth and moon failed.

5 Dec. First transcontinental airlift of Atlas completed by C-133B aircraft, after seven-hour flight from California.

17 Dec. Final weapon system flight test of Thor accomplished.

1960

2 Feb. Ignition of Titan second stage at altitude occurred for the first time.

24 Feb. First 5000-statute-mile flight test of Titan. Data cassette ejected from re-entry vehicle recovered one hour and 13 minutes after launch.

25 Feb. First test launch of Pershing tactical-range missile.

11 Mar. Pioneer V, designed to investigate interplanetary space between the orbits of the Earth and Venus, launched by Thor-Able IV vehicle.

1 Apr. Tiros I, a 270-pound NASA meteorological satellite, launched.

13 Apr. Transit 1B, designed to determine the feasibility of a satellite system for all-weather navigation, launched by Thor-Able Star vehicle.

20 May Atlas ICBM propelled its operational-type nose cone on a 9000-mile flight into Indian Ocean near southern tip of South Africa.

21 May Major General Leighton I. Davis assumed command of AFMTC succeeding Major General Donald N. Yates who became Deputy Director of Defense Research and Engineering (Range and Ground Support).

24 May Midas II, satellite designed to determine feasibility of a system for detection of missile launching with satellite-borne infrared sensors, launched by Atlas-Agena vehicle.

22 June Transit IIA, another in a series of navigational satellites, launched with Thor-Able-Star vehicle.

11 July Mace tactical missile launched from prototype "hard site" at Cape Canaveral for first time.

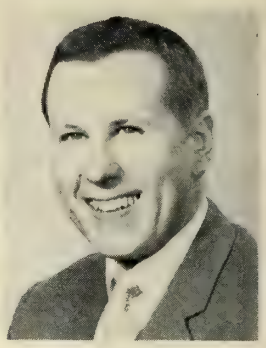
20 July First Polaris missiles launched from a submarine (USS George Washington) and fired 1200 miles down AMR.

names in the news


TOWL


BEARINGER


DOOLITTLE


BUTLER

E. Clinton Towl, named president of Grumman Aircraft Engineering Corp. Towl has been administrative vice president since 1954. The Board of Directors also chose **William T. Schwendler** former senior vice president, as Chairman of the Executive Committee. **Llewellyn J. Evans,** former general counsel becomes a vice president. **Leroy R. Grumman** continues as Chairman of the Board of Directors.

Dr. Van W. Bearinger, appointed director of research for Minneapolis-Honeywell Regulator Co. He has been associate research director since 1956, and now fills a vacancy created a year ago by the promotion of **Dr. Finn J. Larsen** to corporate vice president in charge of research. Other appointments at M-H include **Dr. John N. Dempsey** and **Edward E. Rexer** to assistant directors of research.

Kent Doolittle, named general manager of the Western Operation of CTL Division of Studebaker-Packard Corp. The new plant is located in Santa Ana, Calif.

George D. Butler, International Resistance Co.'s Director of Marketing elected a Vice President. Butler will continue to be in charge of marketing activities.

George Havas appointed Vice President and Director of Engineering of Kaiser Industries Corp. Havas has been Chief Engineer of the Henry J. Kaiser Co. after 1935 and a vice president since 1945. In 1958 he assumed the position of General Manager of the company's Heavy Construction Division and international subsidiaries.

Arthur L. B. Richardson elected Senior Vice President of Sylvania Electric Products Inc. **William F. Rueger** named Secretary of the Company.

In appointments at Sylvania Electronics Systems division: Systems Engineering and Management Operation, **Hunter C. Harris** to technical manager; Buffalo Operations, **Robert C. Boe** to marketing manager.

Sylvania Semiconductor Division: appointed **Frederick S. Kerr** sales engineer for the New England area and **Chester J. Penza** sales engineer for lower Connecticut, New York and New Jersey area.

Edward H. Heinemann, appointed executive vice president of Summers Gyroscope Co. Heinemann is former corporate vice president of Douglas Aircraft Co. in charge of Combat Aircraft Engineering, Aircraft and Missiles.

Richard E. Palmer, named manager of The Garrett Corp.'s AiResearch Manufacturing Division of Los Angeles. Palmer has been associated with AiResearch for more than 18 years.

Emile F. duPont elected to the board of directors of the DuKane Corp., St. Charles, Ill.

A. M. (Tex) Johnston, veteran test pilot and former chief of flight test for Boeing, named an assistant Boeing program manager for *Dyna-Soar* manned space glider.

W. E. Giberson, tapped as chief of the newly organized Guidance and Control Division at California Institute of Technology Jet Propulsion Laboratory.

Dr. James W. Moyer, chosen research director of the Sperry Rand Research Center to be built later this year in Sudbury, Mass. Dr. Moyer has formerly been associated with the General Electric Co.

Leonard H. Davis, elected executive vice president of The Gabriel Co. Davis moves from vice president and general counsel. In another change, Gabriel president **John H. Briggs** also assumes the office of treasurer, relieving **Robert T. Hood** for full time duty as president of the Automotive Div. of The Gabriel Co.

Newly-formed Bell Aerospace Corp., former defense units of Bell Aircraft Corp. announces appointments in the Bell Aerosystems Co., (formerly Niagara Frontier Division.) **William G. Gisel,** (former vice president and treasurer of Bell Aircraft Corp., and general manager of Niagara) named to president. **Dr. Walter R. Dornberger,** vice president (former vice president of Bell Aircraft), and **John H. van Lonkhuyzen,** vice president (was Bell Aircraft's Avionics Div. manager).

Albert W. Brandmaier, selected as director of Consolidated Electrodynamics Corp., international operations for the Bell & Howell International Division.

Lee C. Pulsipher named by Perkin-Elmer Corp. to head its new Vernistat Division operation in Los Angeles.

William S. Aiken tapped as Director of Engineering at The Thompson-Ramo-Wooldridge Products Co. Aiken has been manager of the Project Engineering Department at the computer firm.

John F. Gardner, appointed plant engineer at Hughes Aircraft Co.'s ground systems group in Fullerton, Calif.

Bliss M. Bushman, John D. Gum and **James T. Sharpsteen** appointed director of systems engineering and assistant directors respectively at Consolidated Systems Corp., an associate company of Allis-Chalmers Mfg. Co., Bell & Howell, and Consolidated Electrodynamics.

Kenneth Duncan joins Gorham Electronics Laboratory as staff scientist. He was formerly with Gabriel Electronics Division.

Bernard Krieger moves into position of manager of Marketing for Manson Laboratories, Inc.

F. C. Milner appointed manager of the Los Angeles Area Field Office of the Military Sales Department of Librascope Division, General Precision Inc.

Thomas S. Hurley selected as supervisor of merchandising and advertising for CBS Electronics semiconductor operations. Hurley previously was a sales promotion manager for Raytheon Co.

soviet affairs

By DR. ALBERT PARRY

The Soviet computer program

is not in the best of shape. Plans are grand but their execution lags, and the quality of machinery is low. The Kremlin has appropriated large sums of money for the program: annually, until 1965, two billion rubles ($500,000,000 at the official Soviet rate of exchange) are to be spent to build electronic information processing digital computers. But on June 12 Academician Axel I. Berg complained in a front-page article in *Izvestia:* "The low quality of elements and details in our radio electronic instrumentation hampers the construction of more perfect electronic computing and guiding machines."

A conference on computer technology

held recently in Moscow presented rather mixed results. "We rejoiced at the plentitude of the already built mathematical machines," a Soviet engineer wrote in *Komsomolskaya Pravda* of June 11, "but their quality was no source of joy." As an example of the lag in quality, A. Musatkin, author of the article, stressed that some of the new Soviet computers discussed at the conference were using "old lamps" instead of transistors.

Duplication of effort

by too many Soviet computer-designing and building agencies was also decried by Comrade Musatkin. He urged, as a remedy, concentration of "specialized manufacture of standard elements of electronic computers" under the roof of just one agency. Such a concentration, he pointed out, would lead to a lower cost of the machines as well as their greater reliability. Savings in time required to build each new machine would also result, Musatkin wrote. He noted that "other countries, possessing a high level of development of computing technology, have not as yet adopted such specialized manufacture of standard elements." But this lack should not be an example to the USSR, he declared. "Such a transformation can be quickly effected only in our country which has planned guidance of industry."

Shortage of computer personnel

is another complaint in Russia. Some 200 graduate students are now being trained at the University of Moscow to be sent to Novosibirsk, there to work with large-scale computers. But it will be 1961 before they are finally on their way to their Siberian jobs. Meantime the existing Soviet roll of computer experts is deplorably sparse. Musatkin reveals that the Bauman Technical School in Moscow, one of the country's largest, has so far graduated yearly only some 40 engineers who know how to build electronic equipment and computing machines. He exclaims: "How can we be satisfied with such a quantity when, in order to create even a small electronic computer, no less than 20 engineers are needed!"

A friend who is a computer engineer

has told Musatkin that in the three years since graduation he changed jobs twice—an unusually high fluidity in the Soviet Union where a young graduate is supposed to be "frozen" to his first job, as his obligation to the state, for at least three years. Musatkin writes: "Don't think that he is a poor worker or can't get along with his associates. No, the matter is far more complex. It turns out that it isn't easy to find specialists in computing technology. The demands clearly exceeds the supply. "Men are being lured from job to job.

Some Soviet agencies

in this field try to solve the problem by supplying training in computer-building to the brightest of their engineers who did not study this work in their college years. But such retooling is held by Musatkin to be too time-consuming even if, in the long run, it does "bring the desired result." He calls on the Soviet Ministry of Higher and Middle Special Education to train such experts from a much earlier time of their lives and study.

when and where

AUGUST

Fourth Global Communications Symposium, co-sponsored by IRE, Professional Group on Communications Systems, and U.S. Army Signal Corps, Statler Hilton, Washington, D.C., Aug. 1-3.

Massachusetts Institute of Technology, Special Program on Modulation Theory and Systems, Cambridge, Aug. 1-12.

International Symposium on Rarefied Gas Dynamics, University of California, Berkeley, Aug. 3-6.

University of Connecticut, Institute for Practical Research on Operations, Storrs, Aug. 7-13.

University of Connecticut, Third Annual Institute on Missile Technology, Storrs, Aug. 7-19.

Annual Meeting of the Association of the U.S. Army, Sheraton-Park Hotel, Washington, D.C., Aug. 8-10.

American Astronautical Society, Western National Meeting, Olympic Hotel, Seattle, Aug. 8-11.

American Institute of Electrical Engineers, 1960 Pacific General Meeting, El Cortez Hotel, San Diego, Aug. 8-12.

ASME-AIChE Heat Transfer Conference and Exhibit, Statler-Hilton Hotel, Buffalo, N.Y., Aug. 15-17.

XIth International Astronautical Congress, IAF, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, University of Colorado and National Bureau of Standards, Boulder, Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Aug. 23-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

The German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control, Institute, Storrs, Aug. 28-Sept. 9.

The Combustion Institute, 8th International Symposium on Combustion, California Institute of Technology, Pasadena, Aug. 29-Sept. 2.

10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

SEPTEMBER

Society of Instrument Technology and British Interplanetary Society, One-day joint symposium on Rocket and Satellite Instrumentation, Manson House, London, Sept. 1.

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Calif., Sept. 7-8.



Analog-Pulse Signal Rec/Rep.

A magnetic tape system capable of recording and reproducing both analog and pulse signals has been introduced by Mincom Division of Minnesota Mining and Manufacturing Company.

The model CM-100 video band recorder-reproducer which combines the capabilities of two machines in one is packaged in a single, standard-size rack. Each of the seven video tracks covers an overall bandwidth of 400 cycles to 1.0 megacycle.

The single ½-inch tape travels at any one of six speeds ranging from 7½ ips to 120 ips.

Highlight of application features of the CM-100 is the fact that in the megacycle range it can record at 120 ips one microsecond pulses spaced one microsecond apart and then, because of its versatile, instantaneous speed control, can increase the time axis of the pulses by 16 so that they can be assimilated by a computer to reduce the data.

Circle No. 225 on Subscriber Service Card.

Gaussmeter

Wrisley Engineering, Inc., announced the Model G/M-50 Gaussmeter for use in conjunction with electrodynamic vibration systems for measurement of stray magnetic field at critical specimen locations. No electronics nor external connections are required. Accuracy is better than ± 10% of full scale.

Circle No. 226 on Subscriber Service Card.

Tele-Signal Simulator

A precision telemetry Signal Simulator, the Model 145B, has been developed by Electro-Mechanical Research, Inc. The Model 145B combines in one versatile instrument the means for simulating PAM and PDM pulse trains for checkout, calibration, and evaluation of telemetry decommutation equipment.

Precision of the unit permits its use as a standard for evaluating either system or equipment characteristics such as linearity, stability, and crosstalk. It simulates all PAM and PDM signals specified in MIL-T-26985A (USAF) and IRIG standards.

Circle No. 227 on Subscriber Service Card.



High Tensile Shear Epoxy

A tensile shear of 2200 psi at 300°F on aluminum-to-aluminum for HYSOL 4322 adhesive has just been announced by HYSOL Corp.

HYSOL 4322, a smooth, thixotropic, 100% solid paste that will not flow during cure even when applied to vertical surfaces is ideally suited for bonding porous surfaces. It is also recommended for bonding metal, plastics, ceramics, glass and wood. The adhesive film has a slight resiliency insuring against cracking during thermal shock.

Circle No. 228 on Subscriber Service Card.

Adapterless Cable Plug

Sealectro Corp. announces a "Conhex" cable plug eliminating the usual adaptor necessary in running subminiature coaxial cables into BNC and TNC panel connectors.

The cable plugs minimize power loss and lower the costs of assembly through direct connection. Utilizing the patented "Conhex" design, the cable plug provides a vise-like grip on the subminiature cable with a strength greater than the cable itself. The cable plug is gold-plated to resist corrosion and to provide lower contact resistance.

Circle No. 229 on Subscriber Service Card.

Precision Angle Encoder

A BRL-5 high-precision angle-encoding system has been developed and is now available from United Aircraft Corporation's Norden division and Colorado Research Corp.

This new system divides a single revolution of a shaft into 360,000 parts and simultaneously provides parallel real-time readouts in three forms: electrical 8-4-2-1 binary coded decimal, electrical straight decimal, and visual decimal on NIXIE Tubes. Other systems also are available which provide pure binary resolutions of from 2^{18} to 2^{21} in a single turn.

An important feature of the new electronics is its repackaging and qualification to MIL E-5400 for airborne use a similar size ground-based package also is available.

Circle No. 230 on Subscriber Service Card.

Pressure Cartridge

Holex, Inc. is manufacturing a standard line of nineteen electrically-initiated pressure cartridges available in energy out-put ratings from 10 to 135 ft/lbs. These cartridges are spe-

cifically designed as power generators for the explosive actuation of piston-operated mechanical devices such as valves, cable cutters, actuators, stage separation systems, thrust reversers, etc. All cartridges feature ½-20 UNF thread-in pressure sealed configuration.

Circle No. 231 on Subscriber Service Card.

Wet Tantalum Capacitors

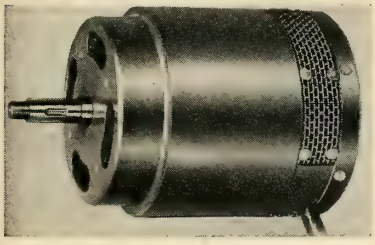
Production of a 100-volt dc hermetically sealed wet electrolyte, sintered anode tantalum capacitor series is announced by U.S. Semiconductor Products.

Immediate delivery of U.S. Semcor's new TSW line is available in ratings from 6 to 100 working volts and capacitance MFD from 270 to 4.7 at 85°C. Applicable MIL Specs are met or exceeded in leads, moisture resistance, temperature and immersion. Supplied with or without insulating sleeve, the bare tube case is 0.188 in. diameter, 0.525 in. length for TSW1 model, and 0.282 in. diameter, 0.720 in. length for TSW2 model.

Circle No. 232 on Subscriber Service Card.

Compact Induction Motor

Kearfott Division of General Precision, Inc. announced the availability of the F-25-2 induction motor. The motor has been tested and conforms to the requirements of MIL-M-7969A



and to the environmental requirements of MIL-E-5272A, Procedure I, including humidity, high and low temperature, explosion-proof, altitude, and vibration.

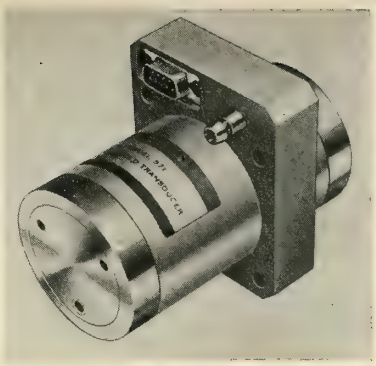
Circle No. 233 on Subscriber Service Card.

Glass Ceramic Cement

A glass-ceramic cement for the electronics industry has been developed by Corning Glass Works to seal glasses and other materials with thermal expansions between 80 and 92 x 10^{-7} cm/cm/°C.

Designated Pyroceram Brand Cement No. 89, it has electrical properties similar to those of Pyroceram Brand Cement No. 95, which seals materials with higher expansions. However, at elevated temperatures the 89 cement is stronger.

Circle No. 234 on Subscriber Service Card.



Altitude Transducer

Bourns, Inc. announces the development of a new instrument/system, the Model 571 Altitude Control Transducer.

The Model 571 employs a unique trapped air pressure design to provide an accurate altitude error signal. This instrument is referenced to the particular altitude to be maintained, and any change in this altitude results in an error signal that can be fed into the flight control system for corrective action.

Circle No. 235 on Subscriber Service Card.

Stable Ceramic Capacitor

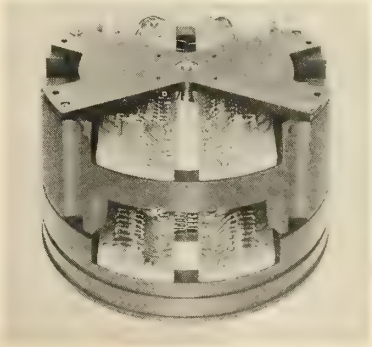
Mucon Corp. has available subminiature ceramic capacitors made low capacitance variation ceramic. The capacitance remains within +4% and –8% of the capacitance at 25°C over the whole temperature range of –55°C to +125°C.

Circle No. 236 on Subscriber Service Card.

Shaft Position Encoder

United Aircraft Corp.'s Norden division has developed a shaft position encoder capable of 100,000 counts in only 100 turns of the input shaft. It is designated the ADC-5-BCD (1000).

This new encoder is basically a 1000 count per turn device. It utilizes the patented Self-Selecting V-Brush technique, which provides a completely unambiguous output without the need



for cumbersome and expensive external logic circuitry, as well as a new split-bit technique, which permits incorporation of this high-resolution encoder into a small package.

Circle No. 237 on Subscriber Service Card.

Miniature Electron Tube

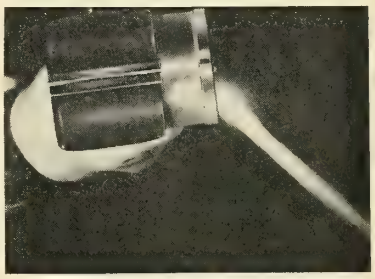
Sylvania Electric Products Inc. has announced the "Ten Pin," a construction in miniature receiving tubes which combines multiple circuit functions in a single bulb or envelope.

The "Ten Pin" uses the regular 9-base pin arrangement of the conventional T-6½ miniature envelope with an additional pin centered in the pin circle. The new design meets demands for improved miniature tube performance and flexibility.

Circle No. 238 on Subscriber Service Card.

Plasma Jet 45° 90° Heads

Newly developed Plasmatron electrodes, which divert the plasma jet 45° or 90° from normal, have been developed by Plasmadyne Corp., a Subsidiary of Giannini Scientific Corp., for use with Plasmatron "S" Series hand held plasma jet spray guns.



The conversion of any Plasmatron "S" Series spray gun from straight jet spraying to 45° angle spraying consists of replacement of the front electrode of the unit. To convert an "S" Series gun to 90° spraying, both front and rear electrodes must be replaced. All other components of the Plasmatron system remain unchanged.

Circle No. 239 on Subscriber Service Card.

Electron Beam Evaporator

A remote-controlled electron beam evaporating unit capable of vaporizing all metals, ceramics, refractory compounds and other non-metallics has been added to the line of EBV vaporizers available as standard products from The Alloyd Corp.

The Alloyd Model EBV-4 is a remote-controlled electron beam gun that, like the EBV-3, is suitable for installation in almost any laboratory or commercial vacuum equipment operating at 3 x 10^{-4} milimeters of mercury or lower. It may be used for either research and development of

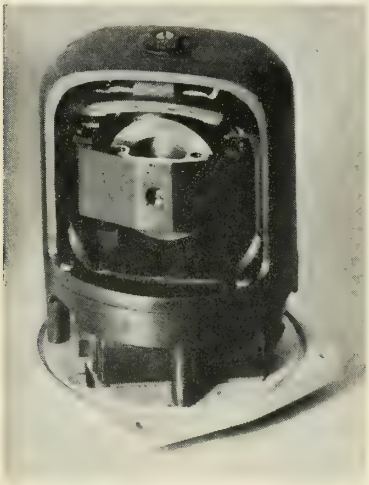
volume production of thin film coatings for microminiaturized electronic circuitry, optical filter films and similar applications.

Circle No. 240 on Subscriber Service Card.

Gas Driven Gyro

Lear, Inc., has developed a gas-driven displacement gyro with only four moving parts.

Its features are absolute design simplicity, a low drift rate, instan-



taneous start time and an inherently long storage life.

It can be produced at a fraction of the cost of convential gyros. Small quantity deliveries can be made immediately.

Circle No. 241 on Subscriber Service Card.

High Temp Foam Tape

TESAMOLL #763, a polyurethane foam plastic pressure-sensitive tape suitable for use in high-temperature operations, has been introduced by United Mineral & Chemical Corp.

In addition to being fungus- and mildew-proof, chemically inert and resistant to temperature and weather extremes and most oils—as all TESAMOLL tapes are—the new high-temperature tape will withstand temperatures up to 248°F.

Circle No. 242 on Subscriber Service Card.

Insulated Thermostat

Catham Controls Corp. is marketing a BW1/4 in. diameter insulated thermostat. It is produced with a patended wiping action and available with contacts that open or close with temperature rises. Any model can be factory calibrated or externally adjusted to obtain the desired actutaing temeprature, which is not affected by ambient temperatures.

Circle No. 243 on Subscriber Service Card.

new literature

ULTRA CLEAN FACILITIES—A three color, 8 page brochure entitled "Requirements for an Ultra Clean Facility" has been made available by Shielding, Inc. The brochure has index tabs for quick reference. The main subject headings are: Construction and Environmental Control Systems. Subdivision discusses: Modular Wall Panels, Non-Dusting Materials, Illumination, Floor Covers, Air-Showers, Pass Through Chambers, Pressurized Cabinets, Temperature-Humidity, Air Pressure, Air Replacement, Filtration, etc. A perforated application information form is attached which enables each potential user to get engineering information for Shielding on his particular application.

Circle No. 200 on Subscriber Service Card.

TUBE CATALOG—An illustrated 20-page catalog has just been released by Pacific Tube Co. This comprehensive manual details materials, size ranges, mechanical and physical properties, tolerances, lengths, specifications, material selection and applications of the mechanical, pressure and aircraft tubing produced by Pacific.

Circle No. 201 on Subscriber Service Card.

VIBRATORY MATERIALS HANDLING—A condensed catalog of vibratory materials handling equipment, vibrating parts handling equipment, power rectification equipment, mechanical shaft seals, paper joggers and portable power tools is announced by Syntron Co. It presents descriptions, data and specifications on all Syntron products, and shows products in operation.

Circle No. 202 on Subscriber Service Card.

LIQUIFIED GAS—A four-page booklet covering the principles and techniques of handling, storing and converting liquified oxygen, nitrogen and argon is now available from Air Reduction Sales Company. Entitled "The Liquid Story," the booklet features discussions of the history of the use of these gases, the advantages of storage in the liquid state, and the design and purpose of equipment used for their storage and delivery. Schematic drawings help to clarify points in the text.

Circle No. 203 on Subscriber Service Card.

FIFTH GROUP STEEL BONDED CARBIDES—A nine-page reprint available from Sintercast Division of Chromalloy Corp., translated from *Planseeberichte für Pulvermetallurgie*, December, 1959, reports the results of investigation on cermets performed at Sintercast by the authors. Vanadium, tantalum, and niobium carbides, bonded with carbon steel, were prepared by standard powder metallurgy techniques, and sintered in both hydrogen and vacuum. Resulting cermets were tested for hardness, density, transverse rupture, and machinability in the annealed condition. Illustrations include several photomicrographs showing grain structure of various cermets, as well as graphs correlating hardness of carbides with hardness of resulting cermets. In addition, several tables summarize the physical properties of carbides and steel-bonded compositions.

Circle No. 204 on Subscriber Service Card.

MAGNETIC LAMINATIONS—A two-color, 36-page catalog just released by G-L Electronics, contains an abundance of factual information, formulae and engineering data regarding each individual EE, EI, F, DU and W shape which is currently available from G-L. In this catalog, the manufacturer also introduces a new part numbering system which easily identifies each transformer lamination shape by its decimal equivalent. A handy cross reference index guide on the back cover shows additional comparison figures and specifications for individual shapes.

Circle No. 205 on Subscriber Service Card.

IMPULSE COUNTERS—A 6-page bulletin, describing Sodeco Ti Series Heavy Duty Electric Impulse Counters, is available from Landis & Gyr, Inc. Complete technical data is given including operating instructions, execution possibilities including several circuit diagrams, electrical information for both AC and DC models, and dimensional data.

Circle No. 206 on Subscriber Service Card.

NITRONEAL GENERATOR—A booklet of interest to industrial users of nitrogen or nitrogen-hydrogen mixtures has been published by the Chemical Division of Engelhard Industries, Inc. Titled *Nitroneal Generator*, the booklet provides detailed descriptions of equipment with capabilities ranging from 50-100 up to 2500-10,000 standard cubic feet per hour, including flow diagrams.

Circle No. 207 on Subscriber Service Card.

SILICON RECTIFIER DATA—Fansteel Metallurgical Corp. has published four separate data sheets helpful to any engineer or designer who specifies, uses or is concerned with silicon rectifiers. The sheets cover many of the technical aspects of application, heat sink requirements, surge voltage protection, parallel operation and series operation of silicon power rectifiers.

Circle No. 208 on Subscriber Service Card.

contracts

NAVY

Douglas Aircraft Corp., Santa Monica, for the development of the Missileer, the launching aircraft for the *Eagle*. Amount not disclosed.

Horkey-Moore Associates, Plastics Division, Torrance, Calif., for production of 400 rocket nozzles. Amount not disclosed.

The M. M. Newman Corporation of Marblehead, Mass., for the production of a special form of Heli-Tube, a cable-harnessing material designed for use in nuclear-powered submarines. Amount not disclosed.

$60,113,000—The Electric Boat Division of General Dynamics Corp., Groton, Conn., for two nuclear-powered fleet ballistic missile submarines.

$32,405,000—Newport News Shipbuilding and Dry Dock Co., Newport News, Va., for one nuclear-powered fleet ballistic missile submarine.

$28,000,000—Northrop Corp., Beverly Hills, for the design, development and production of electronic components for the *Polaris* system, including automatic checkout systems, gyroscopes, type 11 periscopes and radiometric sextants.

$6,000,000—RCA, Moorestown, N.J., for production of mobile radar sets to be installed at the Pacific Missile Range.

$1,600,000—Telechrome Manufacturing Corp., Amityville, N.Y., for communication systems for the *Tartar* and *Terrier* missiles.

$419,000—Bulova Watch Co., Inc., Flushing, N.Y., for warhead safety and army devices for the *Terrier* and *Tartar*.

$208,497—Computer Systems, Inc., Monmouth Junction, N.J., for services, labor, materials, equipment and facilities to design, develop, manufacture and furnish ballistic missile analog plotting board.

$198,767—Northrop Corp.'s Radioplane Division, Van Nuys, for target drones and parts.

MISCELLANEOUS

Micromega Corp., Venice, Calif., for the design and fabrication of low-noise parametric amplifiers to be installed in a satellite tracking radar. Amount not disclosed.

$150,000—The Martin Co., Baltimore, for development and production of a radioisotope-fueled generator for use with an automatic electronic "sentry" powered by nuclear energy and capable of recording data and transmitting it from a remote ground location for at least two years without refueling or servicing.

AIR FORCE

$7,000,000—Vitro Laboratories, a division of Vitro Corporation of America, New York City, for operation and maintenance of the Eglin Gulf Test Ranges through June 1961.

$3,000,000—Chance Vought, Dallas, for extension of drone services for missile testing from Eglin AFB.

$1,700,000—Vickers, Inc.'s Aero Hydraulics Division, Detroit, for production of battery powered auxiliary power units for nozzle control units for all three stages of the *Minuteman*. Subcontract from Autonetics.

$1,665,336—General Motors Corp., AC Spark Plug Division, Flint, for depot level maintenance on the guidance sub-system of the SM-75 weapons system, its components and the related ground support equipment.

$1,150,118—Fairchild Camera and Instrument Corp., Defense Products Division, Syosset, N.Y., for photographic reproduction system and data.

$1,143,389—Hughes Aircraft Co., Culver City, for spare components in support of the MG-13 fire control system.

$1,100,000—Beckman Instruments, Inc., Systems Division, Anaheim, for two high-speed data processing systems to be used with current satellite programs. Subcontract from **Lockheed Aircraft's Missiles and Space Division.**

$1,002,800—ACF Industries, Inc., Electronics Division, Riverdale, Md., for F-105D, type MB-7 flight simulator, spare parts, special tools, data and services.

$1,000,000—Space Electronics Corp., Glendale, for the fabrication of the electronic systems for the AbleStar upper stage booster.

$571,000—Electronic Specialty Co., Los Angeles, for a complete airborne missile tow target for the Century jet fighter series.

$445,120—Douglas Aircraft Co., Inc., Santa Monica, for system engineering for *Thor*.

$417,347—Melpar, Inc., Falls Church, Va., for development and fabrication of advanced trainer, *Bullpup*, ground pilot GAM-83 A/B, engineering specifications and data.

$360,000—Dynatronics, Inc., Orlando, for PCM data conversion system.

$300,896—North American Aviation, Inc., Rocketdyne Division, Canoga Park, for research and development for fabrication and delivery of pressure storable propellant rocket engine.

$275,000—The Bendix Corp., Eclipse-Pioneer Division, Teterboro, N.J., for two propulsion monitoring systems and data.

$197,230—Coleman Engineering Co., Inc., Torrance, for parachute test vehicle.

$183,600—The Marquardt Corp., Van Nuys, for prototype multi-stage ejector diffuser.

$149,990—Bell Aircraft Corp., Buffalo, for storable propellant data for the *Titan Mark II* program.

ARMY

Tracerlab, Waltham, Mass., for continued research on nuclear altimeter. Amount not disclosed.

$13,084,478—Raytheon Co., Andover, Mass., for industrial engineering services, field maintenance, test equipment and ground equipment for the *Hawk*. (Two contracts.)

$10,935,410—Motorola, Military Electronics Division, Phoenix, for 12 radio communications central systems.

$5,263,650—Minneapolis-Honeywell Regulator Co., Hopkins, Minn., for production of *Honest John* rocket warhead assemblies.

$3,353,466—The Martin Co., Orlando, for *Lacrosse* engineering services.

$3,352,676—The Bendix Aviation Corp., Redbank Division, Eatontown, N.J., for *Nike-Hercules* warhead section, handling, checkout, repair parts and special testing of XM75 adaption kit quality assurance and stockpile reliability program. (Two contracts.)

$3,085,103—Belock Instrument Corp., College Point, N.Y., for *Hawk* missile system training device 3-G-36 and repair parts.

$2,000,000—ITT Federal, Clifton, N.J., for *Nike* support equipment.

$1,749,322—Raytheon Co., Andover, Mass., for repair parts, modification kits for CW acquisition radar for *Hawk* and services to incorporate CCM function in system. (Three contracts.)

$1,344,500—Morrison-Knudsen Co., Inc., Seattle, for construction of control area facilities for *Nike Hercules* battery.

$987,500—The Martin Co., Orlando, for launcher, helical rail, *Lacrosse* missile.

$980,768—Western Electric Co., Inc., New York City, for *Lacrosse* engineering services.

$892,117—Raytheon Co., Andover, Mass., for modification kits and maintenance test equipment for *Hawk*.

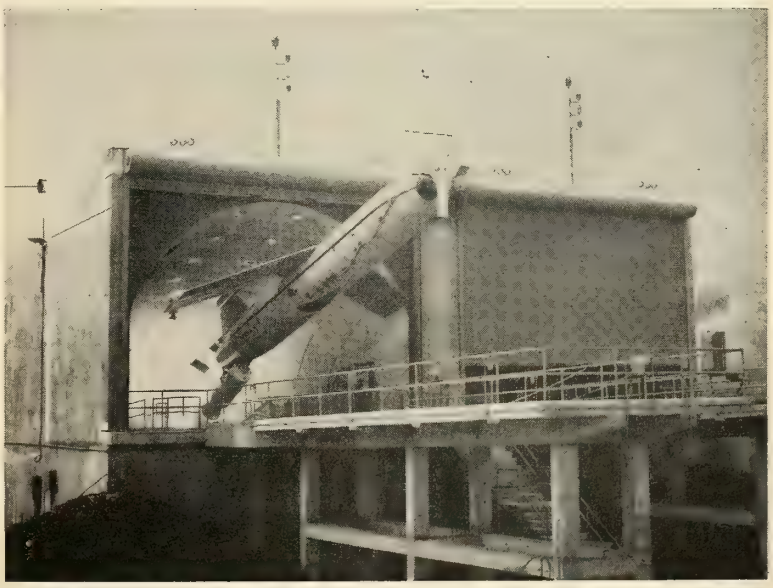
$727,375—The Budd Co., Philadelphia, for development of high performance rocket motor cases.

$235,000—Lockheed Aircraft Corp., Marietta, Ga., for fabrication and assembly of components for *Saturn*.

$176,000—Hayes Aircraft Corp., Birmingham, Ala., for engineering, design and specialized services for manufacture of special tooling and fixtures for *Saturn*.

$149,984—Atlantic Research Corp., Alexandria, Va., for necessary services to conduct a research study in the field of "Flexible Polymers to be Used as Thermal Insulation in Solid Propellant Rocket Motors".

Mace Goes From Hard Site



PROTOTYPE OF MACE B hardened launcher was proved out in a July 11 shot at Cape. Sites will be used in West Germany. The Martin tactical missile was kept on "hot hold" for several hours before firing.

Converted Drones

To the Editor:

I feel you have overlooked an important segment of Aerial Target capability by failing to include Converted Drones in your otherwise excellent special report on drones (M/R, June 27).

We at Sperry point with no little pride to the fact that we have, with Air Force guidance and support, contributed significantly to the successful conversion of the *QF-80, QB-47* and *QF-104* drone aircraft. As a point of fact, developments of the Microwave Command Guidance and "SEE" Systems (both of which were well described in your article) were an outgrowth of our work on converted drone systems.

The Converted Drone, represented at present by the operational *QF-80* and *QB-47* and the developmental *QF-104,* is a significant segment of the Aerial Target capability now in existence and programed for Air Force use in the next few years. In their respective performance classes, these drones provide a payload capacity, endurance, and cost-per-mission capability not approached by any other type of Aerial Target, expendable or recoverable. Operational experience with the QF-80, for example, shows an average record of better than 60 unmanned missions flown per drone prior to loss from any cause other than missile kill.

The unique capability of the Converted Drone will keep it in inventory for some time to come. No general treatment of the drone field can be considered complete without including it.

P. C. Story
Dept. Head
Drone Systems Eng. Dept.
Aeronautical Equip. Div.
Sperry Gyroscope Co.
Great Neck, N.Y.

M/R's encyclopedia covered only powered aerial targets and surveillance drones. Hence it did not include Sperry's highly regarded converted drones.—Ed.

Where It Began

To the Editor:

The "horse and buggy days" of a half century ago blended with the "space age" in the Solar Furnace article and photo in the April 11, 1960 issue of MISSILES & ROCKETS.

The history of these units goes back to 1912 when Blasius Bart developed and patented the Bart Lectroform process, consisting of electro-forming copper over sprayed low melting alloy molds for the reproduction of art objects. In 1929, Blasius Bart developed a bright rhodium process which resulted in a brilliant heat and corrosion resistant surface.

A combination of these processes produced the key item in the solar surface; a 60 inch diameter parabolic mirror electroformed from copper and nickel with the front reflector surface electroplated with bright rhodium. This enabled the production of successful anti-aircraft searchlights and naval search and signal lights.

The advantages of the Bart metal mirrors were published on by the then Major G. B. Robinson, U.S.A.C.A.C. in the December, 1931 issue of the Coast Artillery Journal. The contracting officer in liaison with Bart Labs was Lt. Leslie R. Groves, who is now best known for his great accomplishment on the Manhattan Project.

These reflectors replaced other types and are standard for allied countries as well as ours. Bart Labs helped to establish its production processes at the U.S.A.E.C. plant near Cincinnati, Ohio, which was run by the then Colonel Frank Forney of the Engineers Corps. The searchlights were extensively used during WW II and Bart Labs was congratulated by General Douglas MacArthur for their continuous and outstanding performance on Bataan.

The fact that these mirrors still provide very high reflectivity enabling their use as high temperature (3500°C) research apparatus is a demonstration of the significant protective properties and qualities of the rhodium electroplate and copper and nickel electroforming.

Surplus searchlights were suggested as possible tools in solar studies in '54, and an article was published on this topic in the February '57 issue of Chem. & Eng. News.

This technique developed by Bart about 50 years ago, has now become an important tool in the space age. An improved Lectroform process is now used for the production of wave guide structures, antennas, missile and rocket nozzles, linear electron accelerator structures, hyperthermal, hypersonic tunnels, nozzles, liners, reaction control thrust chambers, plasma gun apparatus, venturis, and many others.

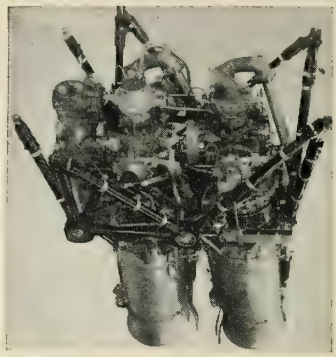
Melvin H. Ehrenberg, Ph.D.
Bart Laboratories & Design Inc.
125 Manchester Pl.
Newark 4, N.J.

Questioned Record

To the Editor:

We were most interested to read in your issue of May 9th this year (Page 25) about the record duration rocket firing made at Rocketdyne's Propulsion Laboratory, Canoga Park, Calif., when their *Atlas* vernier engine ran continuously for over 32 minutes.

We were, however, surprised that this achievement was considered to be a record breaking run, since as early as 1956 we ran a *Spectre 1* engine of our own design (see photo) for 74 minutes



continuously over a range of thrust which included a high proportion at its maximum output of 8000 lb. st. thrust.

The controllable thrust version of the *Spectre* first ran in 1953, and this type of engine may well have been the first type of rocket motor to have a thrust output fully variable between idling and max. output. A distinctive feature of our *Spectre* series of rocket motors is that they all use a topping or "no-loss" turbine where the turbine exhaust gases are used to supplement the main flow in the combustion chamber, a system inherently more efficient than its separate turbo pump counterpart.

We trust that you will understand that we wish in no way to belittle the considerable achievements of our friends at Rocketdyne, but thought that our own achievements as detailed above are at least worthy of note.

J. E. Scott
Public Relations Manager
The De Havilland Engine Co. Ltd.
Leavesden Hertfordshire

For the Record

To the Editor:

In the M/R account (page 17, July 4) of my Colorado Springs speech, I gained the impression that it implied a certain amount of "brittleness" in *Polaris.* I just hope that others won't be led to believe, for example, that a five ft/sec. zephyr along the trajectory will cause a wild shot with this highly accurate system.

Actually, my intent was to convey the message that the *Polaris* system is designed to produce a trajectory of such accuracy that it will be as nearly free of errors—even small ones—as current tech-

nology can make it. Upon reading over my speech now, however, I see that I did not use exactly those words. At the same time, I feel that the words I did use could not reasonably be interpreted in any other way.

Incidentally, my remarks were not repeated with quite the same precision we require of *Polaris* guidance! In my comments on errors I did not name *Polaris*. While drafting the speech I was careful to avoid *Polaris* numerical data because of their security classification. Thus, instead of *Polaris,* I said "a typical missile" and, having paid particular attention to that item, I was careful to give extra emphasis to those words when I said them at Colorado Springs.

Please do not interpret my comments as "nitpicking." This is just an attempt to set the record straight in connection with a subject in which I have a greater than normal interest just now.

J. A. Jaap
Rear Admiral, USN
Dept. of the Navy
Washington 25, D.C.

Why Bases Slip

To the Editor:

Your editorial in the July 11, 1960, issue of MISSILES AND ROCKETS inadvertently omitted to mention the most important single factor responsible for the loss of time, and, incidentally, also for excessive costs of *(Atlas)* missile base construction.

Under the existing regulations, missile base projects must be treated as they were simple roads, and construction contracts are awarded to the lowest bidders without sufficient evaluation of their technical and engineering qualifications to handle complex projects.

Encouraged by outmoded procedures, the profit motive very often predominates, and the essential requirements of providing adequate engineering field supervision and coordination of subcontractor's work is not given sufficient emphasis by the construction contractor.

It would appear that the responsible Government Agency has difficulties in discharging its managerial responsibilities, as witnesses by the amount of rework due to inadequate inspection and resulting delays.

Since, under the existing regulations, neither the Air Force nor Convair have full jurisdiction over missile construction contracts, they cannot be responsible for the delays.

There is only one way to eliminate the slippage and that is to have a single qualified agency, preferably the prime contractor, responsible for the entire weapons systems program.

Dr. Alex J. Paszyc
Professional Engineer
San Marino, California

Truth About Polaris

To the Editor:

On Thursday July 21, 1960, a newspaper columnist wrote a story about *Polaris* missiles based upon half truths, and misinformation.

First of all let me state, and the Navy will substantiate this, that there has not once been a delayed firing of a *Polaris* missile due to Aerojet's failure to have the motors ready. There have been some close calls in this respect, but those have been occasioned by the Navy's pushing the schedules ahead. It should be remembered too that the *Polaris* program is currently running three years ahead of its original schedule and that this is in a great part due to three "technical breakthroughs" by Aerojet. These are:

(1) Dr. Karl Klager's development of higher impulse propellant with superior physical properties that permitted its early application to *Polaris* motors. For this he received the Navy's distinguished service award for civilians.

(2) Resolution of the thrust termination problem at a much earlier date than anticipated. This problem concerned the determination of range and was at the beginning considered one of the toughest problems surrounding the successful evolution of the missile.

(3) The guidance problem utilizing thrust vector control had never before been done in solid rocketry, but here again an earlier than expected breakthrough by Aerojet scientists was accomplished.

When the original Navy specifications were written they called for a 1500 nautical mile missile. At that time the design of submarines and the state-of-the-art of propulsion systems would not permit planning for a missile with greater range.

As a matter of fact, the 1500-mile missile even then was considerably beyond the state-of-the-art; however, it was decided to go ahead anyway and shoot first for an interim missile in the 1000 to 1200 nautical mile range and that is precisely what is being made operational today.

Following close on the heels of the A1 *Polaris* comes the A1a, the A2 and the A2a. These missiles are not behind schedule at all but are currently being test fired from the pads at Canaveral. And contrary to the columnist's allegation, in the development of these advanced *Polaris* missiles Aerojet has happily experienced only a minimum of difficulty. Actually, the A1A *Polaris* will be capable of 1500 nautical miles and this has been occasioned by the fact that additional space has been made available in the submarines to accommodate a slightly larger missile.

The A3, which has not as yet been funded, will have a range of 2500 nautical miles, a range that was not even conceived when the Polaris program got underway. Considerable technical and background work has been done already on the A3 which will result in a speedup in its development time.

Walter G. Winslow
Public Affairs
Aerojet-General Corp.
Washington, D.C.

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editorial . . .

Money—For Weapons and Time

THE successful double launching of two *Polaris* missiles from the nuclear submarine George Washington off the coast of Cape Canaveral last week was the best news on the American defense front for a long time.

The sub-based and launched *Polaris* gives the U.S. arsenal a new weapon that will add both strength and versatility to the U.S. defense posture.

For the first time it makes the Navy a real part of the U.S. deterrent force, presumably with assigned targets in event of war.

And the sea-going *Polaris* will complicate immeasurably the defense problems of the Soviet Union, which is another way of saying the Russians will have to think even longer about attack as it becomes more and more difficult to neutralize our retaliatory forces.

The schedule for building the nuclear submarines to carry the 1200-mile missiles is as follows: nine under present construction; five authorized, for a total of 14. In addition, the Navy is authorized to contract ahead for the long lead time items necessary in the likely event that seven more are authorized, bringing the possible grand total up to 21.

Of these, two will be operational during 1960, two or three more in 1961 and the others about as rapidly as a new administration feels they are important.

Each sub will carry 16 missiles, a total of 224 for the 14 authorized, representing somewhere in the neighborhood of 200 megatons—that is 200 million tons—of explosive power.

It is a rather terrible thought—just as terrible, we hope, to the Kremlin as it is to us.

Last week on this page we wrote that in the present temperature of the not-so-cold war it is almost impossible for the United States to be too strong; that visible brute strength is the one elemental factor in world politics the Communist leaders respect and bend to; that we cannot be equally as strong as Russia—but we must be stronger.

In the last session Congress voted over half a billion dollars more than the Administration asked for weapons and space exploration. Much of this half billion was marked for missiles and missile-carrying aircraft.

There is considerable doubt—and Congress shared this doubt—that the additional money voted will be spent by the Eisenhower-Stans decision. A better reason for voting the money was so that it would be available for the new Administration in January.

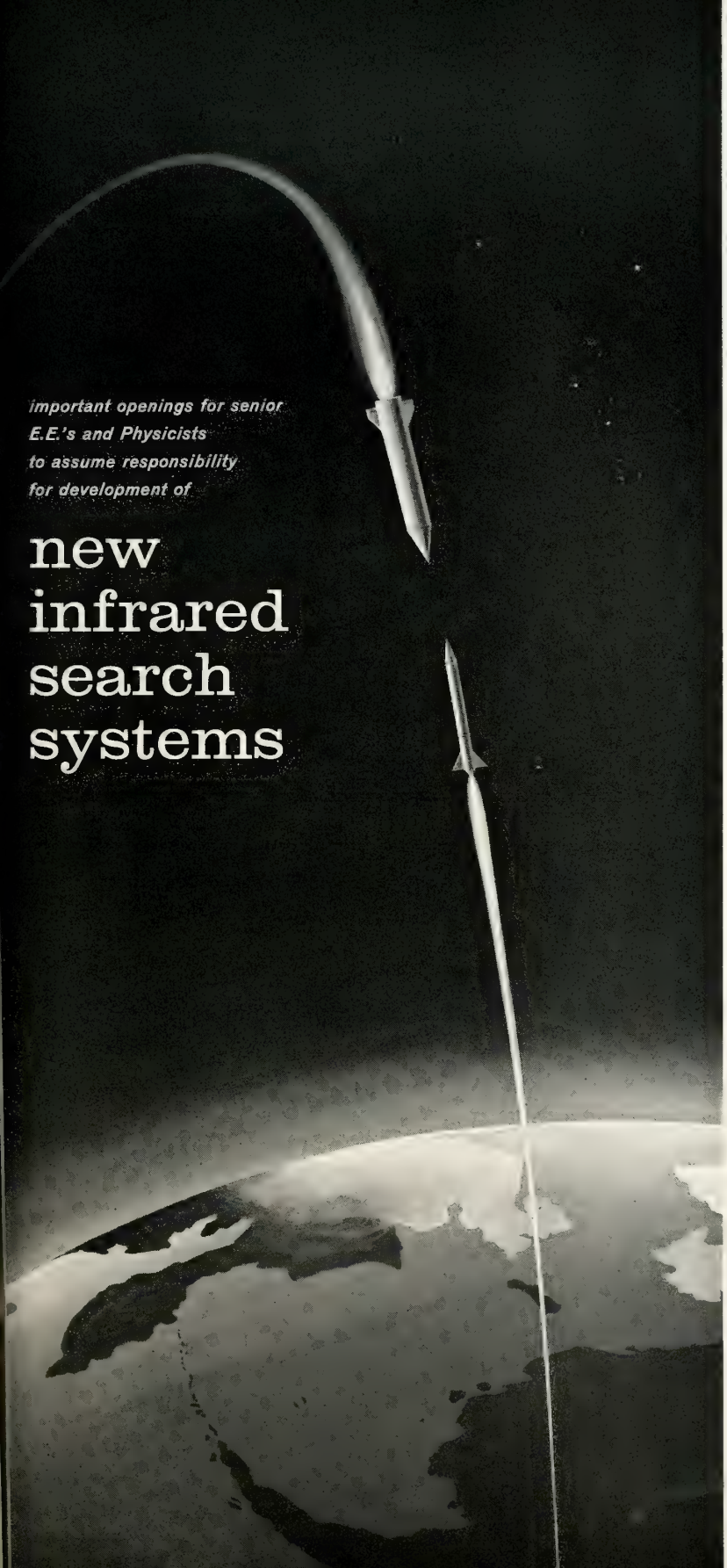
WE DO not believe the defense of the non-Communist world falls *wholly* on the United States, but we do believe that it falls *mainly* there. This includes the arms, supplies, transport and even troops for any United Nations force employed anywhere, from Africa to Cuba.

The half billion voted by Congress will buy hardware. More important, perhaps, it will buy time—time that we may find very precious one of these days.

The *Polaris* is a welcome and powerful addition to the arsenal of the free world. But *Polaris,* like SAC's bombers and ballistic missiles, is just one side of the defense picture. Strength means tactical forces as well as strategic, conventional weapons as well as nuclear. It means mobility—for distances of five miles or five thousand.

The money which Congress added to the budget (plus more they would doubtless vote if requested) and the weapons and time that money would buy may not be the entire answer to Khrushchev's belligerence but it certainly could be a good part of it.

Clarke Newlon



important openings for senior E.E.'s and Physicists to assume responsibility for development of

new infrared search systems

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2. AICBM
3. Air-To-Air Detection Search Sets
4. Satellite Detection & Identification
5. Infrared Range Measurement
6. Detection Cryogenics
7. Detector Application Physics
8. Optical Systems Design

These activities have created a number of new openings for graduate engineers and physicists with analytical and inventive abilities.

You are invited to investigate these openings if you have several years of applicable experience in infrared, optics or electronics, and can assume responsibility for systems analysis and preliminary design.

The importance of infrared development at Hughes is shown in substantial development contracts and in the fact that Hughes is investing its own funds in further exploration.

We invite your earliest inquiry. Wire collect, or airmail resume directly to: **Mr. William Craven,** Manager, Infrared Hughes Systems Development Laboratories, Culver City 32, California

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missiles and rockets

THE MISSILE/SPACE WEEKLY

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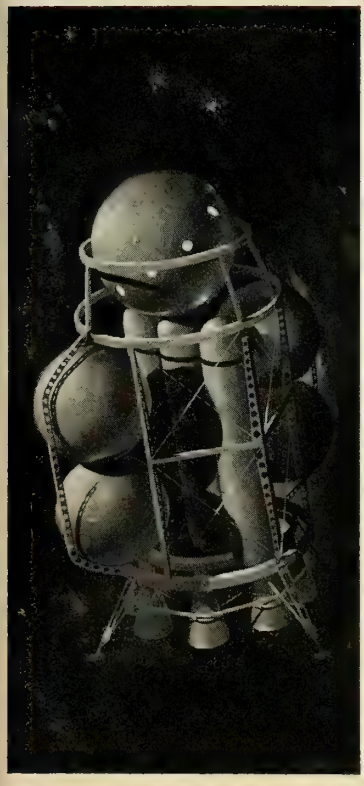
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OUTERSPACE VEHICLES—Sundstrand has been the prominent factor in the development of a solar mechanical engine which, using an advanced working fluid, is capable of providing a continuous source of power generation for satellites, platforms and other space vehicles. A closed cycle power conversion system, this exotic, advanced power system is typical of the research and development work *currently* being conducted by Sundstrand for outerspace vehicles.



UNDERWATER VEHICLES—With an increasing interest in utilizing the deep oceans for both peaceful and defensive purposes, Sundstrand is *currently* engaged in a program investigating the use of a common working fluid in closed cycle systems for underwater propulsion. This work also includes the study of advanced research torpedo configurations.



RE-ENTRY VEHICLES—Since Sundstrand developed the first successful monopropellant missile APU in 1952, Sundstrand has produced a continuous flow of advancements in this area. Sundstrand is *currently* developing a chemically fueled open cycle power generation system which, using hydrazine or hydrogen and oxygen as the propellant, drives a generator for electrical power. It is proposed for re-entry vehicles and similar applications.

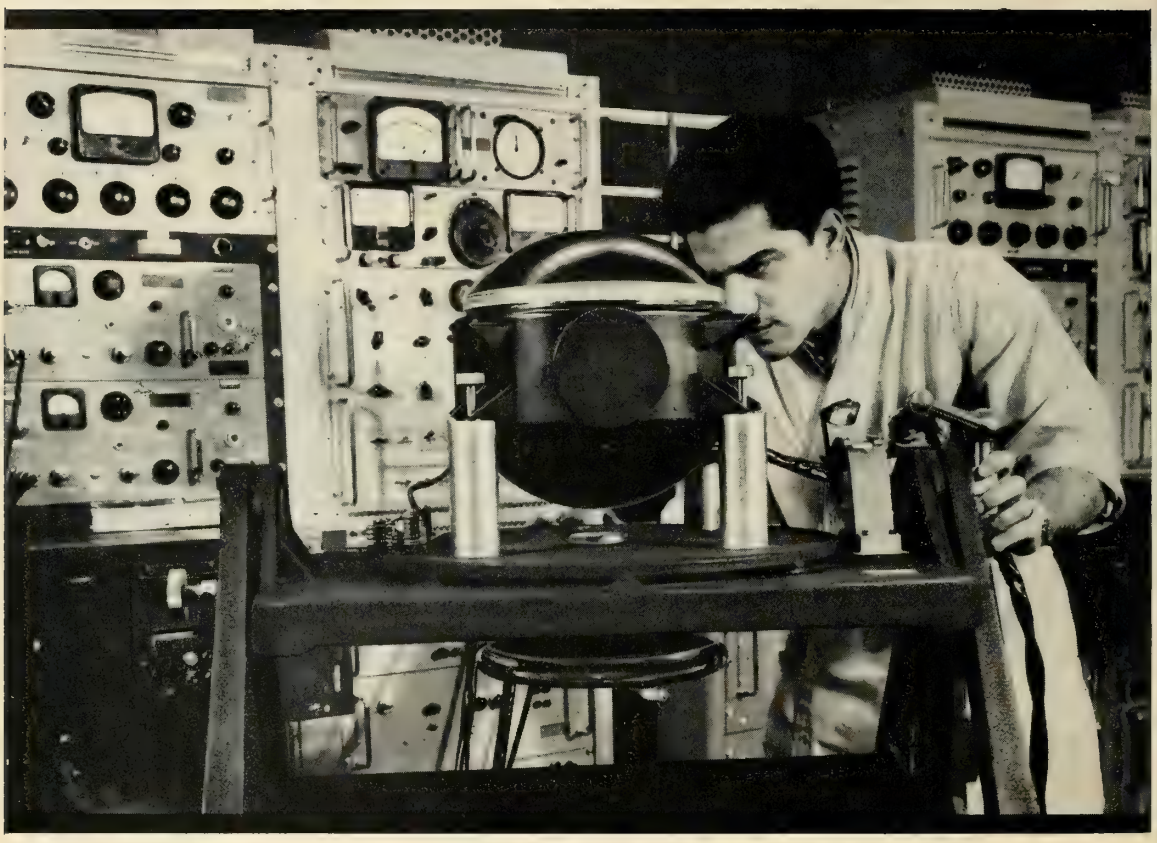
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missiles and rockets

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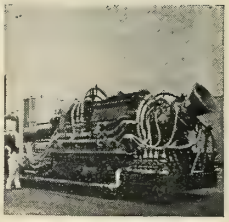
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Tory IIA is an experimental reactor in joint AEC-AF Pluto program to demonstrate feasibility of nuclear ramjet propulsion. Static test is due this year in Nevada.

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WASHINGTON

Campaign Surprise

Administration officials are keeping mum, but COUNTDOWN hears Nixon forces may uncork a real surprise at the height of the campaign. The word is out that the Navy could—starting today—put five *Polaris* submarines on station within three weeks. Just the George Washington is scheduled to be ready in October. But the *Polaris* program has moved fast enough so that four more subs could be loaded up with 1200-mile missiles and sent to sea anytime if a real emergency developed. This would put 80 *Polaris* missiles around Russia.

New Army-AF Battle Brewing

The Tactical Air Command is understood to be reaching for authority to deploy 1000-mile range ballistic missiles—presumably developed by the AF. This range is a gap in the U.S. missile arsenal that the Army has been flirting with for years. There could be a collision if the Army tries to fill it with a souped-up *Pershing*.

Wings Return

AF officials are saying (perhaps wistfully) that if there are any additional interceptor requirements, they will revive the cancelled F-108 fighter—rather than place further orders of the *Bomarc B* missile. Although the airframe was stopped, work has continued on some of the F-108's instrumentation.

Luck o' the GOP

A whole series of space shots are due in October—right at a critical period in the presidential campaign. Republicans will be hoping they have better luck than during the week of the GOP convention. A half-dozen shots were scheduled at the Cape that week. Some were scrubbed, a *Titan I* was destroyed and an *Atlas-Mercury* blew up.

Fix for Discoverer

The AF thinks it finally has a fix on *Discoverer*. At any rate, the next shot in the series—*Discoverer XIII*—will be carrying special equipment that is expected to send back the best data yet on precisely what happens when a *Discoverer* tries to eject a capsule back to earth from orbit. Launching of the 13th is imminent.

New Slip for Transit

Transit—the Navy-ARPA navigation satellite—is slipping again. The next R&D shot won't come off until late October. The problem is said to be booster and pad scheduling at the Cape.

State Stays SNAP-1

Fear of international repercussions reportedly has prompted the State Department to insist upon a delay in flight-testing SNAP-1, which generates 3 watts from a Polonium-210 isotope. AEC, NASA and DOD are all agreed there is no hazard—but State considers it a hot potato.

INDUSTRY

Medaris to Lionel

Former AOMC Chief John B. Medaris is the new president of Lionel Corp. The toy train maker is branching out into defense electronics.

Personnel Problem

AF's non-profit Aerospace Corp. is reported to be wrestling with a top management organizational problem. As a result, recruiting of lower echelon personnel is about a month behind time. Still undecided whether he will go with the new company is STL's director of advanced systems planning, Al Donovan.

Firefly is Bottled

NASA has decided not to fund the flashing-light geodetic satellite, sometimes called *Firefly*. A review is underway on the program with DOD sitting in. NASA may release funds in the future if the study indicates the program is still warranted.

Shelter Prototype?

A by-product of the *Titan* base-building program may be civil defense shelters. Some congressional investigators are looking into the possibility of adapting to shelter construction the methods used to build the hard underground tunnels at *Titan* sites.

Contracts

The Army has signed a $30 million contract with Martin-Orlando for continued work on the *Pershing* solid-fueled missile. . . . Atlantic Research Corp. has a $130,000 award to aluminize the *Arcon* sounding rocket so that it will boost 40 lbs to 85 miles, against present 25 lbs to 70 miles.

INTERNATIONAL

Which Red Missile

Best speculation regarding Soviet Adm. Golovko's claim that Russia has several operational missiles aboard subs and surface ships is that he was referring to the *J-3* and *M-2* missiles. The 450-600 mile range *J-3* and the *M-2* have been sighted, according to reports by the Swedish Navy, aboard seven Soviet cruisers. But, the Russians are also known to be working in the Black Sea on underwater launching of missiles. One of these may be the 600-mile solid-fueled *Komet 2*.

Matra 530 Tested

France has started test-firing the solid-fueled *Matra 530* (similar to U.S. *Falcon*) from Vautour fighters.

Scout to Italy

NASA is furnishing some *Scout* rockets to Italy for some rocket testing that is to begin in November on Sardinia.



FOR USE BY THE STRATEGIC AIR COMMAND, MSVD has developed this soon-to-be operational ablation re-entry vehicle for Atlas—the Mark 3. Currently, MSVD-developed heat-sink Mark 2 re-entry vehicles are operational with SAC.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in payload delivery for SAC

Today, as a vital part of SAC's deterrent weapon mix, Mark 2 operational re-entry vehicles developed by the General Electric Missile and Space Vehicle Department stand ready—helping to guard the peace of the Free World.

Continuing its progress under the direction of the Air Force Ballistic Missile Division, MSVD has developed an even more advanced re-entry vehicle—the Mark 3—which soon will be operational with SAC's missile squadrons. The Mark 3's payload delivery capability was dramatically demonstrated just 4 weeks ago when it successfully survived a 9,000 mile trajectory—longest re-entry vehicle flight in the world to date.

Now MSVD is designing and will build the re-entry vehicles for SAC's newest air-launched ballistic missile, the GAM-87A, SKYBOLT.

Hand-in-hand with this re-entry vehicle progress, MSVD has designed and developed items of re-entry vehicle ground support equipment for SAC. Latest of these is the air-suspension mating trailer, now being produced for SAC's use on both Titan and Atlas missiles.

Through such programs, MSVD continues to help increase the deterrent capability of SAC—strongest power for peace in the world today. Missile and Space Vehicle Department, General Electric Co., Philadelphia 1, Penna. 160-94

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT

A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, Dept. 160, MSVD

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Big Hike in Defense Funds Unlikely

by James Baar

Demands for immediate big new defense spending appeared this week to be more oratory than planned action as Congress gathered for its pre-election "catch-up" session.

Here is the outlook:

—The Republicans indicated they might unfreeze some more of the $866 million added to the defense bill by Congress before it adjourned for the national conventions. But, at the same time, they made clear that they had no intention of requesting the multi-billion-dollar supplemental bill sought by GOP Gov. Nelson Rockefeller of New York.

—The Democrats appeared to be emphasizing domestic programs such as farm legislation and old age health insurance for enactment in the brief session. They could push through some kind of "shopping list" defense appropriation, but congressional insiders contended that the odds were against it.

• **Democrats' dilemma**—Both Democratic Presidential nominee John F. Kennedy and GOP Presidential nominee Richard M. Nixon face serious problems if they wish to rush a new big defense bill through Congress at this time.

Kennedy and his running mate, Senate Democratic Leader Lyndon B. Johnson, undoubtedly could jam a large defense money bill through the Democratic-controlled Congress.

However, to do so, they would have to talk the powerful Senate Appropriations Committee into reversing the position it took only a month ago when it rejected individual Democratic proposals to increase defense spending. This would make the committee look rather flighty at best and open it and the Democrats to a number of unpleasant charges by the Republicans.

Finally, President Eisenhower has said through Vice President Nixon that he would veto any "massive spending measures" not accompanied by new taxes.

• **Republican compromise?** — Reports emanating from the summer White House at Newport, R.I., have said this applies particularly to any big increase in defense spending which the President would regard as a repudiation of his defense program.

And here, in the attitude of the President, lies the problem for Nixon.

Any Administration request for a big defense money bill at this time would be a complete reversal of the President's repeatedly-stated position. If Nixon were to call for such a bill, he would be openly breaking with the President, a very dubious course politically.

However, Nixon and the Administration can try what the Administration has done many times before on the defense issue: Give a little, thereby taking some of the edge from a Democratic attack.

The White House already has released the $241 million voted by Congress over Administration objections for two more *Polaris*-launching submarines. That leaves $525 million in frozen funds from which the Administration can draw in part on the grounds that the international situation has grown somewhat gloomy.

This includes money for the B-70 Mach 3 bomber, *Samos* and Army modernization.

Nor is this all. The Administration, without opening itself to charges of an about face, can call on Congress to restore part of the more than $1 billion that it cut from various defense programs. The juiciest item is the $418-million across-the-board cut in procurement.

The Republicans are being forced to make some move in this direction in order to try to undercut the Democrats.

Johnson already has demanded an accounting from Defense Secretary Thomas Gates on the use of the frozen funds. In a letter July 28, Johnson noted that the extra funds had been frozen by Gates' order and called for an item-by-item report before Congress reconvenes.

He also called for a report on how Gates eliminated "wasteful contracting, supply mismanagement and other procurement deficiencies" in order to effect the $418-million procurement cut made by Congress.

Thus, the outlook is: The Republicans probably will try to undercut the defense issue with some part-way measures. The Democrats probably will shy away from anything beyond the frozen funds rather than waste precious time winning a vetoed or frozen defense bill and some painful political punches for their trouble.

Of course, none of this follows too easily from the parties' platforms or statements.

The Democratic Platform declares that U.S. military power for the last seven and a half years "has steadily declined relative to that of the Russians and the Chinese and their satellites." It promises to lead the way to recovery. Kennedy has called for a $3-billion increase.

The Republican Platform promises to "accelerate as necessary" development and production of missiles and missile bases and to keep balanced forces for dealing with "brush-fire wars."

Both parties clearly indicate that increases are on the way. But neither platform says when.

Frozen DOD FY '61 Money

Program	Amount (in millions)
B-70	$190 to $290
Samos	$83.8
Minuteman	$27
Army Modernization	$160
Air Alert	$85
Total	**$625.8**

(Polaris, already released, $241)

Congress-ordered Procurement Cut

	(In millions)
Army Missiles, Equipment	$46.2
Navy Aircraft, Missiles	$66.2
Navy Shipbuilding	$71.6
Other Navy Procurement	$13
Marine Corps	$2.8
AF Aircraft	$100.5
Airlift	$9
AF Missiles	$80.8
Other AF Procurement	$27.1
Total Cuts	**$418.1**

Mercury Capsule Apparently Survived Explosion of Atlas

A second shot may come next month, probably testing performance of capsule in sharp-angle re-entry

by Jay Holmes

The working-model *Mercury* capsule apparently survived the explosion of an *Atlas* launch vehicle on its first flight test July 29. Sections of the capsule were recovered off Cape Canaveral by Air Force salvage vessels the following day. The capsule was unmanned and contained no animal or biological specimen.

An "event of a catastrophic nature" destroyed the *Atlas* 65 seconds after it was launched in a driving rain and heavy wind at 8:13 a.m. (EST). But the telemetry from the capsule continued until 3½ minutes after launch, at which time it presumably struck the ocean surface and broke apart.

Another *Mercury-Atlas* test will be held as soon as possible, presumably next month. NASA officials said the failure would have no effect on the schedule for the *Mercury-Redstone* tests, which will precede the launching of an astronaut on a sub-orbital ballistic trajectory. The first *Mercury-Redstone,* also unmanned and without any biological specimen, has been scheduled for next month too.

However, a high NASA official conceded a day before the *Atlas* test that a manned *Mercury-Redstone* shot before the end of 1960 is becoming less likely. Dr. Homer Joe Stewart, director of NASA's Office of Program Planning and Evaluation, told the National Rocket Club in Washington that the shot is "theoretically possible" but, "the margin is obviously rather thin."

• **Degree of success**—There was one successful phase of the July 29 test. An abort-sensing-and-implementation system (ASIS) worked perfectly. ASIS is a series of electronic monitors at various points on the *Atlas,* which check performance of engines, airframe integrity, electrical circuits and the motion of the booster frame.

In future flights, if a sensor detects a significant variation in performance, the system would signal the escape system, which would immediately separate the capsule from the booster. In the test, the system operated on an open loop basis. The 16-ft. superstructure and solid-rocket escape system was omitted.

ASIS did signal something wrong a few seconds before T plus 65. Thus, scientists said, the escape system would have worked in plenty of time to get the astronaut away from the exploding rocket. Because of its success in this shot, ASIS will not need to be tested on an open loop basis again.

The parachute re-entry could not come into play because the parachute release was to have been armed by the separation of the capsule from the *Atlas.* The explosion took place while all three *Atlas* engines were still burning. The cause has not been determined.

Sections of the capsule were found five miles offshore in water 50 ft. deep. They were returned to the Cape, where a thorough engineering analysis is under way.

• **More systems later**—The capsule, designated MA-1 *(Mercury-Atlas 1),* did not contain all the systems that will be included in later flights. Among those omitted were the environmental control system, astronaut couch and control panel and the attitude and stabilization control jets. In their place were more than 200 lbs. of sensing instruments, cameras, recorders and a telemetry system.

Telemetry transmitted continuously on 16 channels of continuous or commutated information. It was programed to transmit throughout the flight except for a minute or two during re-entry. The planned trajectory called for the capsule to reach an altitude of 110 statute miles, a speed of about 13,000 mph and landing 1500 miles downrange 20 minutes after launch.

The flight was designed to test capsule structure and afterbody heating on a mission abort. The capsule afterbody was to sustain extremely high temperatures and high air-load conditions resulting from re-entry at a sharp angle, four to five times the normal orbital return angle of about 2°.

• **Sharp-angle procedure**—Presumably, the sharp-angle re-entry will be tested on the next *Mercury-Atlas* flight. Here is how it will work:

The *Atlas* will power four minutes of flight—a full two minutes on the booster engines and a premature shutoff of the sustainer engine—bringing the vehicle to about 100 miles above the earth. A few seconds later, the capsule will be freed by the firing of explosive bolts on a locking clamp ring. Then small packages of rockets attached to the blunt end of the capsule will fire, pushing it away from the booster.



MERCURY-ATLAS gets off pad in July 29 launch. Vehicle exploded moments later.

When the capsule hits the atmosphere, thickening atmosphere will slow it to 700 mph. At about 42,000 ft., an altitude-sensitive switch called a barostat will release a drogue parachute, which will slow the capsule to about 200 mph.

At 10,000 ft., another barostat opens the main 63-ft. chute, which slows the capsule to 20 mph as it hits the ocean. The impact releases radio rescue beacons, turns on a flashing recovery light and releases aluminum strips to aid radar location. Sea marking materials will be loosed and two SOFAR bombs will be exploded for sonar location.

The main chute will be disconnected and all capsule electric power—except that required to operate radio aids—will be cut off.

The Missile/Space Week

New Polaris Subs to be Largest Underseas Craft

Four *Polaris* submarines recently ordered by the Navy will be the largest undersea craft ever built. Designated the Lafayette class, the subs will weigh 7000 tons, and measure 425 ft. long, 45 ft. longer than the George Washington class.

Polaris Blown Up in Fourth Underwater Test

After three successful 1100-mile trips, the fourth *Polaris* missile to be fired from a submerged submarine veered off its course 47 seconds after launch and had to be destroyed. The actual launch from the George Washington nuclear submarine and mid-air ignition of the solid rocket motors were termed successful, the malfunction occurring in flight.

US-Great Britain Hold Talks on Missile Subs

Britain disclosed last week that talks are underway between United States and Great Britain on the use of British ports by rocket-firing submarines. The Foreign Office report scotched rumors that Britain had already agreed to use of her ports for replenishment by *Polaris*-carrying submarines.

Atlas, Titan Site Activation Chiefs Chosen

Twelve senior Air Force colonels have been assigned as site activation task force commanders for *Atlas* and *Titan* ICBM bases. They will be responsible for construction, installation, checkout and turnover of the sites in operational condition to SAC in accordance with an official program schedule.

Sites and their commanders are: *Atlas*—Fairchild AFB, Col. Thomas S. Jeffrey Jr.; Walker AFB, Col. Robert I. Barrowclough; Forbes AFB, Col. William E. Ruark; Schilling AFB, Col. Arthur W. Cruickshank; Altus AFB, Col Ernest L. Ramme; Dyess AFB, Col. Hugh H. Manson; Plattsburgh AFB, Col. Calvin W. Fite. *Titan*—Larson AFB, Col. Edwards J. York; Beale AFB, Col. William E. Sault; Ellsworth AFB, Col. Kenneth W. Norhamer; Mountain Home AFB, Col. Harmon E. Burns; Lowry AFB, Col. James H. Thompson.

Labor unions and management alike were charged to do their part in seeing that the missile bases are completed on schedule. Army Corps of Engineers labor relations officer E. Irving Manger recently warned that work stoppage at missile bases because of strikes could seriously endanger the nation.

Thiokol Says Year Won't Match 1959

Thiokol Chemical Corp.'s second quarter income topped the same period in 1959 by 12%, but the company forecasts that it won't equal last year's total profits. Six months earnings were $1.7 million, against $2.9 million for the first half of 1959, although sales were up 3% to $83 million. Chemical division sales in the first half fell 27% from the first half of 1959, attributed to a reduction in sales to the rocket division.

Goddard Estate Receives $1 Million

The government last week awarded one million dollars to the Robert H. Goddard estate in settlement of claims for rights to use over 200 patents covering basic inventions in rockets, guided missiles and space exploration.

Dr. Goddard assigned half interest in his patents to his widow and half to the Daniel and Florence Guggenheim Foundation, a nonprofit organization which sponsored almost all of his research.

Navy Will Buy 120 Douglas Missileers to Pack Eagles

by William J. Coughlin

SAN DIEGO—The Navy's new air-launched *Eagle* missile will be capable of knocking down aircraft and missiles traveling at speeds from subsonic to Mach 4 and altitudes from zero to 100,000 ft. Range of the Mach 4-5 solid-propelled missile will be 100 miles.

Douglas Aircraft will receive some $600,000 in contracts for the Missileer aircraft which will carry the *Eagle*.

These facts were disclosed by Vice Adm. R. B. Pirie, Deputy Chief of Naval Operations for Air, at the Institute of Aerospace Sciences meeting on the future of manned aircraft. Missiles, in fact, dominated the news coming out of the classified sessions.

Prime *Eagle* contractor is Bendix Corp., with Grumman Aircraft as airframe system contractor. Radar homing guidance is by Bendix, and Aerojet-General is developing the solid booster. Litton Industries won the competition on the fire control system.

The *Eagle* is one half of a new Navy defensive concept: high-performance missiles on relatively low-performance aircraft. The contract for Missileer was awarded to Douglas last month.

The Missileer will be a twin-engined carrier-based aircraft of some 50,000-lb. gross weight, powered by Pratt & Whitney TF-30 Turbofan engines. It will carry a crew of four—two pilots and two radar operators. Each plane will carry six *Eagles*, about 15 ft. long and weighing about one ton apiece.

Each aircraft will carry what is, in effect, a small combat information center (CIC). Its electronic gear will be capable of simultaneously acquiring, tracking and firing at as many as six different targets.

The Navy will commit $75 million to the Missileer program in Fiscal 1961, according to Rear Adm. Paul Stroop, Chief, Bureau of Naval Weapons. He estimated development costs of the aircraft at about $200 million.

Each plane without spares is expected to cost about $5 million; *Eagles* should cost somewhat less than $300,000 each in quantity production.

The Navy plans to replace all fighter squadrons on its attack carriers with Missileers in the next 10 years. The Marines also will be equipped with Missileers, for an ultimate total strength of 20 squadrons.

Adm. Pirie said there will probably be six planes per squadron compared to 14 now, although this may increase.

The program as planned would cost well over $1 billion. Some estimates have placed it as high as $4 billion over the 10-year period.

Nike-Zeus Seen Ahead of Schedule

SAN DIEGO—Scientific improvements in the past 12 months have put the Army's *Nike-Zeus* anti-missile weapon system well ahead of schedule from a technical standpoint.

These improvements have included:

–An increase of three to four times in range.

–Doubling of radar power.

–Increased frequency, significant in terms of increased ability to track and discriminate.

Richard S. Morse, Army Research Director, disclosed that the Thiokol solid-propellant booster of the surface-to-air anti-ICBM and anti-IRBM weapon now develops more than 500,000 lbs. thrust. This is the nation's largest solid propellant booster under development, he pointed out, and it has been successful in every firing.

The program is on schedule, in terms of both time and money, Morse said. Construction of the Kwajalein Island site from which *Nike-Zeus* will be fired at target ICBM's launched from Vandenberg Air Force Base is well along. Test firings of this type probably will get underway sometime in early 1962 and the system is expected to be initially operational about 1964.

Morse said that in addition to 18 *Atlas* missiles which the Army will buy for use as targets, it also is planned to use *Titan* and *Minuteman* ICBM's. He said the test firings probably will continue for many years.

• **Air Force launch crews**—Although the Army will buy and "control" the target ICBM's, Morse said, Air Force crews are expected to do the launching, thus providing dual training with each firing.

Prior to the start of the *Atlas* test firings, *Nike-Zeus* will be tested at the Kwajalein Site on simulated intercepts and on low-altitude shots. Morse also disclosed that a *Nike-Zeus* installation at Pt. Mugu on the Pacific Missile Range will go into operation shortly to overcome limitations placed on testing by the short White Sands Range in New Mexico.

An Ascension Island installation of *Nike-Zeus* tracking radars already is tracking ICBM's fired from Cape Canaveral the Army Research Director said. These can discriminate between the warhead and other incoming portions of the missile.

Morse also made these points in his progress report on the program:

–*Nike-Zeus* possesses an antisatellite capability which may be exploited in the second-generation weapon.

–The system is designed specifically to cope with submarine-launched missiles as well as ICBM's.

–Out-of-atmosphere control of *Nike-Zeus* is by a "wierd" type of jet control and the system continues its discrimination capability after launch.

• **"We've got the range"**—Morse admitted that the *Nike-Zeus* system would not be able to handle a saturation of, for example, 100 enemy ballistic missiles arriving on target within a period of five seconds.

"But," he added, "I think the multiple target problem has been overplayed in some circles in this country." He said that if there were six, 10 or 15 seconds between arrivals, *Zeus* would be able to cope with the bombardment because it can simultaneously track and discriminate more than one target at a time.

Range capability of the system now is over 1000 miles, the Army Research Director said. "We've got the range we need to do the job," he commented.

He gave this sequence of events as an example of the system's operation: a Soviet ICBM aimed at Washington, D.C., would be acquired well north of Boston. By the time the incoming weapon was over New Jersey, the radars would have discriminated between the active warhead and any dummies. *Nike-Zeus* would be launched while the Soviet ICBM was somewhere between Wilmington and Baltimore on its downward trajectory. Intercept would occur about 80 miles from Washington at an altitude of 100,000 to 200,000 ft.

The nuclear warhead of the *Zeus* would destroy but not detonate the warhead of the incoming ICBM, Morse said. He declined to elaborate further on this. Any fallout would come only from the relatively clean and small nuclear warhead of the *Zeus*, it was indicated.

The Army scientist said that while the current ban on nuclear tests means that nuclear warheads will not be used in the Pacific *Nike-Zeus* test program, this is not expected to handicap the program.

He said the Army is not pushing the *Nike-Zeus* as an antisatellite weapon, but pointed out that it is the only ground-based weapon currently under development which possesses this capability.

Lt. Gen. A. G. Trudeau, Chief of Army Research and Development, told the meeting that U.S. Defense chiefs are seriously concerned with the possibility of Soviet deployment of mobile tactical missiles in Cuba (M/R, July 18, p. 51). He also suggested that instances in which sandwiches and wrenches have been found in critical portions of the *Atlas* weapon system may have been caused by sabotage.

Nuclear Flight Studies Set

The National Aeronautics and Space Administration last week chose Lockheed Aircraft Corp. and The Martin Co. to make six-month parallel paper studies of requirements for a nuclear rocket flight test program.

The studies, costing $100,000 each, will cover the scope of system preliminary design, development programming, planning of test and tracking facilities, schedules and safety factors. NASA chose two contractors to obtain differing points of view on a question that has caused a dispute between officials of NASA and the Atomic Energy Commission.

Harold B. Finger, NASA nuclear propulsion chief, and a number of NASA officials believe the first flight test should be from orbit. Col. Jack Armstrong and other AEC officials concerned with nuclear propulsion believe the first test should be a launch from the ground. A third possibility is testing the nuclear rocket as a second stage atop a chemically fueled booster over a short ballistic trajectory. The study is not limited, however, to these three alternatives.

The prime requirement of the system, called the Reactor In-flight Test System, will be that the program supply technical data applicable to a useful nuclear rocket stage. However, NASA said, the system need not be capable of performing useful space missions.

NASA has set 1965 as the target for the flight test. It is expected that *Saturn* launch vehicles will be available at that time for obital start or second-stage test.

Though tariffs are tricky . . .

U.S. Firms Find Bonanza in Europe

Liberalization of regulations in the Common Market has attracted American defense companies; there are pitfalls

by Bernard Poirier

In the Paris suburb of Montrouge this week a new company opened up for business in what is fast becoming a familiar pattern.

The maufacturing plant is a subsidiary of Polarad Electronics Corp. of Long Island City, N.Y.

Mission: production of an industrial line of microwave instrumentation for sale in the European Common Market.

Polarad, which already has a subsidiary in Amsterdam, is one of scores of American defense companies which have succumbed to the lure of doing business abroad.

Last month, the Rocketdyne division of North American Aviation and Thiokol Chemical concluded deals with France's SEPR (Societe d'Étude de la Propulsion Par Réaction)—largest rocket manufacturer on the continent. Bendix Corp. and Telefunken have just embarked on a joint venture—Teldix—in West Germany.

U.S. defense interests abroad, a risky adventure only a few years ago, today are swelling in volume as Europe grows more economically stable and as individual countries in the NATO alliance contribute more and more to their common defense.

West Europeans have a combined $12-billion defense budget which is expected to increase substantially. Foreign plans for rocket development and for supporting equipment are impressive even from the U.S. point of view and are commercially lucrative.

An American defense firm is in a particularly good bargaining position because of the intense desire of Europeans to save their own capital by learning the latest American know-how.

This gives the U.S. firm the chance to choose between establishing a manufacturing subsidiary and entering into a participation agreement which involves the exchange of technical know-how, products, and some capital for a share in the profits made by the European company.

What is accelerating this eastward business migration?

More than anything it is a liberalization of regulations covering defense products in the Common Market.

New rules offer a considerable advantage to U.S. firms who locate within European Economic Community countries—sometimes called the "Inner Six." They are France, Germany, Italy, Belgium, Luxembourg and the Netherlands.

A recently formed competitive group known as EFTA (European Free Trade Area) is composed of Britain, Austria, Norway, Denmark, Portugal, Sweden and Switzerland. EFTA, also referred to as the "Outer Seven," does not hold the same advantages as the Common Market.

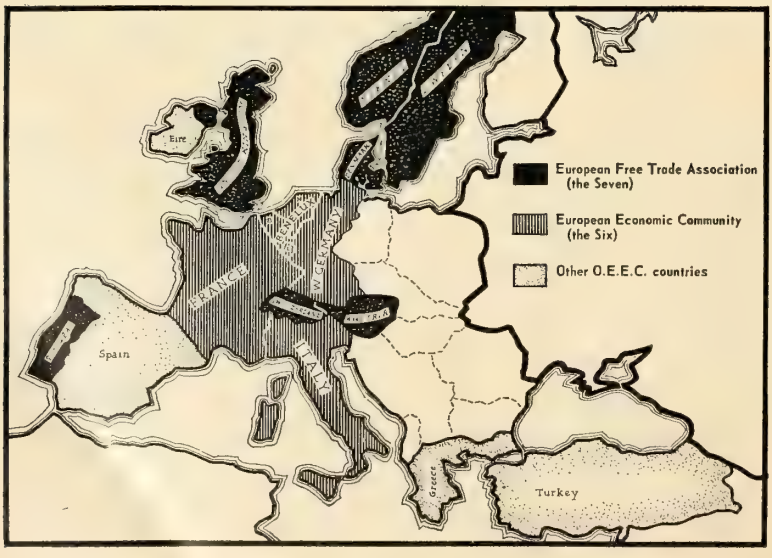
• Lower marketing costs, more sales—Where does the best potential for profits lie? The pros and cons of locating in Europe must be carefully weighed.

It is clear that in just a few years most profits in foreign trade will return to industries located within the European market. It is also becoming apparent that export trade originating outside the European markets will find it increasingly difficult and in some cases impossible to compete.

Non-member export traders face excessive end-costs to member customers. The common external tariffs will provide member suppliers with a big edge in lower end-costs to member customers.

A fundamental concept of the Common Market is to wipe out import duties between member countries and to establish a common wall against outside competition through a uniform external tariff.

• To abolish 4 Customs Unions—The four Customs Unions within the Common Market are still effective, and will continue to be for several years until all internal tariffs are completely erased from the books. Making up these Customs Unions are the Benelux-Netherlands combination, France, Germany, and Italy. The ad valorem Tar-





FOUR LIQUID-FUEL rocket engines being tested at S.E.P.R. facility near Paris. Firm has made big deals with U.S. firms.

iff rates they had on Jan. 1, 1957, are what we will call *basic* rates.

The simple arithmetical average of each basic rate on a product serves as an interim goal for internal tariffs during the transition period at the end of which all internal tariffs will be abolished. To complete the transition cycle a common external tariff will be initiated next year against non-member countries.

Some of the new external tariffs on defense products are:

Rocket motors, jet engines ....Tariff 12% a.v.
Rocket motor components ....Tariff 12% a.v.
Helicopters, empty wt. 4400 lbs. or less .....Tariff 15% a.v.
Helicopters, empty wt. Over 4400 lbs. .....Tariff 12% a.v.

(Empty weight excludes the weight of fuel, personnel, and optional equipment.)

Another recent amendment to the EEC Treaty contains a special feature suspending all external rates until Dec. 31, 1963, for helicopters with empty weight exceeding 4400 lbs. Community members get additional benefits as can be expected. France, for instance, has suspended all internal tariffs on rocket motors and certain jet engines.

In other cases even the external tariff is suspended if the motors or engines are destined to be mounted on vehicles qualifying as being of Community origin. One overall restriction which remains is contained in Treaty Article 223; it gives each member nation the right to establish special regulations for trade involving certain defense-type products.

• **Bring a slide rule**—Once the method of calculating internal and external tariffs is understood, it becomes easier to appreciate the foreign experiences of U.S. firms. The simplest way to figure tariffs might be by remembering a short hypothetical case involving an Italian customer who informs a French firm and a U.S. firm that he wants to purchase a product which each manufactures.

Italy's basic tariff on this product had been 10% a.v., but the tariff later was established at 15% a.v., which we will call the current tariff. Common Market authorities established a uniform 20% a.v. on this product. Italy's basic tariff was obviously well below the arithmetic average used by the Common Market authorities. Therefore, when two 10% reductions on internal rates was effected, Italy had to raise the tariff on this product making it conform to the uniform trend. The present Italian internal tariff is 12%.

Now the real mental gymnastics start. The Common Market tariff by the new regulations is reduced by 20%, making it 16%. The Italian basic rate (10%) is subtracted from the 16%, leaving 6%. This is multiplied by a common factor—0.30—whose product, 1.8, represents the first increment. Since the current Italian national rate is lower than the interim Common Market tariff, the new increment must be added to the current rate as the first step in aproaching a uniform goal. Thus the Italian external tariff at this moment is 16.8% a.v.

Both the French product and the U.S. product have a F.O.B. (mfg. site) price of $44,000; the overland freight charge from the French firm is $300, while the export c.i.f. (costs, insurance and freight) from the U.S.A. is $1000.

The Italian's end cost for the French product becomes $49,616; for the U.S. product, $52,560. The Italian will save $2944 by purchasing the product manufactured in France—whether by a French firm or by an American subsidiary.

• **U.S. firms reveal problems**—Several pitfalls can be avoided by companies contemplating moves abroad if they look at the experiences of U.S. firms now in the European markets and analyze the moves made by foreign competitors in their own market. Republic Aviation has a wholly-owned subsidiary in Switzerland; but recently Republic acquired a portion of Fokker Aircraft of Amsterdam in a participation deal. When both the subsidiary and Fokker offer the same product, it is evident that Community customers will do business with Fokker to save money.

Republic said, "It is reasonable to assume that Fokker will be favored with some of the subsidiary's business" and that the U.S. firm's "close cooperation with Fokker" will more than offset any profit loss on the part of the subsidiary.

A Republic spokesman boiled the situation down to: "a company within this complex (Common Market) would be more desirable than one outside."

The economic comparison of the "Six" and "Seven" is contained in data listed in Table. When conducting a marketing study on the European markets a few observations on current

EEC and EFTA Statistics of Trade
(1957) In Billions of Dollars

Trade Category	Dollars
Total Intra-EFTA Trade	$ 6.9
Total trade between U.K. and others in EFTA	2.6
Total trade between U.K. and EEC members	2.5
Total Intra-EEC Trade	13.7
Total trade between the EFTA and the EEC	8.5
Total EFTA Foreign Trade	34.8
Total EEC Foreign Trade	46.7

Note: The EEC is the World's largest importer with almost $23 billion in 1958.

politics is essential.

• **British dilemma**—The EFTA is not an institution such as the Common Market. EFTA was conceived as a negotiation lever with the "Six" and has gone through competitive motions in an on-again-off-again manner greatly influenced by Britain's "damned if she will and damned if she won't" reply to the Common Market's invitation to join.

Her decision to join may come too late. There is the possibility that the "Six" may close the door to any new memberships.

Many defense firms entered the Common Market soon after its inception. Others already there expanded foreign facilities. United Aircraft Export Corporation has been very active in expanding its influence in the Common Market. United made early deals with FIAT of Italy and with Ratier-Figeac S.A. of France. Their Hamilton Standard division has acquired 50% interest in Microtecnica S.p.A. and 10.9% in SNECMA.

United also reported at this writing that Hamilton is negotiating with two other top firms, San Giorgio S.p.A. and Perilec S.A., "to obtain further coverage in the Common Market." Several of these European firms are important missile system contractors.

James R. Patterson, assistant to United is export president, made it clear that the expectation of profit was strong but would not elaborate for obvious "competitive reasons."

American Cyanamid, du Pont, Tracerlab, Metals and Controls, Worthington, Titanium Metals, Daystrom, Perkin-Elmer and others are among those to be found with new or additional facilities since the "Six" was formed.

• **Operation boot straps**—Community firms were the first to recognize the advantages of their own institution. Some formed subsidiaries under joint ownership, others consolidated branches which formerly were scattered over frontiers even when not demanded as much by product distribution as by former national restrictions that existed.

Matériel Schneider Westinghouse, Nobel-Bozel, SIMCA, and Ducellier are among those who consolidated. Internal deals were consummated by Merckle K.G. and Giovanni Augusta; Messerschmidt and S.F. Fouga. Following suit were Breguet, Dormier, SNECMA, Bayerische Motorenwerke and many others.

Bodenseewerk which is NATO prime for the *Sidewinder* missile is controlled by the U.S. firm Perkin-Elmer. The U.S. firm has already introduced missile support equipment manufactured by its young German affiliate during the last few months.

Passive Systems Praised at Symposium on Communications

Passive communication satellites have at least one big advantage over the active repeater types: they're within the present state of the art and offer our first hope of practical systems.

Passive systems can be put in the air within the next few years; active systems won't be operable until the 1965-70 period. In addition, the passive reflectors offer more flexibility, greater reliability, and are less vulnerable to jamming and interference.

This comparison between the two systems was offered by Donald T. Worthington of the AF Rome Air Development Center.

Speaking at last week's National Symposium on Global Communications in Washington, he said the efficiency of the passive systems could be upgraded by continued research and development to make them even more comparable to active communications satellites. He cited three areas of possible improvement: antenna gain, reflection characteristics, and information capability.

Communications satellites and associated areas received a thorough review during the GlobeCom Symposium. Two sessions were devoted to the subject—one chaired by Dr. Hans Ziegler, chief scientist of the Signal Corps R&D Laboratory, and the other by Esterly C. Page, president of Page Communications. Costs, timetables, and problems of operating military and commercial satellites were all discussed.

• **Years away**—Dr. Ruben F. Mettler, executive v-p of STL, confirmed other opinions that practical systems are some years off. He said that "we will probably fall short of what is now predicted for accomplishment during the next three years, but will probably do more during the next 25 years than is generally accepted today."

He predicted that a large and expanding communication satellite system development is warranted on the basis that it will contribute sufficiently to our communication needs and objectives.

• **Profit promised**—The practicality of commercial systems was demonstrated by L. Pollack of ITT. He said that such a system would operate at a profit.

He estimated overall costs of a typical global satellite network to be in the neighborhood of $18 million per year over a ten-year period. Gross annual revenue would amount to about $80 million. In addition, Pollack pointed out that satellites would provide communications for many small countries now virtually isolated.

In line with previous statements that passive reflectors need considerable refinement, Maurice G. Chatelain reported on Ryan Electronics' work on anisotropic reflectors. Pointing out that the simple isotropic reflector—such as NASA's 100-foot metallized Echo sphere—leaves much to be desired in efficiency, he discussed ways of making the inflatable reflectors more efficient. He cited several examples of configurations that offered promise—some spherical and others of polyhedral construction.

The spherical models described included several interesting modifications to the *Echo*-type balloon. Generally, these involved partial metallizing of the sphere's surface. One method proposed was a metallized checkerboard pattern which reportedly reflects and back-scatters a larger proportion of incident energy than a 100% reflecting surface and reduces weight of the sphere.

Two different polyhedral satellite configurations were described by Chatelain. These involved 12-face dodecahedron and 20-face icosahedron shapes moulded into the satellite's surface. Each face can be surrounded by 135-degree oblique walls to provide high incident-energy reflection. According to Chatelain, this type shows the most promise of those investigated at Ryan.

For active satellites, best directive antennas seem to be those built on a sphere, inflated in space, and containing spherical arrays of conical helixes or spiral beam antennas. The spherical spiral antenna developed for *Transit* was mentioned as a candidate for active communication satellites.

Interference big problem in communications—Attention given to interference and spectral problems at GlobeCom was inversely proportional to its importance, according to some observers. One session was devoted to this subject.

One speaker—Bernard H. Baldridge of GE's Light Military Electronics Department—deplored inadequate system planning that has permitted evolution and system mix of megawatt and microwatt power-level equipment "with little concern for overall system degradations resulting from subsystem interactions." According to Baldridge, "we don't build a system by marrying together sets of sets; we just let them live together in sin."

Autolite, Hiller May Merge

Electric Autolite Co. may move further into the defense business field with a merger with Hiller Aircraft Co. Hiller makes light helicopters and is prominent in Vertical Take-Off and Landing (VTOL) aircraft development and other military research projects.

Stanley Hiller, Jr. president of Hiller Aircraft Corp. and R. H. Davies, Autolite president jointly disclosed that negotiations are underway for the merger. Autolite would acquire Hiller on the basis of one Autolite share for each four and one-quarter shares of Hiller.

Although Hiller would operate as a separate unit, the newly-formed Autolite Aero/Space Division and Special Product and Research Division (SPARD) would cooperate in research and development activities. Ceramics, electro-hydraulics, electronics have been mentioned among areas of cooperation.

——mergers and expansions——

CONVAIR ASTRONAUTICS, General Dynamics Corp. will complete a million-dollar electronics manufacturing facility at Kearny Mesa, Calif. by September. The 68,400 sq. ft. structure will house areas for constructing prototypes of electronics products for advanced missile and space studies, components for Azusa tracking system, and a modern calibration laboratory.

The plant will feature a "dust control" station through which all materials will pass for cleaning prior to distribution. Working environment will be controlled to temperatures between 73° and 83°.

BOWMAR INSTRUMENT CORP. has doubled its manufacturing capacity with a 23,000 sq. ft. plant at Fort Wayne, Ind. The facility features a newly-equipped laboratory and special enclosed sections for ultra-precision machining, heat treating and painting of tiny precision components.

ELECTRO-MECHANICAL RESEARCH has formed a Systems Division to assume advance planning, engineering, development, production and quality control services. Initial efforts will be directed to airborne and ground telemetry systems, data processing and reduction systems, satellite systems, ground support equipment, automatic checkout equipment and others.

HYDROMATICS, INC. of Livingston, N.J. has bought a complex of buildings totaling 80,000 sq. ft. from General Electric in Bloomfield. Move will be made Sept. 1.

LABORATORY FOR ELECTRONICS, INC. has leased a 100,000 sq. ft. plant and office facility adjacent to its present headquarters in Boston. LFE departments and divisions in other sections of Boston will be relocated there by December.

NORTHERN RESEARCH & ENGINEERING CORP. has opened research and development offices in London, England. The firm conducts R&D and industrial consultations on heat transfer, thermodynamics fluid mechanics and related technical marketing.

financial

Thompson Ramo Wooldridge—reports increased sales and earnings for the first half of 1960 compared to the same period a year ago. Sales of $219.1 million represent a gain of $19.6 million, or about 10% over sales for the like period of 1959. Gain was attributed to a 35% increase in electronics, missiles and space business, compensating for a slight decline of military requirements for manned jet aircraft components.

Net income totaled $5 million for six months, compared with $4.9 million for the first period last year.

Chance-Vought Aircraft—Sales and incomes for six months ended June 30 this year total $113.6 million, compared to last year's $132.5 million. Net income dropped to $1.5 million from $3 million.

Minnesota Mining & Manufacturing—3-M reports second quarter sales of $134.3 million and earnings of $16.1 million. In the same 1959 period, sales were $122.2 million with earnings of $15.6 million.

Bell & Howell—Highest second quarter and six months sales and earnings in the history of Bell & Howell, (including Consolidated Electrodynamics Corp.) were reported. Second quarter earnings were $2.4 million compared with $1.8 million for the same 1959 period. Sales were up from $23.1 million to $30.1 million for the second quarter.

Reflectors for Space Generator



HUNDREDS OF THESE 4-inch solar reflectors will be built by Hamilton Standard Div., United Aircraft Corp., to develop a workable 100-watt prototype space generator for the Air Force. Ultimate goal is a 1500-watt system using 7000 reflectors over 700 sq. ft. Conversion mechanism is a thermocouple employing a temperature differential of as high as 600°.

missiles and rockets

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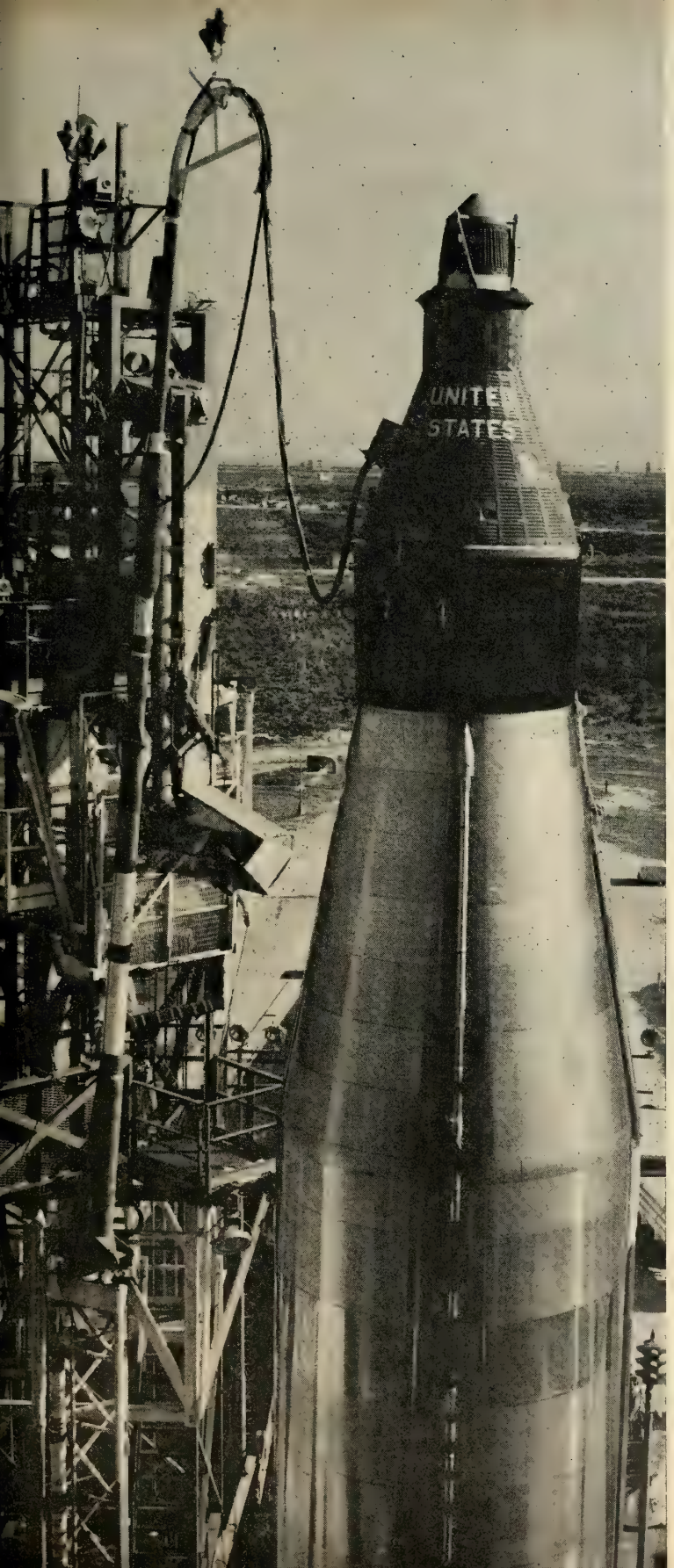
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NASA

SPECIAL REPORT

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NASA
SPECIAL REPORT

Industry May Get $12 Billion

NASA's 10 Year Plan: more contracts with private companies— including Saturn booster, Apollo spacecraft and new satellite projects

Industry and other contractors will share in the National Aeronautics and Space Administration plans in the amount of $9 to $12 billion—and possibly more—in the next decade.

This prospect is held out by Administrator T. Keith Glennan. Of a budget for the decade totaling $12 to $15 billion, he says, at least 75% will be spent with contractors. If the total for the decade is to reach this figure, Glennan says, annual spending must rise from the current level of $915 million to more than $1½ billion.

These other key points emerged from a July 28-29 NASA-industry conference:

–Production of the *Saturn* booster may be shifted to industry after the first 10 boosters are produced at Huntsville, Ala.

–The NASA payroll will rise from its current level of just under 17,000 and stabilize at about 19,000.

–A prime systems contract for Project *Apollo,* America's first civilian space ship, may be awarded in FY 1962.

Names and details of a series of advanced space projects were disclosed. They include:

• **Project Prospector,** an unmanned spacecraft boosted by the *Saturn* launch vehicle, capable of making a soft landing on the moon and remote-controlled exploration of an area within 50 miles of the landing point. Under study by the Jet Propulsion Laboratory and the Marshall Space Flight Center at Huntsville, Ala.

• **Project Voyager,** an unmanned spacecraft boosted by *Saturn* and able to fly to Mars or Venus, orbit the planet and eject an instrumented capsule for atmospheric entry and perhaps landing. Under study at JPL.

• **Project Aeros,** a 24-hour weather satellite program not yet approved but under study. If approved, the project could begin in 1962 and launchings might begin in 1964.

• **Project Mariner,** a series of early interplanetary probes that will mark the first U.S. missions to Venus and Mars.

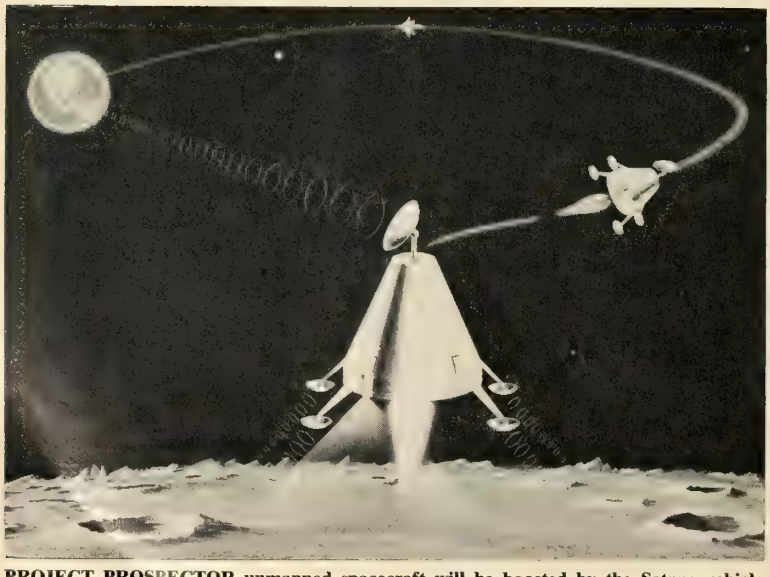
• **Project Surveyor,** a name just assigned to the spacecraft boosted by *Centaur* that will make the first soft landing on the moon and conduct a variety of observations from a stationary position. Space Technology Laboratories, McDonnell Aircraft, North American Aviation and Hughes Aircraft were chosen last month to make competitive five-month studies. The contract, to be awarded early next year, could mean business totaling $50- to $100-million for the winner.

The only important growth in the NASA payroll is planned at the Marshall Center in Huntsville and the Goddard Space Flight Center in Beltsville, Md., Glennan said. The overall NASA total July 1 was 16,840. This included 4524 at Marshall and 1265 at Goddard. By next year, Marshall will grow to 5500 and Goddard will reach 2400.

No major new government installations are planned and no major increases in existing installations are expected after Marshall and Goddard reach authorized strength, Glennan said.

"With the exception of the Marshall Space Flight Center, NASA possesses no significant capacity to design, develop and manufacture launch vehicle systems," the administrator said. "Only a very limited capacity to undertake the design and prototype production of spacecraft and instrumentation to be carried in those spacecraft is available in NASA centers."

Maj. Gen. Don R. Ostrander, director of launch vehicle programs, told the conferees that NASA will be depending on industry more and more in the development of launch vehicles. Although the first stage of the big *Saturn* booster was engineered at the Marshall Center, he said all of its upper stages will be designed and built by industry.



PROJECT PROSPECTOR unmanned spacecraft will be boosted by the Saturn vehicle to a soft landing on the moon, where it will explore by remote control.

"In fact," Ostrander continued, "it may prove desirable at some point in the future to have the first stage built by industry. The increased workload at Marshall, because of the responsibility for many more development tasks under NASA, is going to result as time goes on in greater and greater reliance on industry."

A spokesman said the space agency held the conference, its first such meeting, because officials felt there was a need to give industry a comprehensive account of the program, which has been laid out in detail before Congress. It had been given to industry only in bits and pieces previously.

The spokesman said the conference had no political implication. However, it was obvious NASA was at least indirectly soliciting support for its plans for bigger budgets in the years to come.

Deputy Administrator Hugh L. Dryden said NASA plans 260 launchings during the decade. Of these, 41 will be missions relating to manned space flight, 96 will be scientific satellites, 33 will be lunar and planetary scientific missions and 28 will be satellite applications.

Dryden gave this timetable of major launchings:

• **1960**—First launchings of *Tiros* meteorological satellite (already accomplished); *Echo* passive reflector satellite; *Scout, Delta* and *Atlas-Able* vehicles; suborbital flight of an astronaut.

• **1961**—First orbital flight of an astronaut; first launchings of *Centaur* vehicle and lunar impact vehicle.

• **1962**—First instrumented probe to the vicinity of Venus and/or Mars; first launching of a two-stage *Saturn* vehicle.

• **1963 or 1964**—First launchings of unmanned vehicle for controlled landing on the moon and orbiting astronomical observatory.

• **1964**—First unmanned vehicle intended to circumnavigate the moon and return to earth; first reconnaissance of Mars and/or Venus by an unmanned vehicle.

• **1965**—First flight test of a nuclear second stage "if unexpected problems are not encountered."

• **1965-67**—First launching in a program leading to manned flight around the moon and to a near-earth space station.

• **Beyond 1970**—Manned flight to a moon landing and return to earth.

A continuing shift in the NASA program from aeronautical to space research was reported by Ira H. Abbott, director of advanced research programs. About 26% of the in-house effort is primarily aeronautical and about 65% is primarily space-oriented, Abbott said.

Abbott gave this outline of the missions, staff and capital invested at the research centers:

• **Langley Research Center, Langley, Va.**—Structures and material applications, aerodynamics of re-entry vehicles, aircraft aerodynamics and structures, and fundamental plasma physics; staff 3220; investment $154 million.

• **Lewis Research Center, Cleveland, Ohio**—Propulsion and power generation for space vehicles; staff 2736; investment $148 million.

• **Ames Research Center, Moffett NAS, San Francisco, Calif.**—Aerodynamics, gas dynamics at extreme speeds, automatic stabilization, guidance and control of space and re-entry vehicles, space environmental physics; staff 1440; investment $107 million.

• **Flight Research Center, Edwards AFB., Calif.**—*X-15* flights, *Dyna-Soar* studies; staff 116.

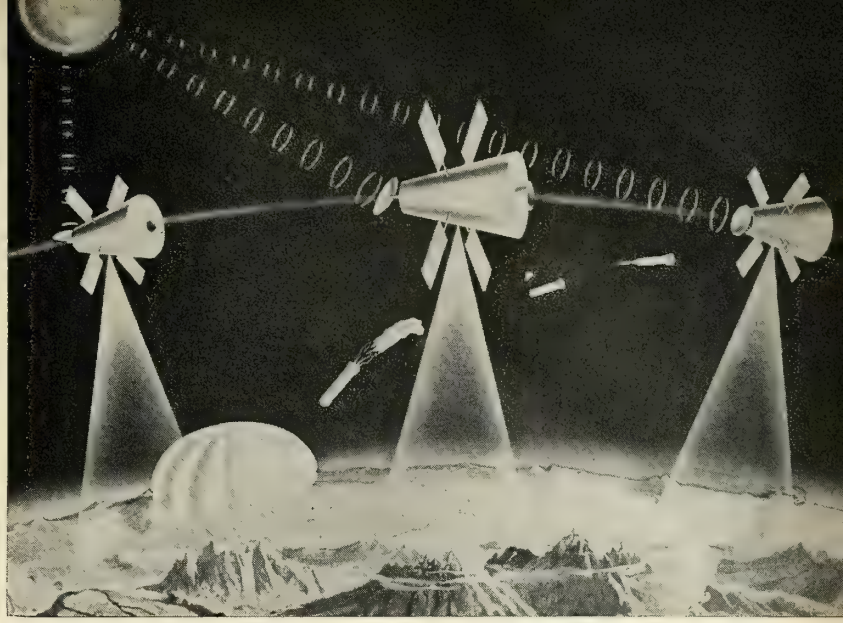
Abbott said the four centers will cost $100 million to operate this year. New facilities will cost $22 million.

Ostrander defended NASA's policy of having fewer backup vehicles available than does the military program. "In our civilian space exploration program," he said, "although failure in any particular program or specific launch is certainly undesirable, it is not catastrophic to the extent that our security may be in jeopardy or that the remaining space program will grind to a halt until we obtain success." He added:

"In a civilian program, it is usually more prudent to back a broader program to gain additional knowledge than to provide dual capability to assure performance of a single task."

The percentage of industry participation is greater in the spacecraft programs than in the NASA program as a whole. Dr. Abe Silverstein, director of space flight programs, estimated that 75% of the space flight program budget goes to industry contractors, 5% to universities and non-profit organizations, and 20% is spent in-house. The current space flight total is $312 million.

In all space-flight missions, Silverstein said, there is need for tracking equipment capable of determining orbital data or position time histories, and for command signals, telemetry receivers, data acquisition and computing equipment.



PROJECT VOYAGER unmanned craft, also boosted by Saturn, will be able to fly to Mars or Venus, orbit either planet and eject an instrumented capsule.

Industry Guide . . . NASA's Next 10 Years

The comprehensive report of NASA's plans for the next decade starting on these pages fills a special section extending through page 33.

Missiles & Rockets editors compiled the report from censored copies of a 100,000-word classified document presented to 1300 representatives of industry, universities and other government agencies by NASA officials on July 28-29.

The document comprising 22 papers actually contained only three short sentences which were classified. But, because these three sentences were read at the briefings, the press was barred from the proceedings.

NASA
SPECIAL REPORT

Apollo 3-Man Craft to Follow Mercury

Tests flights could start by '62—if program gets funds; Saturn to be used as booster for earth-orbital missions in '66

Provided they get the money, NASA space specialists hope to begin test flights of a three-man spacecraft successor to *Mercury* by 1962.

As described by George M. Low, Chief of NASA's Manned Space Flight Program, to industry representatives, *Apollo* will be a three-man modular spacecraft that can perform as an earth-orbiting space station or circle man around the moon and bring him back.

Pointing out that *Apollo* "has no official standing as yet," Low optimistically predicts that Congress will give NASA money during FY '62 to turn the proposal into development hardware. He says a prime contract will be let during that fiscal year for design studies, engineering and fabrication.

Low believes that development of *Apollo* will be rapid enough to test early configurations on top of *Atlas-Agena-B's* in 1962. These tests will continue until *Saturn* is available.

"Earth-orbital missions, using the final spacecraft, could conceivably begin in 1966," Low predicts, "with circumlunar missions following as soon as the state of both technical and aeromedical knowledge permits such flights."

Nothing Low said revised the earlier NASA estimate that the U.S. space program would not put a man on the moon before 1970.

The post-*Mercury* program had $2 million alloted to it in FY '60, but this was handed over to *Mercury* when that program's costs began to run well ahead of estimates and when Congress refused to give NASA requested *Mercury* funds. (See M/R, Jan. 11, 1960.)

• **Module concept**—What is now called *Apollo* actually received only $100,000 during FY '60 and $1 million during the present fiscal year.

In order to allow *Apollo* to perform multiple missions, NASA has employed the "building block" concept for this three man spacecraft's theoretical design.

Industry would be called upon to produce a spacecraft consisting of three modules: A command center module, a propulsion module, and a mission module.

As described by Low, the command center module "would house the crew during launch and re-entry phases of flight; it would also serve as the flight control center for the remainder of the mission. We anticipate that this module would be identical for both the circumlunar and earth-orbital missions."

The propulsion module, according to Low, "would serve the primary function of providing safe return to earth in case of an aborted mission. In this sense, it might be compared with the escape tower and retrorockets of the *Mercury* capsule.

"In addition, for circumlunar flight, this component should have the capability of making midcourse corrections; it might also be used to place the spacecraft into an orbit around the moon and eject it from orbit."

In an earth-orbital mission, the propulsion module must, Low stipulated, "permit a degree of maneuverability in orbit or rendezvous with other vehicles."

The mission module, which might not be needed for lesser missions, would vary with the object of the mission.

• **Severe re-entry problem**—For circumlunar flight, Low believes, "it would be used to provide better living quarters than the command center can afford and some equipment for scientific observations."

During earth-orbital missions, the mission module can be considerably larger, taking up poundage used for propellant on longer missions. "This module can usefully serve as an earth-orbiting laboratory, with adequate capacity for scientific instrumentation and reasonable long lifetimes in orbit."

The more important of the three modules, from a design standpoint, is the command module, which must serve its crew during launch and re-entry. This requires an ability to "re-enter the earth's atmosphere at essentially parabolic velocity, or about 36,000 feet. It will have to withstand the severe heating encountered at these velocities, and must be statically stable over the entire speed range from 36,000 feet per second to the landing speed."

It was disclosed at NASA's 1959 Inspection (See M/R, Oct. 19, 1959, p. 11) that the Langley Research Center is already doing extensive research on two new types of heat shields that could give *Apollo* this capability.

One of the two types under study which could withstand greater heat and allow the capsule to have a greater angle of re-entry uses an insulating material which is held in place on the load-carrying structure by a thin metallic outer skin. The outer skin is corrugated to provide a means for absorbing thermal expansion and to provide sufficient stiffness to prevent flutter. This design will be fabricated from a refractory metal such as molybdenum, niobium, or tungsten, and will reduce the temperature of the load carrying structure to 1200° F when the heat shield surface temperatures are 2500° F.

The other type of heat shield under investigation has an added heat-absorbing capacity in the form of water which is stored in a light absorbent material in channels formed by the stiffeners on the structure. This type of shield provides protection to the entire capsule or module structure and can hold the structure's temperature to that of boiling water. A more complicated structure design will be needed because of the difference in temperature between the shield and the structure.

• **Midcourse power**—In order to allow the command module to stay within the rather narrow flight corridor during the period of re-entry, a degree of maneuverability will be required. This can be provided, according to Low, by a midcourse propulsion system.

How much of a role will the three pilots play in maneuvering *Apollo*? Low believes that if Project *Mercury* demonstrates that man can, indeed, perform useful functions in space, "we believe that in all future missions the primary control should be onboard."

Function of the propulsion module will, according to Low, greatly depend on the mission. One duty it must always perform is abort of the manned payload in case of a "catastrophic failure of any of the *Saturn* stages . . ."

Other primary duties of the propulsion module, Low states, will be the ability to correct *Apollo's* course, and to return it from orbit. The propulsion module during more advanced missions must also allow *Apollo* to affect a lunar orbit and to maneuver within its earth orbits.

Once *Apollo* is outside the earth's atmosphere and free of the radiation belts, its three-man crew, according to present planning, can take off their pressure suits, and conduct "shirtsleeve" operations in the mission module.

This comfort will especially be needed, according to Low, during *Apollo's* missions as an earth-orbiting laboratory or during circumlunar orbits. "where it may be desirable to keep" . . . the craft in space . . . "for periods ranging from two weeks to two months."

One important challenge that industry must fulfill before *Apollo* becomes a reality is the development of a 3-man environmental system, that will provide, during certain periods of the flight, the "shirtsleeve" environment.

"These systems," according to Low, "will be incorporated into the command center, the orbiting laboratory, and the circumlunar module. Gaseous-, liquid-, and chemical-oxygen systems all deserve consideration for these applications."

And two other problems calling for solution are the need for a system sensing and controlling the craft's attitude, and power supplies that can provide something like 400 kilowatt hours, with a peak load of roughly four kilowatts.

• **Shielding impractical**—A major problem which must be solved before man goes very far into space for any length of time is radiation.

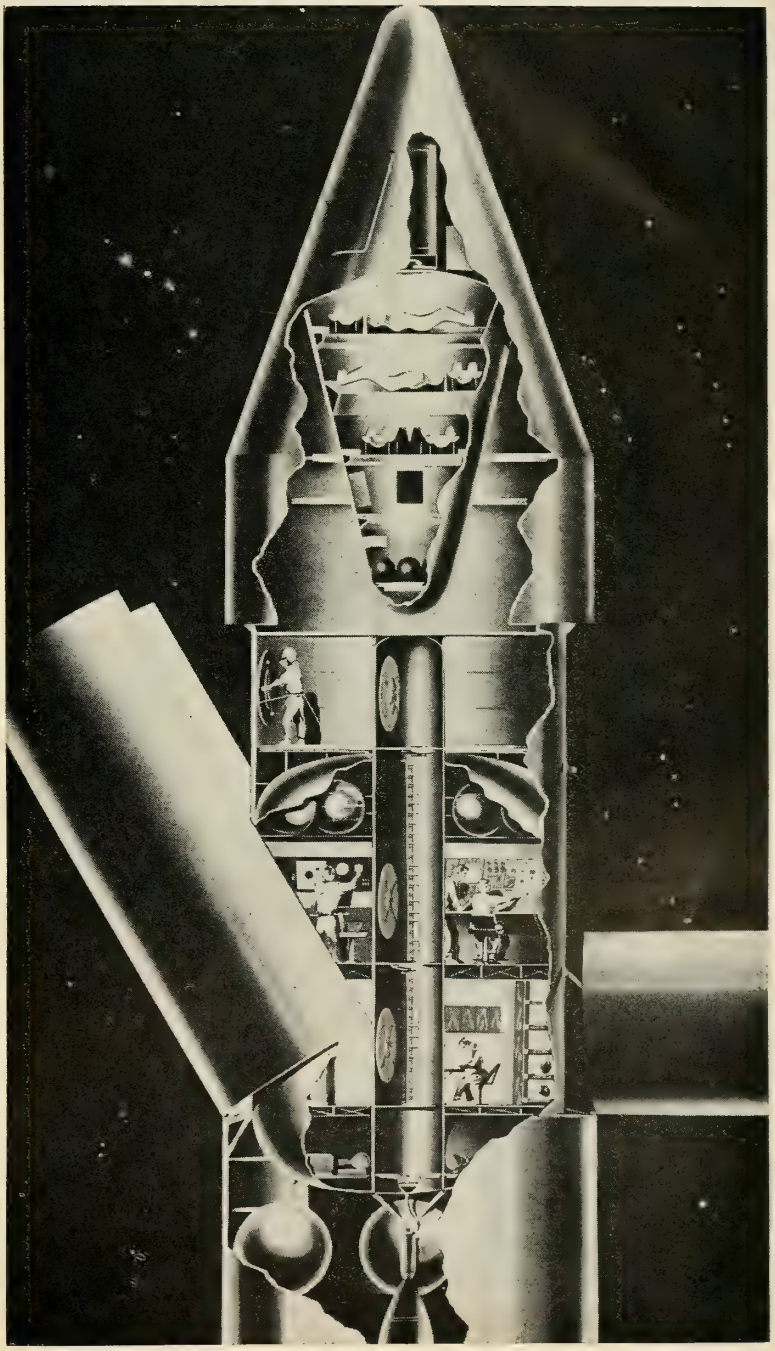
The trapped radiation in the Van Allen belts, which is of rather high intensity but of low energy, can be overcome with only a small amount of shielding.

"The energies of cosmic radiation," according to Low, "are so high that shielding becomes impractical. However, the peak intensity is sufficiently low that no danger is expected in a five-day mission."

The real danger is from solar flares where the energy is "of a magnitude that may require more shielding than is practical from the standpoint of weight."

The only present solution, according to Low, is that "it should be possible to predict these flares," circumventing their danger by "avoiding flights during a time of anticipated major flare activity."

Though NASA does extensive research on *Apollo's* problems in its laboratories, Low believes that the space agency must rely on industry for many of their solutions. He believes that *Apollo* may give the missile and space industry one of their greatest challenges of the space era.



STEP BEYOND APOLLO could be this space laboratory capable of sustaining a crew of six or more.

NASA
SPECIAL REPORT

Huge Fleet of Unmanned Ships Needed

Funding of spacecraft and payload development—$35 million this fiscal year—expected to swell; rugged instruments are demanded

A total of $35 million will be spent in industry this fiscal year for developing unmanned spacecraft and their payloads for the National Aeronautics and Space Administration. This money is expected to go up with time.

Total NASA money programed this year for unmanned lunar and planetary exploration is $75 million. Of this amount, $20 million is being spent on launch vehicles. The remaining $20 million is being used for NASA in-house work connected with the program.

For its unmanned lunar work during the 60's, NASA will be developing and buying fly-bys, rough orbiters, impactors, stationary soft landers, soft landers with mobile payloads, advanced orbiters, and craft for remote return of surface samples.

NASA is calling for similar but more advanced craft for its unmanned planetary and interplanetary explorations. Thus this program involves deep-space probes, fly-bys of near planets, planet orbiters, planet landers, and higher energy missions such as those out of the plane of the ecliptic or to distant planets.

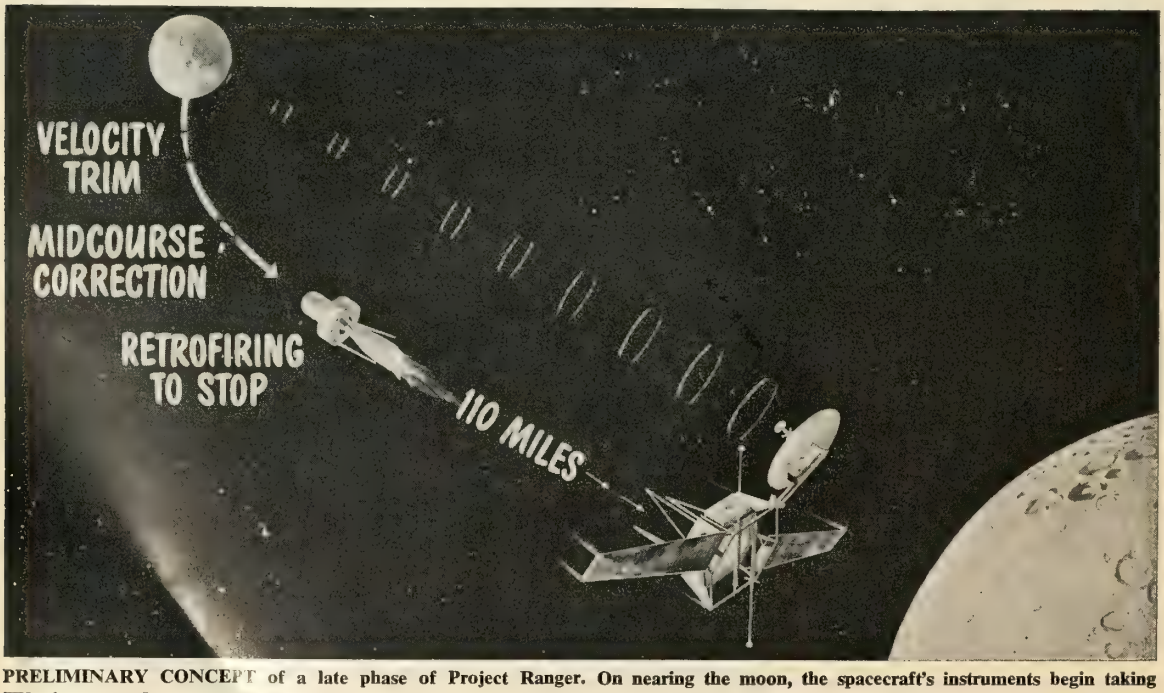
The Jet Propulsion Laboratory under direction of NASA headquarters will be executing the agency's lunar, planetary and interplanetary unmanned program. "JPL will rely heavily on contracting to industry not only for complete spacecraft but also for systems, subsystems, components and parts," says Edgar M. Cortright, Assistant Director for Lunar and Planetary Programs.

He added that universities and nonprofit organizations will be playing a major role in developing the scientific experiments.

• **Advanced instruments needed**—One point was understood. "NASA would welcome additional initiative on the part of instrument companies" in devising effective and rugged devices for making environmental and observational measurements.

In his list of needed instruments, Cortright stated that NASA could use the following ones, which fall in the somewhat arbitrary environmental category:

–Radiation detectors of all types



PRELIMINARY CONCEPT of a late phase of Project Ranger. On nearing the moon, the spacecraft's instruments begin taking TV pictures and gamma-ray spectography. The ship then rough-lands, depositing a seismometer on the lunar surface.

covering all ranges of the energy spectrum and hopefully discriminating between particle types and electro-magnetic radiation.

–Micrometeroid detectors.

–Pressure, temperature, and ionization gages.

–Sound detectors and analyzers.

–Mass spectrometers.

Under the category of observational instruments, the ones needed were given as follows:

–Television, ranging all the way from microscopic examination of particles to far-scanning of the lunar terrain.

–Radar to be utilized both on the surface and in orbit to determine not only position but also contour of the land and perhaps some of the surface structure.

–Spectrometers of all types including the X-ray, fluorescent, gamma-ray, and mass varieties.

–Seismometers.

–Magnetometers.

–Penetrometers

–Chemical analyzers.

–Microbiological equipment.

–Gravimeters.

The major problem is to place the required instruments at the exploration site and then have them obtain the desired information and send it back to earth. Cortright said preliminary work on many of these instruments has already begun, and indeed first-generation ones have been flown on a number of occasions.

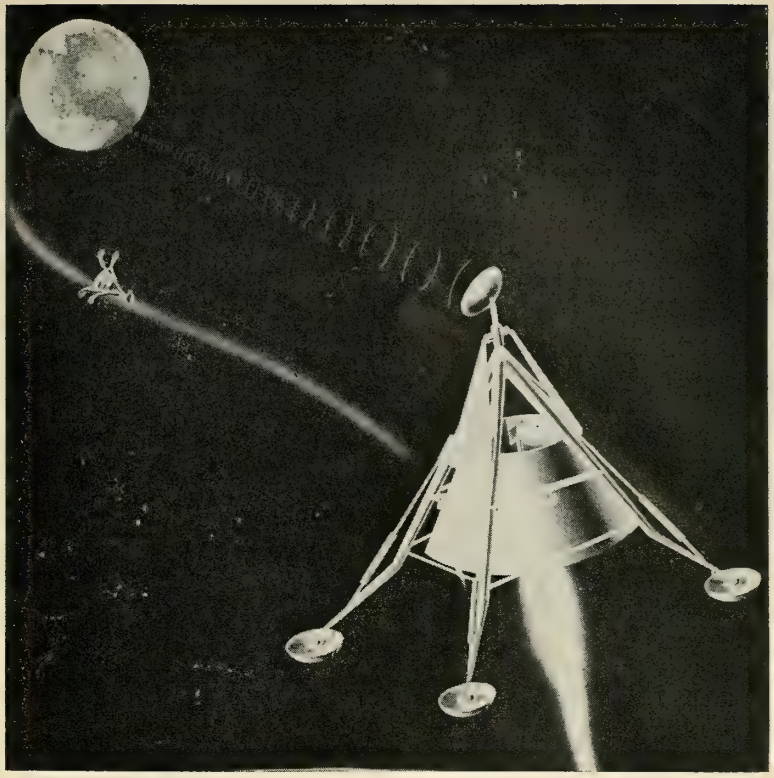
Cortright underscored the need for strong imagination and initiative to develop the advanced equipment required for interplanetary missions. These include high-power telemetry; low-noise receivers; improved power supplies of chemical, solar, and nuclear varieties; and advanced computers to be carried aboard the spacecraft.

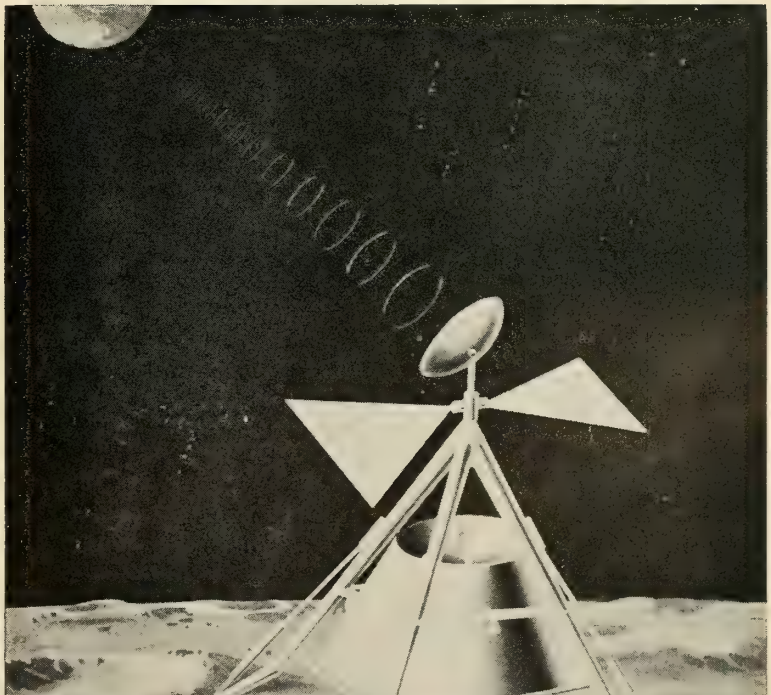
• **Mobile planetary vehicles**—Other needs include advanced guidance, navigation and control equipment for both midcourse and terminal phases, and advanced spacecraft propulsion equipment of both the chemical and electrical variety.

As a matter of fact, electrical propulsion shows definite promise for the more difficult exploratory missions, Cortright said.

There is a requirement for improved lightweight spacecraft structures and packaging techniques. Furthermore, methods must be developed for entry and survival in the planetary atmospheres. Equipment must be researched and developed for sample gathering and processing through the scientific instruments.

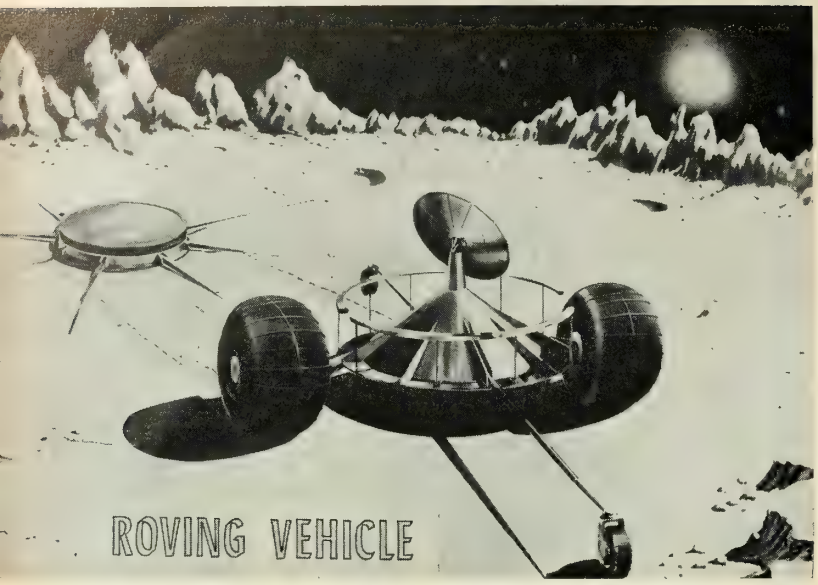
A major problem exists in developing propulsion techniques for mobile surface exploration vehicles. The ve-





PROJECT SURVEYOR spacecraft, powered by a Centaur launch vehicle, would make a soft landing on the moon carrying a payload of some 200 lbs. of instruments.

improved reliability is vital . . .



ARTIST'S CONCEPTION of Prospector spacecraft, shown in background, and roving vehicle that craft deposited on lunar surface for exploring the nearby terrain.

hicle planned for *Prospector* will be capable of exploring throughout a radius of perhaps 50 miles, terrain permitting. It would obtain orders of magnitude more data than could be obtained with a stationary spacecraft.

Cortright emphasized that "applying to all of these technological areas, and to the instruments as well, is the vital necessity for improved length of life and reliability."

The objectives in NASA's program of unmanned instrumented deep-space exploration can be roughly grouped into:

–Physics of the moon and planets.

–Solar and interplanetary physics.

–Biosciences and extraterrestrial life.

–Cosmology.

With these objectives in mind, NASA has devised its unmanned deep-space program under two governing principles: (1) Selection of a limited number of important goals on which to concentrate. (2) Establishment of an evolutionary sequence of missions where each step paves the way for the more difficult phase to follow and makes full use of increased technological capability as it becomes available.

Program for Unmanned Lunar and Interplanetary Spacecraft

Project Name	Mission	Launch Vehicle	Status	Notes
Spacecraft Under Development				
(none)	lunar orbiter	Atlas-Able	Previous flight attempt aborted 11/26/59. Next shot expected October 1960. Craft developed by Space Technology Laboratories reporting through Air Force Ballistic Missile Div. to the Goddard Space Flight Center.	Spacecraft weighs about 400 lbs., including the hydrazine monopropellant for midcourse and terminal maneuvers, is spin-stabilized, and carries eight separate experiments. Looks very much like Pioneer V.
Ranger	interplanetary flights	Atlas-Agena B	A set of seven scientific experiments have been approved for flight. First flight planned for 1961.	Spacecraft weights will vary between 600 and 1200 lbs. Flights intended primarily to test spacecraft and components development.
Mariner	flights to Mars and Venus	Atlas-Agena B	First flight planned for 1961.	Differs from Ranger primarily in instrumentation carried.
Ranger (later phase)	lunar landing, rough but safe	Atlas-Agena B	Planned for 1961-2. Spacecraft being developed by Jet Propulsion Laboratory; capsule under contract to Aeronutronics Div. of Ford Motor Co.	Spacecraft designed to carry a survivable capsule containing a seismometer as the primary experiment.
Spacecraft Being Planned				
Surveyor	lunar soft landing	Centaur	Four companies currently making spacecraft design studies which are to be completed by end of 1960. Developer of hardware to be selected early 1961. Landings planned for 1963-4.	Spacecraft for putting on moon a moderately heavy scientific payload, 100 to 300 lbs.
Prospector	lunar soft landing	Saturn	Planned for 1965. Under study by the Jet Propulsion Laboratory, and by the Marshall Space Flight Center for JPL.	First priority payload is a mobile laboratory able to explore near-terrain.
Voyager	Mars and Venus orbiter	Saturn	Planned for 1965.	Orbiter ejects instrument capsule for atmospheric entry and perhaps landing on planet. Data relayed from capsule to orbiter, and then to earth.

NASA
SPECIAL REPORT

Agency Eyes Standardized Satellite

Multi-purpose concept would save money, add reliability; survey of satellite application plans, long-range launching program

National Aeronautics and Space Administration is thinking of developing a standardized satellite which it can use for its orbiting astronomical and geophysical observatories.

Morton J. Stoller, assistant director for the Satellite and Sounding Rocket Program, says that if the concept can be developed successfully, a number of future space experiments would be conducted with the vehicle.

The standardized units would employ the same structure, same basic power supply, attitude control, telemetry and command system. Built to carry large payloads (the orbiting astronomical laboratory will weigh 3500 lbs.), NASA would have only to take it "off-the-shelf" and put in the scientific sensors and specialized devices it wants to do a specific job. This would result not only in a savings in cost and time, but significantly increase reliability.

For FY 1961, the agency has programed $33 million for satellite scientific experiments. An additional $15 million will go to the meteorological satellite program and $5.5 million for communication satellites. Sounding rocket studies will get $5.5 million, with $2.5 million going for sounding rocket vehicle procurement.

Industry can expect to get the lion's share of this money. NASA says about 75% of the spaceflight program funds will go to private industry, 5% to university and other non-profit research organizations, and 20% to NASA installations.

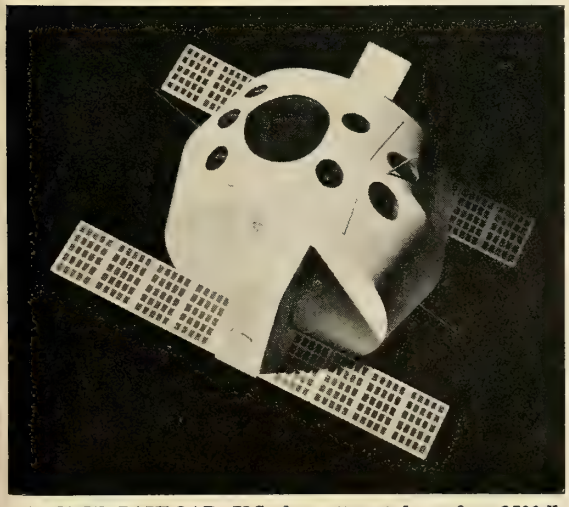
SATELLITE APPLICATION PROGRAM

There are two major fields in this program—meteorology and communication. NASA cautions that because of its experimental nature, the program is subject to change. However, Newell D. Sanders, assistant director for applications and manned flight programs, announced this schedule:

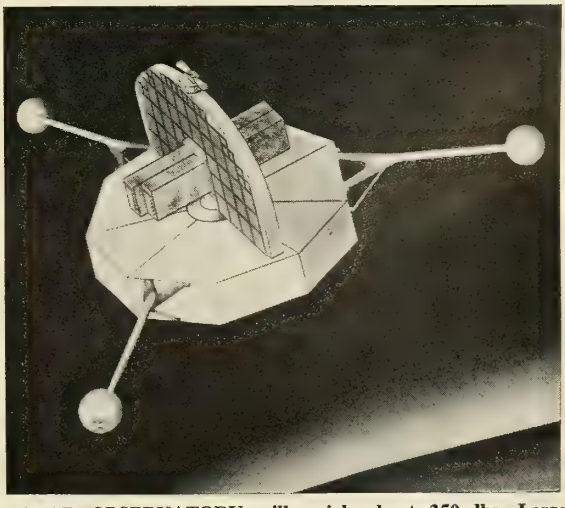
• **Meteorological:**—*Tiros*—Follow-on experiments to *Tiros I,* launched in April are scheduled during 1960 and 1961. Infrared equipment will be added for measuring the earth's heat balance and for measuring radiation in particular spectral ranges.

–*Nimbus*—Now under development, a systems integration and basic structure contract will be awarded this fall. Specifications are now being written and the invitation for proposals is imminent. Other contracts to be awarded separately are for the stabilization system, power supply, sensing equipment and special experiments to be carried aboard.

Managed by the Goddard Space Flight Center, the 600-700 lb. satellite will be launched by *Thor-Agena.* A stabilization system will keep cameras pointed earthward. Sensors will include television cameras, passive and scan-type radiation-sending equipment and



LARGEST PAYLOAD U.S. has attempted so far, 3500-lb. NASA Orbiting Astronomical Observatory will be about 10 feet in diameter.



SOLAR OBSERVATORY will weigh about 350 lbs. Large flywheel and extended arms rotate to stabilize; arm (top) holds instruments.

other experiments. Later models may include simplified radar for observing precipitation, spectrometer for temperature measurement and an image orthicon camera for observing night cloud cover.

–*Aeros*—Not yet approved, the code name *Aeros* has been selected for a proposed "24-hour satellite" which might be initiated in 1962 with possible launchings in 1964. The satellite would be launched in an equatorial orbit which would make it appear to stand stationary, since its orbital period would coincide with the earth's rotational period. Three satellites could permit continuous observation of most of the earth's surface.

NASA asks industry for ideas on feasible methods and devices for atmosphere measurement. Areas which must be measured and observed are: a) cloud cover and storm location, b) precipitation, c) temperature, d) wind direction, e) heat balance, f) water vapor and other constituents.

• **Communications**—The civilian space agency has thus far confined its research to passive satellites, while DOD has studied active satellites. Active satellites later will be evaluated by NASA. Projects forthcoming at NASA:

–*Echo*—Follow-on experiments are scheduled in 1961 and 1962 with *Thor-Delta* launch vehicles. Langley Research Center is now evaluating bids for a satellite launching in this series using a rigid, large reflecting structure. Launch will come in 1962 if this concept proves feasible.

Current *Echo* experiments have been concerned with problems of inflating and orbiting large erectable satellites. Jet Propulsion Laboratory at Goldstone, Calif. and Bell Telephone Laboratories facility at Holmdel, N.J. are planning further communications experiments, as are other independent organizations.

–*Rebound*—Experiments with multiple passive communications satellites are being considered. NASA feels that at least 12 passive communications satellites spaced around the world would provide continuous communication. However, several such satellites would have to be launched by one vehicle, possibly *Atlas-Agena B*, to make the plan economically feasible.

Early projects will attempt the packaging and erecting of reflectors upon injection into orbit. The next step will be the problem of providing period control for multiple passive satellites. If all goes well, launchings might come in 1963-65.

Research and development work also is taking place at JPL and Bell Telephone Labs on ground communications facilities required for acquiring and holding the satellite—pointing the antenna—and for establishing optimum signal-modulation requirements. Studies on reflective characteristics of nonspherical shapes also will be conducted.

Key Areas for Industry Participation

Communications satellites:

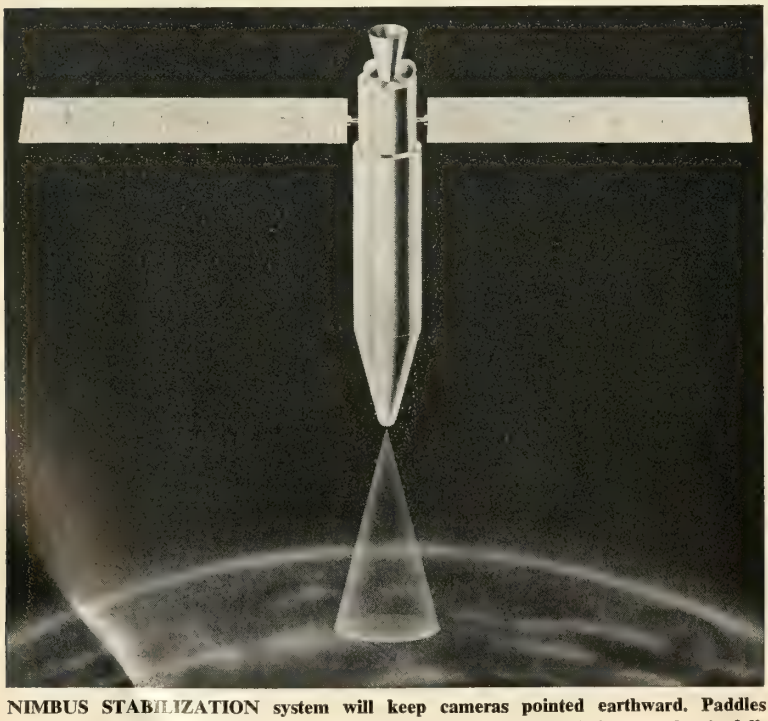
- Inflatable structures
- Plastics for space environment
- Passive stabilization
- Period control systems

Scientific studies:

- Ion mass spectrometers, vacuum gages
- Radiation detectors and analyzers
- Ultraviolet and X-Ray detectors and analyzers
- Directional magnetometers
- Plasma probes
- Telescope pointing controls

Meteorological satellites:

- Attitude sensors and stabilization systems
- High-resolution RV systems
- Data-storage systems
- Data-transmission systems
- On-board data-analysis systems
- Period control systems
- Materials for space environment
- Power supplies
- Radar



NIMBUS STABILIZATION system will keep cameras pointed earthward. Paddles carry solar cells to power subsystems. Contracts for 600-700 lb. Nimbus are due in fall.

SATELLITE AND SOUNDING ROCKET PROGRAM

NASA plans to launch four large satellites for scientific experiment per year by 1964. Small satellites will be launched at the rate of six to nine per year now with six per year by 1963 (generally by *Scout*). One hundred sounding rockets will be launched per year by 1962.

• **Off-the-shelf**—Components will be directly or indirectly procured from commercial sources, and the agency wants to establish stable sources of supplies. Standardization and reliability are keywords in this program.

Fields in which these satellites and rockets will be employed are: 1) geodesy and gravitation, 2) upper atmosphere, 3) ionosphere, 4) magnetic and electric fields, 5) radiation belts, 6) cosmic rays, 7) the Sun, 8) solar terrestrial relations, 9) the stars, 10) biosciences. This area of research will not concern moon, planets and interplanetary space.

• **Sounding rockets**—A limited num-

ber of sounding rockets will be used for all research. At present, NASA has 11 types in fairly regular use, including the highly sucessful *Aerobee—Hi*. Goddard Space Flight Center will, however, ask proposals when improvements on existing models seem necessary.

Commercial electronic and mechanical systems such as telemetry, power supply units and tracking aids will be used for the sounding rocket program whenever possible. Industry and research groups are asked for work on sensors and instrumentation for the scientific investigation.

• **Earth satellites**—Two satellite systems will, in the near future, be procured from industrial sources by Goddard Space Flight Center. Spacecraft systems contractor will be selected through regular procurement procedures, with experiments handled separately.

–Orbiting Astronomical Observatory—Bids have been received and are now being considered for the largest payload attempted to date—3500 lbs. Cost of the program may mean as much as $100 million over 10 years to the winner.

In the running are: Lockheed MSD, Aeronutronics Div. of Ford Motor Co., Hughes Aircraft and General Electric MSD. Team bids are: Bendix/Republic Aviation, Systems Div., Martin Co./General Precision Instruments Inc., Westinghouse Electric/Grumman Aircraft, Aerojet-General/Motorola, McDonnell Aircraft/Philco, RCA/North American Aviation/Perkin-Elmer, and Douglas Aircraft/Itek Corp./IBM/Vidya of Massachusetts Institute of Technology.

–Orbiting Geophysical Observatory—Procurement action will be initiated in four to six months, probably in the form of an inquiry as to interest in submitting a proposal. Standardization of components and systems is again expected to be emphasized.

NASA wants help on problems of efficient ways of dissipating heat released in course of operation of the international devices, since the temperature range must be restricted for stable performance. Improvement also is desired in environmental control and "desensitization" of components and subsystems.

• **Data Collection and Processing**—One of the biggest problems in the satellite and sounding rockets programs will be the processing of the enormous amounts of data that can be obtained. Industry is asked for work on preprocessing and automatic processing techniques for both satellite and ground readout stations. Specialized requirements will be announced later as each program progresses.

NASA Satellite Application Program

METEOROLOGICAL

	59	60	61	62	63	64	65
TIROS							
R&D							
Launching		2	1				
Data Analysis							
NIMBUS							
R&D							
Launching			1	1	2		
Data Analysis							
AEROS							
R&D							
Launchings						2	2
Data Analysis							

COMMUNICATIONS

	59	60	61	62	63	64	65
ECHO							
R&D							
Launchings		2	1	1			
Qualification							
Structure Rigidization							
Tracking & Ephemeris Generation							
REBOUND							
R&D							
Period Control R&D							
Launchings					1	2	2
ADVANCED TECHNOLOGY							
Communications R&D (Ground Tests)							
Active Satellite Study							



SATURN STATIC TEST at NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

NASA
SPECIAL REPORT

Launch Vehicle List May Drop to Four

Survey of propulsion plans includes Saturn schedule and programs for nuclear, electrical and chemical power

The National Aeronautics and Space Administration is reducing from 10 to six the number of launch vehicles it will use. The number may drop to four later.

Abraham Hayatt, deputy director of launch vehicle programs, outlined the plans at last week's conference with industry, government and university representatives.

Present vehicles in development or operation, in ascending order of payload capacity, are *Juno II, Scout, Thor-Able, Delta, Thor-Agena B, Centaur* and *Saturn*. *Juno II, Thor-Able, Delta* and *Atlas-Able* will be dropped from the list.

Atlas remains on the list only for its mission of orbiting *Mercury* capsules. Heavier manned vehicles will require launch equipment of *Centaur* or *Saturn* type.

"Only eight *Thor-Agena B*'s are programed for NASA missions," Hyatt said. "Therefore, it too may disappear from the picture, particularly if *Thor* production for Air Force requirements ceases."

Thus the list will reduce to four—*Scout, Atlas-Agena B, Centaur* and *Saturn*—until programs get under way later in the decade on advanced *Saturn* and *Nova* vehicles.

• **Scout**—Hyatt disclosed that the estimated cost of a production *Scout* plus the launching operation is $900,000. This is greater than the $750,000 figure given earlier this year because launch operation costs were not included. At present, *Scout* is launched by government personnel. Later, the operation is to be turned over to a contractor completely.

Despite the rising estimate, Hyatt maintained that low cost is one of *Scout's* principal merits. "In comparison," he said, "to buy and launch a *Delta* may cost as much as $3,500,000."

Scout has a capacity of putting 200 lbs. into a 300-nautical-mile orbit or lifting smaller payloads on vertical probes up to 4000 miles. It will be launched from both the Atlantic and Pacific Missile Ranges as well as from Wallops Island, Va. Development is to be complete within a year.

• **Thor-Agena B**—An advanced version of the *Thor-Agena,* which the Air Force has been using in its *Discoverer* program, *Thor-Agena B* will be used at the Pacific Missile Range for launchings into polar orbit or highly inclined earth orbits.

Hyatt said the vehicle was chosen because of the relatively high reliability *Thor-Agena* has demonstrated for putting payloads into orbit. It will be used for such missions as scientific satellites, meteorological satellites and other missions requiring medium-weight payloads. The capacity will be 1600 lbs. in a 300-nautical-mile orbit and 850 lbs. in a 1200-nautical-mile orbit. Flights will begin next year.

• **Atlas-Agena B**—The Air Force will undertake several firings of *Atlas-Agena B* before it is used for a NASA mission. Common use by NASA and the Air Force will provide a large number of launchings and thus high reliability, Hyatt said.

NASA plans to use the vehicle for early lunar exploration and scientific earth satellites.

Most NASA launchings will be from the Atlantic Missile Range. A few will be from the Pacific Missile Range. First NASA launching will be early in 1961. Its payload capacity is 5800 lbs. in a 300-nautical-mile orbit and 750 lbs. for a lunar probe.

• **Centaur**—Design of the hydro-

gen-oxygen *Centaur* stage, will be atop an *Atlas,* is rapidly nearing completion, Hyatt said. *Centaur,* which will be launched in mid-1961, has an inertial guidance system with many advanced features.

Centaur will be used for lunar and planetary exploration and geophysical satellites. It will be launched down the Atlantic Missile Range. Payload capacity is 8500 lbs. in 300-nautical-mile orbit or 1450 lbs. for escape velocity.

• **Saturn**—Oswald H. Lange, *Saturn* Project director at the Marshall Space Flight Center in Huntsville, Ala., outlined the first 10 *Saturn* vehicle flights, based on the 10 boosters to be fabricated at Huntsville.

There will be three flights of the booster and dummy upper stages, one in 1961 and two in 1962. Three flights will be of booster, live second stage and dummy third stage—one in 1962 and two in 1963. Three firings of three-stage test vehicles in 1963 will precede the first flight of the operational prototype in 1964.

In the first three flights with dummy upper stages, the H-1 engines will be operated at a thrust level of 165,000 lbs., giving a total thrust of 1.3 million lbs. Subsequent vehicles will have booster thrust at 1.5 million lbs.

The first *Saturn* vehicles to fly will be the C-1 configuration—made up of the booster, the Douglas S-IV and the Convair S-V. The S-V is a modification of the *Centaur* stage. The S-IV stage is similar to *Centaur* but has four, instead of two, Pratt & Whitney LR-115 engines.

The next version of *Saturn* will be the four-stage *Saturn* C-2. The new second stage will be the S-II, a cluster of four 200,000-lb.-thrust Rocketdyne J-2 engines. Lange said specifications for the stage depend on definitive information on the engine and will be formulated near the end of this year. Selection of a contractor for S-II is tentatively scheduled for the spring of 1962.

Lange gave these net payload capabilities for the *Saturn* C-1 vehicles:

100-mile orbit	20,000 lbs.
307-mile orbit	19,000 lbs.
Escape	6000 lbs.
24-hour orbit	3400 lbs.
Lunar soft landing	1500 lbs.

• **Nuclear propulsion**—Several NASA contracts to industry will be awarded soon in support of Project *Rover,* the NASA-Atomic Energy Commission nuclear rocket. Harold B. Finger, NASA chief of nuclear propulsion, said preliminary design work on the nuclear engine is being completed so that hardware development on a flight-test engine can begin immediately after tests have been run on a reactor using liquid hydrogen as a propellant.

Finger gave no details on the liquid hydrogen reactor test. However, AEC sources have indicated that testing of the reactor, Kiwi-B, is planned for the summer of 1961.

Finger said industry would develop the hardware. Apparently, the contract is to be awarded in the fall of 1961.

To meet plans for a 1965 flight test, Finger said, it is necessary to begin work on facilities required for developing the engine and vehicle as soon as possible. The facilities work will be handled by industry.

• **Electrical propulsion**—Finger said that according to present programing, the SNAP-8 nuclear power system will be developed to give a 90-day operating life in 3½ years and a 1-year life in 5 years. SNAP-8 will provide 30 kilowatts of power for an electrical propulsion system.

Elliot Mitchell, assistant director for propulsion in the Office of Launch Vehicle Programs, said a 30-kilowatt arc jet engine and a 30-kilowatt ion engine are being developed for readiness about 1965. The program also includes feasibility studies on a magnetohydrodynamic engine.

• **Chemical rockets**—The Rocketdyne F-1 engine, rated at 1½ million lbs. thrust, has been fired several times at thrust levels in excess of 1 million lbs., Mitchell reported.

In solid rockets, NASA is devoting considerable effort to reducing rocket inert weight in upper stages. Mitchell said it should be possible to go from the present maximum mass ratio of about 90% as high as 96%.

Large solid booster design studies will be continued to determine their feasibility as first stages for future NASA vehicles, Mitchell said.

Mitchell gave this breakdown of current propulsion spending:

–Engine development (H-1, F-1, LR-115 and J-2) .....$93.5 million

–Advanced liquid technology .....$6 million

–Solid rockets .....$2.8 million

–Electrical propulsion, $3.3 million

NASA is spending $10 million in the nuclear area—$5.5 million for nuclear rockets and $4.5 million for nuclear electric generating systems. However, the matching AEC expenditures are several times those of NASA.

In the current fiscal year, on the Saturn *project alone, NASA is spending about $160 million with industry for design efforts, component development and delivery.*

Focal point for industry contact is the Saturn Systems Office at the Marshall Space Flight Center, Huntsville, Ala., headed by Oswald H. Lange. Items under development contract or required soon from industry include:

—Guidance components
—Control equipment
—Telemetry
—Range Safety
—Tracking equipment including transmitters, receivers, transponders and antennae
—Advanced pressurization schemes
—Propellant level control devices

The budget for Fiscal Year 1962 is expected to provide for a consistently large share committed to industry, Lange said.

Orbital Missions

Payload Requirements		Vehicle Boost Capacities	
		Scout	200 lbs.
Geophysical, Meteorological	500-2000 lbs.	Thor-Agena B	1600 lbs.
Orbiting Astronomical Observatory	3500-6000 lbs.	Atlas-Agena B	5800 lbs.
		Centaur	8500 lbs.

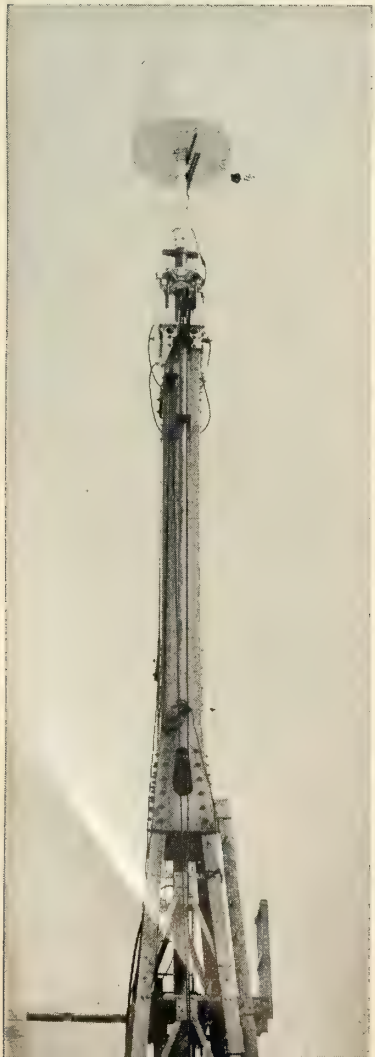
Escape Missions

Payload Requirements		Vehicle Boost Capacities	
Geophysics—highly elliptical orbits, rough lunar landings	500-1500 lbs.	Atlas-Agena B	800 lbs.
		Centaur	1450 lbs.
Planet orbiters, soft lunar landings (static package)	2000-3500 lbs.	Saturn C-1	9000 lbs.
		Saturn C-2	15,000 lbs.
		Nova	120,000-200,000 lbs.
3-man circumlunar flight; moon surface exploration; planet probes	10,000-20,000 lbs.		
Manned lunar landing and return	100,000-200,000 lbs.		

NASA
SPECIAL REPORT

Future Will See Vast Boost In Tracking

Big business of ground instrumentation will grow even bigger tomorrow



The number and capability of ground instrumentation stations must be tremendously expanded in the next ten years to meet tracking and data gathering requirements of future space satellites.

Anticipated NASA firing schedules indicate that there may be 150 to 200 artificial satellites in orbit between 1965 and 1970. Forty of these could be transmitting vehicles.

According to E. C. Buckley, assistant director for space flight operations at NASA—who outlined projected space operations in last week's industry briefings—demand on tracking and data collecting systems will be greatly increased by future requirements.

He pointed out that the primary purpose of carrying out space flight programs is to obtain information about the space environment. Therefore, the provision of adequate ground instrumentation to track the space vehicle and to acquire and record accurately the data gathered by its instruments is of paramount importance.

Buckley said that both capacity and capability must be increased: capacity of ground data collecting systems to handle higher rates of information transmitted from space vehicles to earth, and capability of ground instrumentation for operation over much longer ranges.

These increased requirements will, NASA anticipates, be met mostly by development and installation of higher capacity facilities at existing tracking sites rather than by establishment of new sites.

Buckley cited several areas where research and development are needed to provide these increased instrumentation capabilities:

–Automatic data handling
–Wideband communication links
–Satellite beacons
–Improved programing
–Low-noise amplifiers
–Improved data coding
–Increased information bandwidth
–Large ground antennas

Basic aim of deep space communications R&D is to increase both capacity and range of the space-earth data link. More efficient instrumentation, data coding, and transmission techniques were cited as possible areas of fruitful research.

Getting down to specifics, Buckley said that NASA's major R&D effort in ground instrumentation is expected to be in six areas:

–Information theory—Emphasis on improvements in communications efficiency and data-handling techniques based on application of information theory.

–Data reduction and computation—Effort in basic R&D directed toward rapid and random-access computer memories suitable to data reduction and orbit computation together with development of techniques to reduce data reduction effort.

–Low-noise multipurpose receiver components—Development of phase-stable, low-noise, parametric or maser amplifiers for ground and spaceborne applications in frequency ranges near 400, 1400, 1700, and 2300 mc.

–Data communications between sites on earth—New and improved methods of reliable data transmission to effectively make use of tracking and telemetered data.

–Large aperture antennas—Increased ranges and information collecting capabilities of space probes will require larger ground antennas with high-gain, low-noise characteristics suitable for multiple or broad frequency bands.

–Long-term reliability—Although the greatest problem is in spacecraft, reliability is also a problem in the ground complex. A critical phase of a deep-space mission may occur when only one tracking site is in view of the spacecraft, and the success of the mission would depend upon proper transmission of commands to the spacecraft.

• **Big business**—Ground instrumentation is a big business today and, based on NASA's program, will be even bigger in the future.

In fiscal year 1961, approximately $32 million is programed for the completion of our satellite tracking networks and $44.8 million for their operation. The latter figure contains $22.8 million for the *Mercury* network, including recovery costs. In addition, $10 million is programed for advanced development of ground instrumentation.

The total capital cost of Minitrack stations will be approximately $16 million. Capital costs of three large-antenna installations—Goldstone, South Africa, and Australia—will amount to about $17 million.

Total cost of the *Mercury* network now being installed will be around $53 million. Annual bill for communications tying the networks together—using a combination of commercial-leased and DOD circuits—will add up to some $8 million. Total expenditure for instrumentation and equipment at Wallops Island from 1959 through fiscal 1961 will be about $14 million.

In spelling out the future for ground instrumentation for NASA's space flight operations, Buckley pointed out that the program is "dynamic and subject to change as we progress in the field of space research."

'FEED' mounted on antenna tower at Jodrell Bank receives Pioneer V signals.

Stress on Fuel Cells, Solar Systems

Electrical power research aims for lighter, more reliable solar and chemical sources; nuclear systems get less attention

Key sub-system in all space vehicles is the primary electrical power systems. NASA's FY 1961 budget calls for a funding of $4.7 million in this category with a concentrated effort on fuel cells and solar energy systems.

Batteries will be improved but the trend is to replace them as soon as possible with more efficient, cheaper, lightweight systems. Current and near future use is dictated by their proven reliability.

Nuclear systems are progressing satisfactorily but the emphasis has waned.

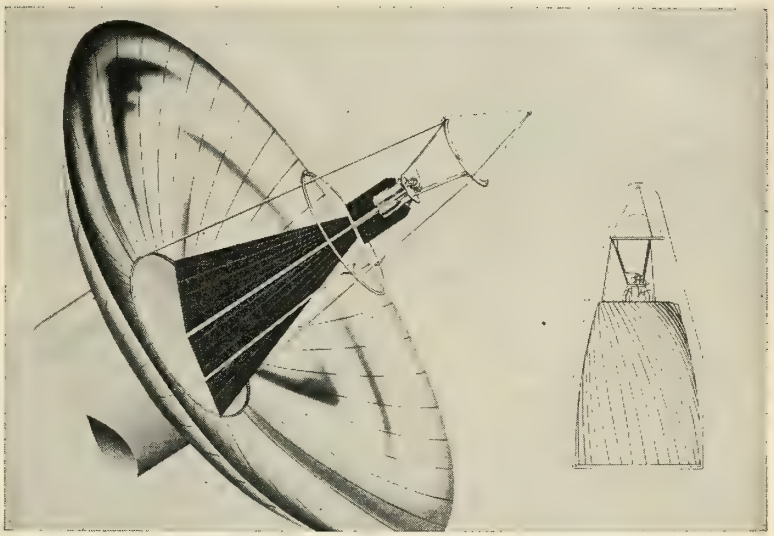
• **New payload needs**—Through 1963, average electrical power-level requirements for vehicles now scheduled is under 300 watts. NASA's William C. Cooley described what the vehicles are and what the power sources will be through the 1960's.

–Unmanned: silicon solar cells with storage batteries; *Scout* or *Delta* launched satellites—10 w; *Pioneer V* and *Tiros* type satellites—30 w; *Nimbus* (meteorological) 250 w average; *Ranger* (lunar instrument landing)—115 w, regulated, in flight and 0.2 w for 1-3 months after landing: Mars probe—over 500 w.

–Manned: *Mercury* capsule—144 lbs. silver-zinc batteries for average orbit power of 70 w, peak 1 kw; lunar circumnavigation, *Saturn* launched, 1965—1.2 kw for 14 days for 4 kw peak; orbiting laboratory, late 1960's—1 to 3 kw average with 4 to 6 kw peak.

• **Advanced power research**—Lightweight, reliable solar and chemical energy sources will receive heavy emphasis under scheduled NASA R&D. Two general programs are in effect—one for system improvement and one for new advanced systems.

–Chemical—to lift reliability of storage batteries for near-vacuum operation, Space Technology Labs. has the task of determining life capability of nickel-cadmium batteries in simulated space environments. In cooperation with DOD, more contracts will be let to improve secondary batteries.



ARTIST'S DRAWINGS show how Sunflower system will operate. At left, the collector of solar heat. At right, a detailed view of the system's turbogenerator.

Although energy-limited by chemical weight limitations in space use, chemical sources—particularly fuel cells—avoid sun-orientation problems inherent with solar power units or the hazards of nuclear systems. This is especially true for short-time manned missions up to about 2 weeks.

At least one and probably more contracts will be let to prove feasibility and develop fuel cells for space use. Biggest problem in zero-gravity state is controlling phase separation between liquid water and gaseous fuel.

–Solar—Two serious problems plague silicon solar-cell power supplies: exorbitant cost ($500,000/kilowatt) and Van Allen belt radiation degradation. The radiation damage is now being investigated for NASA by RCA.

It is hoped however that the whole problem can be bypassed with development of solar-mechanical and solar-thermionic systems. Not as sensitive, they offer the additional advantages of using thermal energy storage instead of batteries and reduced production cost per kilowatt capacity.

For *Centaur* or *Saturn* vehicles in 1964 the Sunflower program is now underway for development of a 3-kw, 1-year continuous output. Tapco Group of Thompson Ramo Wooldridge will produce the solar-turboelectric system using a mercury Rankine cycle and molten lithium hydride as the storage material.

A second system to be started this fiscal year is one using cesium vapor thermionic converters. In support of these contracts also will be studies of materials and optics for better solar collectors.

–Nuclear—The SNAP-8 30-kw system for nuclear electric power is to be designed primarily for flight testing electrical propulsion systems. SNAP-8 will use a mercury turbine in the conversion system being developed by Aerojet-General Corp.

NASA
SPECIAL REPORT

More R&D Money for Structures, Materials

The structures and materials research budget of the National Aeronautics and Space Administration is currently hovering around $15 million —and several increases are anticipated in the next few years.

Richard V. Rhode, Assistant Director, Structures, Materials and Operating Problems, reports that this money is about evenly divided between the two fields.

In outlining the major research areas, Rhode breaks down the problems into four categories—aircraft, missiles and launch vehicles, spacecraft, and re-entry and landing vehicles.

In aircraft, the NASA expert said that aluminum alloys will not be satisfactory for speeds in excess of Mach 2. Steels and even beryllium are being investigated as structural materials. The relative merits of various structural approaches such as skin stringer and sandwich types. The latter seem to be more efficient but higher cost and fabrication difficulties will affect the degree of acceptance.

In launch vehicles, NASA expects the lengths to exceed 200 ft. and weights to be in the +1 million lb. range. Rhode points out that the importance of light structural weight leads to flimsy and flexible boosters. Thus there are problems in launch dynamics, wind shear response, flutter, noise vibration and compatibility with cryogenic environments.

Launch dynamics are complicated by the interaction of the vehicle structure, control system and the sloshing of large fluid masses.

• **Deep space vehicle**—Spacecraft design and operation include meteorite impact, long time vacuum exposure and the effects of particle radiation. This last is damaging to some types of materials but the problem is compounded by the presence of humans.

Rhode said that temperature controls and the techniques for expandable structures also require additional study.

The question of meteorite impact has led to many investigations at NASA and elsewhere. It has been established that penetration at high speeds is not nearly as deep as previously thought. This is because the projectile and the target become molten at instant of impact and the projectile disintegrates.

In re-entry vehicles, the thermal protection problems have dominated the area. A wide variety of re-entry bodies are currently being studied at NASA. These include both drag and lift configurations.

In the lift vehicles, problems of aerothermoelasticity and flutter are expected to be important. Landing impact problems, either on earth or somewhere else, are also receiving some attention.

• **Expanding boundaries**—Thermal protection systems have been explored and exploited. These include heat sink radiation and ablation approaches. NASA research will expand the boundaries of heat-protection systems to higher temperatures and longer exposure times to include lifting re-entry and re-entry from deep space.

Rhode said that combinations of ablation and radiation systems in the form of charring ablatives appear to offer "special promise" and will be ". . . exploited in our effort to extend our capability for safe re-entry."

The solid-state physics of defects was given as an example of an important basic research area at NASA. Rhode said this could be the key to understanding and controlling the strength and ductility of materials. The ultimate payoff from advancements here can be exemplified by the ultra-high strength of defect-free whiskers.

Work is continuing in the study of materials at 4200°F and higher.



SATELLITE ENVIRONMENT is closely approximated in this circular table, balanced on a metal sphere supported on a cushion of compressed air, at NASA's Ames facility.

Materials Demands

Traditional		Additional
Density Strength Ductility Stiffness Fatigue	Directly Related to Temperature and Temperature Changes	Creep Strength Thermal Expansion Thermal Conductivity Specific Heat Thermal Shock Resistance Emissivity
		Ignition Characteristics
	Directly Related to Environment of Space	Ablation Characteristics Radiation Shielding Radiation Sensitivity Meteorite Impact Resistance Vaporization

Lawyers Urge Change in Patent Law

Space agency counsel hopes Senate will okay House-passed modification, feels present policy discourages contractors

Present legislation covering NASA patents hurts the nation's space effort, and NASA lawyers hope that Congress will modify NASA patent laws during the August special session.

This was the encouraging message given by Gerald D. O'Brien, NASA's Assistant General Counsel for Patent Matters, to industry leaders.

The problem, according to O'Brien, is that "NASA contractors are largely from the same segments of American industry which contract with the Department of Defense in the aeronautical and space fields."

DOD allows industry to retain exclusive title to more proprietary items developed under government contracts than does NASA.

The resulting industry dissatisfaction, according to O'Brien, is "evidenced by some contractor opposition which h i n d e r s NASA's ability to achieve the necessary performance of its mission . . . and has caused a certain unwillingness on the part of some prospective contractors to participate in projects of importance to our national space program."

• **Senate may act**—The House has already passed a bill modifying NASA patent legislation. The bill is presently before the Senate Space Committee. O'Brien hopes that the Senate takes action during the August session.

Some opposition can be expected in the Senate because of the belief that the government must retain the rights to inventions or processes discovered in the course of a NASA contract in order to protect the national interest.

O'Brien disagrees with this view. "We are deceiving ourselves," he told his listeners, "if we assume that the government really acquires anything of value when it takes ownership to a patent in preference to a mere royalty free license."

The bill modifying NASA's patent laws, according to O'Brien, "is patterned after legislation in 1950 for the National Science Foundation."

• **Details of bill**—Generally, the bill will give NASA a non-exclusive royalty-free license to use the patentable invention and the company will retain title. But this contract is revocable and waiver of title will be affected if NASA finds the company's use of their patent is to the exclusion of the national interest.

A company retaining patent rights must also prove that it is seeking to exploit the invention within a reasonable period time. If the company fails to do so, all rights to the invention would be returned to the government.

The only two areas whereby NASA, under the modified law, may take more than a non-exclusive royalty-free license are when (1) the importance of the invention or process to the welfare of the country is such that title should be retained; or when (2) the invention or process has to do with atomic energy and AEC patent policies are involved.

Production-type Contracts May be Let in Some Programs

The National Aeronautics and Space Administration's procurement for some time to come will be research and development with no requirements for production-type contracts, according to Procurement Director Ernest W. Brackett.

Outlining NASA's procurement system before industry leaders in Washington last week, Brackett said NASA so far hasn't adopted the systems management by contractor concept, but that it may do so in an individual program where it is necessary to place full responsibility on one contractor to integrate a complete project.

He said NASA has found out that in research and development the negotiated cost-plus-fixed-fee contract is more suitable. He said the agency has made a few negotiated fixed-price contracts with a price redetermination provision but as yet has made no incentive-type contracts, either fixed-price or cost-plus-incentive-fee.

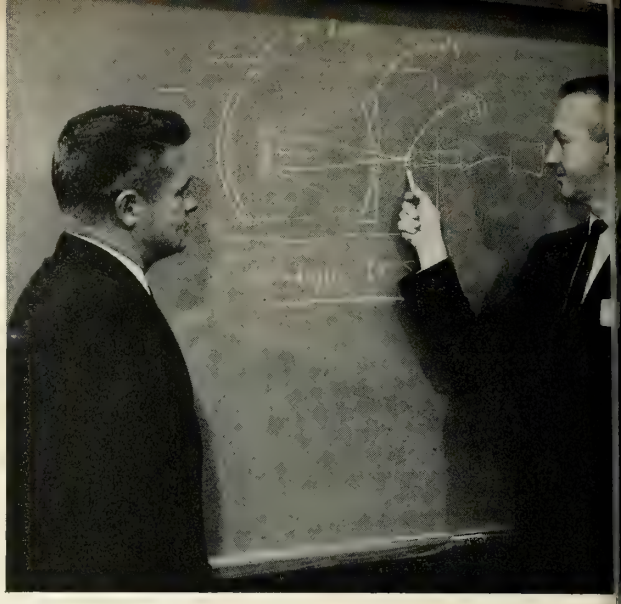
Stressing that NASA's procurement system is decentralized, he pointed out that the place to go to be considered for business is the seven NASA centers. Over 80% of the total appropriation for FY 1961, he said, is planned for contracts. Brackett said there is a big field for small business concerns in doing subcontract work, and NASA will ask larger contractors to see that small business shares.

The fixed fee, he said, is only one element of the overall cost factors. He said NASA uses a great deal of care in considering the experience, facilities, technical staff, and engineering plan as well. The major point in selection of a contractor, he said, is technical superiority. When two or more proposals are comparatively equal in technical respects, the proposal having the most reasonable cost estimate will be the one selected, he added.

Brackett said NASA is reviewing evaluation procedures in detail, including how it may debrief companies which lose competitions, in a way that will be of assistance to them in preparing later proposals.



"This missile age of ours requires vast scientific and engineering technology. MISSILES AND ROCKETS keeps us posted in this market that expands daily." D. M. Tenenbaum (left), Mgr., Test Division, Sacramento Plants.



"Technical news developments concerning the industry are a day-to-day occurrence. MISSILES AND ROCKETS keeps us right up to date." Dr. R. H. McFee (right), Dir. of Research, Aerojet-General's Avionics Division.

WHY DO SO MANY KEY PEOPLE AT AEROJET-GENERAL READ MISSILES AND ROCKETS?



438 PAID SUBSCRIPTIONS! One of the outstanding leaders in the research, design, development, and production of both solid and liquid propellant rocket engines, Aerojet-General ranks 19th among all major defense contractors. Naturally, there are a large number of paid subscribers to MISSILES AND ROCKETS at Aerojet-General—438, to be exact. And since many of the copies have high pass-along readership, there is an even larger number of readers at Aerojet-General.

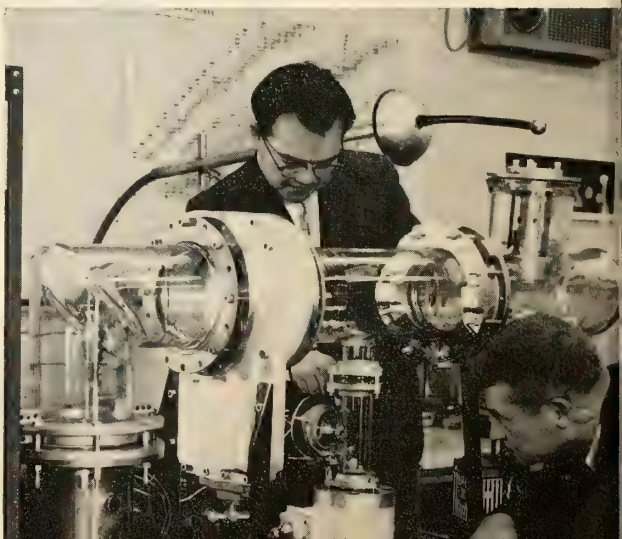
Some of the many reasons why M/R commands intense readership among key people at Aerojet-General are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Editor Richard Van Osten (insert).

These comments and those of other key readers in other missile/space companies clearly show what M/R has known all along . . . that the missile/space industry is a separate, distinct market with rapidly changing requirements that can best be met by *undiluted, weekly* technical/news coverage. It is this kind of coverage that makes M/R unique . . . explains its deep, penetrating readership and acceptance.

"Today's missile industry evolved from the old concept of the aircraft-missile business but each is now a separate and distinct industry. We read MISSILES AND ROCKETS for that very reason. It deals 100% with Astronautics." M. L. Stary, Director, Aerojet-General's Systems Division.



"In this young industry it is absolutely necessary that engineers be filled in on new data as it develops. MISSILES AND ROCKETS provides a complete, clear picture weekly of what's happening in the field of World Astronautics." Dr. G. Moe (left), Aerojet-General's Space Technology Division.



Technical Countdown

ELECTRONICS

Cosmic Radiation to be Studied

Biological effects of outer-space cosmic radiation will be studied under a new AF contract with Controls for Radiation, Inc. Representative mammalian cells will be bombarded by simulated cosmic rays generated by high-energy cyclotrons and linear accelerators to evaluate radiation effects on future space travelers.

CCTV Operates in Rocket Blast

A closed-circuit television camera developed by General Electric can be mounted within a few feet of a rocket engine to monitor firing and launching. The super-ruggedized camera has reportedly operated successfully in tests located in the maximum noise zone only eight feet from the engine.

Thermoelectric Coolers Into Production

AiResearch Division of Garrett Corp. has announced the first of a new line of thermoelectric cooling units for aircraft/missile electronic system components. The new Peltier-effect device dissipates 65.3 watts of heat to sea-level ambient air at 140°F.

GROUND SUPPORT EQUIPMENT

Saturn Recovery Delayed

A reputed $23-million transfer of funds from *Saturn* program to other NASA space projects by Director T. Keith Glennan will delay booster recovery-system development. Cook Electric still has a recovery-system R&D contract, but hardware production contract award will be delayed temporarily. Subsystem development has progressed rapidly. Cook recently tested its huge conical inflated retarder at the Tullahoma Wind Tunnel. Wearing its own nose cone (for re-entry), it withstood Mach-5 velocities successfully.

Polaris FCS Simulator Ready

First *Polaris* fire control simulator, developed by General Electric will be installed aboard the USS Theodore Roosevelt. Its 5 cabinets and master console can simulate all firing conditions. Used for training at sea, malfunctions can be programed into the system. The almost 5 x 5 ft. dimensions of the computer/console require its installation through the side of the sub's hull. In development 1 year, three prototypes have been built.

ASW ENGINEERING

Emphasis on Acoustics

One former Naval officer estimates there are more than 10,000 persons in the 26-odd Naval laboratories working on the ASW acoustics problem alone.

Packaged Liquids for Torpedoes?

Navy is not at all happy with solid propellant torpedo results. Problem basically is how to get enough solid propellant into almost standard 24-inch torpedo diameter and still meet the newer requirements of more burning time for longer range. Navy thus is taking a long hard look at encapsulated liquid fuels.

Systems Push by General Mills

Back of the recent acquisition of Magnaflux and Daven Companies by General Mills' electro-mechanical division, insiders say, will be a major push for ASW systems capability. Daven has been strong in electronic components development work while Magnaflux has experience in ultrasonics.

Second Attack Sub Commissioned

Navy's second attack-type submarine, USS Scorpion, was commissioned last week in Groton, Conn. Built by Electric Boat Div. of General Dynamics, Scorpion joins its sister ship, the Skipjack, which was first of this class of high speed, high performance nuclear boats. Both subs have nuclear-power plants of advanced design, streamlined hull forms, and single propellers.

PROPULSION

Max. Saturn Thrust by 1962

First use of 1.5-million lbs. thrust in *Saturn* booster will be in late 1962, says NASA. This will be the fourth flight test, but first to launch live second stage with dummy third. First three flights will carry dummy upper stages and use only 1.3 million lbs. thrust.

Fuel Needs Computed Electronically

Rocket-fuel performance data for use in determining missile and rocket requirements can now be produced rapidly by computers. The service, offered by IBM's Service Bureau Corp. in Los Angeles, can provide data on fuels with 20 atomic species, 250 molecular species, and 20 condensed phases.

MATERIALS

Largest Hopkins Ingots in Production

High-temperature alloy ingots, 20 in. diameter and weighing 8000 lbs., are being produced at Firth Sterling Inc. through the Hopkins process. The electrode is melted under a slag blanket, protecting the metal against the atmosphere and insuring against the addition of undesirable properties.

Minuteman Motor-Case Award

First-stage *Minuteman* motor cases will be produced by the Allison Division of General Motors. The contract was awarded by Thiokol, manufacturer of the missile's first-stage engine.

Polaris Motor Cases Deep Drawn

Second-stage *Polaris* motor cases will be turned out by Lyon Inc. through a proprietary deep drawing method. A $1.45-million contract was granted because of the firm's ability to produce the chamber and aft closure in one piece—eliminating welding and three-dimensional machining.

High Energy Formed Antennas

Explosive forming technique will be used at Ryan Aeronautical Co. to fabricate a large number of aircraft and missile radar antennas. The major order came from the Dalmo-Victor Co.

Lear Builds a Space Vehicle 'Cockpit'

by Charles D. LaFond

GRAND RAPIDS, MICH.—A complex man-machine study to develop reliable and practical control-display panel design procedures for the Air Force has just been completed by Lear, Inc.

To demonstrate application of the rigid design methodology, Lear has built the Mark IV space vehicle crew station. Revealed to industry and the press recently, the mockup purports to be the four-man cockpit of some future generation boost-glider carrying SLBM's (space-launched ballistic missiles).

Efforts to identify the futuristic display with any scheduled follow-on to the *Dyna-Soar* boost-glide space vehicle brought forth conflicting answers. One official said further discussion was classified; another said the weapon system application was purely hypothetical.

Whether for real or just for fun, the mockup nevertheless is the culmination of 17 months effort and $400,000. And Lear had done similar studies for a year and a half prior to award of this contract. This phase of the program ends this month.

Next step in the program is to prove, disprove, or improve instruments and displays. This will involve a more detailed study of requirements for deorbiting and re-entry with the "hypothetical" vehicle.

• **For 4-man crew**—The problem as seen by Wright Air Development Div.'s Flight Control Laboratory is the great lag between efficient cockpit design and other spacecraft technological advancements.

The goal is to develop a disciplined procedure for designing cockpits that will provide the best possible instrument configuration and selection for optimum operator efficiency. A second, but equally important aim, has been to improve flight safety by reducing the probability of pilot error. To do this, essential and interpretable data during critical periods of flight must be provided rapidly and accurately for proper pilot support.

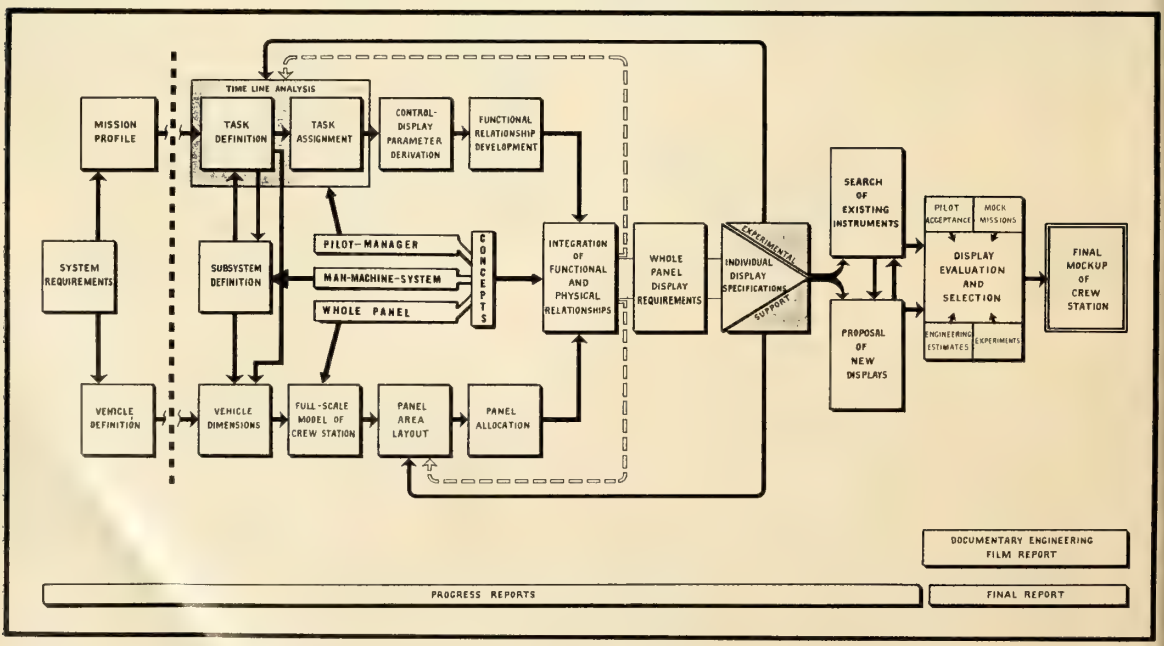
With the physical limitations imposed on the pilot during angular acceleration and re-entry, controls and readout design must correspond to operator ability to manipulate or interpret.

The hypothetical vehicle around which the study attack is centered is described by WADD as an "orbital bombardment system." Carrying a 4-man crew, the ship is designed for a 30-day mission in a roughly circular orbit, altitude 300-350 miles. The five missiles aboard would be dropped when employed and ignited after separation.

A major task in the problem is that of re-entry. Initiated by retro-rockets, the vehicle would have to be maneuvered to penetrate the Earth's atmosphere through a precisely defined, narrow corridor. Fine control must be maintained to dissipate the enormous aerodynamic heating.

Deviation from the re-entry corridor would result in either the destruction of the vehicle and crew or at the very least in missing the launching site. Following re-entry, the glide path would cover roughly one-third of the globe.

• **Singling out problems**—The WADD/Lear team is comprised of both engineers and psychologists. Together, they have studied mission requirements and human factors to develop a "time-line analysis." This is an instant-by-instant definition of tasks necessary for a successful mission.

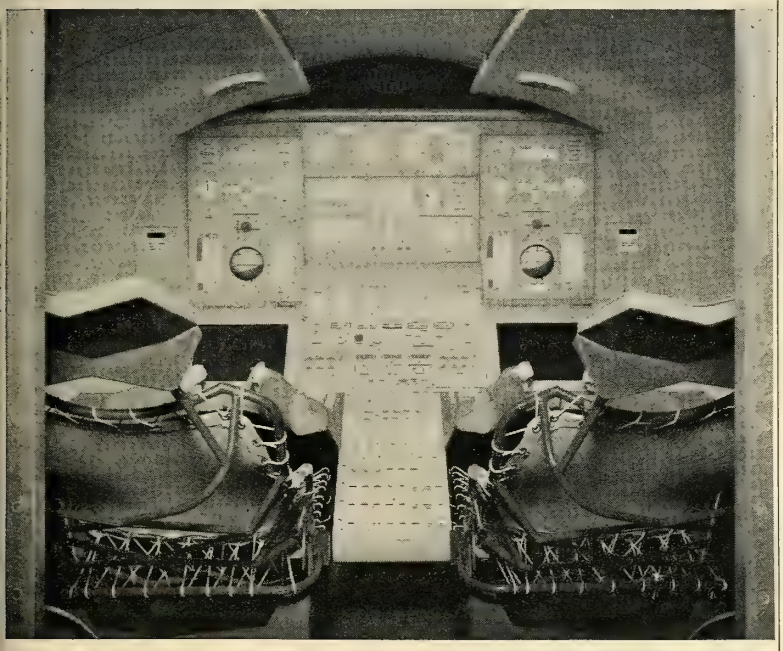


DISPLAY DEVELOPMENT Procedure Diagram is blueprint for MK-IV design method.

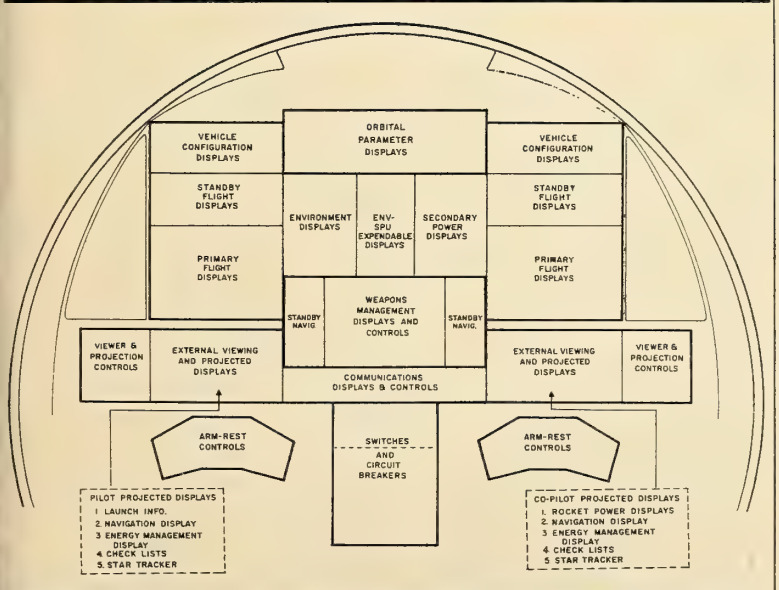
As shown in the accompanying diagram, display development requires an exhaustive and comprehensive investigation process.

The application of this design methodology points out new and often unrecognized problems long before the hardware stage is reached.

For the future, WADD intends to further refine the method of analysis of time functions. Another question to be solved is how and when should all of the various inputs be directed to the overall system designer. Further study also is required to learn what panel instrumentation is really needed by the pilot and what functions are better performed under computer control.



MARK-IV COCKPIT features instruments and screens grouped for easy readout. Soft colors used—green, yellow, blue—are non-fatiguing. Controls are operated solely by wrist and finger movements.



ALLOCATION CHART shows organization of operators' display panel.

EIA Finds Satellites Can Share Earth Frequencies

Space satellite communications systems operating on the same frequencies as point-to-point systems on earth will not interfere with each other, according to the Electronic Industries Association. This conclusion was based on an intensive study of radio frequency requirements for space communications in the bands above 890 mc.

Based on the findings, EIA has recommended that the FCC use its present frequency allocations system —which provides for channel sharing —for allocation in the above-890 mc bands.

The EIA comments were filed in the form of a statement to be included in FCC's Docket 11866. The Association's position was supported by some 28 pages of technical calculations.

The study was conducted by EIA's Microwave Section, headed by L. G. Walker, manager of communications and controls systems of Raytheon. These specific conclusions were reached:

- Satellite communications systems utilizing either the passive or active type of satellite repeater will not cause harmful interference to surface point-to-point communications systems operating on the same frequencies, providing reasonable systems engineering judgment is exercised.
- Surface point-to-point communications systems will not cause harmful interference to satellite relay systems operating on the same frequencies, again providing reasonable systems engineering judgment is exercised.
- Based on the feasibility of co-channel sharing between satellite communications and conventional point-to-point systems, it is not necessary for separate allocations to be made for this new use of the spectrum.
- Any non-government authorization for satellite communications purposes should be confined within the present allocation structures for fixed services.

Japanese May Put Rockets On Their Helicopters

Japan's Ground Self-Defense Force has begun studies on arming medium sized helicopters with radio controlled guided missiles as part of ground support operations.

The present fleet of H-13 helicopters is expected to be equipped soon with rocket guns of 2.36 in. or 3.5 in. caliber. The GSDF plans to arm the Japanese-made craft with Japanese-made air-to-surface rockets and anti-tank rockets.

Planets to be Colonized in 50 Years

Rocket authority predicts routine, scheduled space flights resulting from improved utility and vastly lowered costs

by Robert C. Truax*

Space flight is due for an explosive expansion over the next 50 years.

Within that period there will be permanent colonies on the moon, Mercury, Venus, Mars and, perhaps, on the moons of Jupiter and Saturn. Numerous manned artificial satellites or planets will have been placed in our solar system. Interplanetary space will be filled with ships making routine, scheduled trips between planets.

This increased activity will result from two main factors:

–An increase in utility which will justify a several-fold increase in financial support.

–A decrease in the cost of space operations which will permit more flights for the same number of dollars.

We all remember *Vanguard I*, when a three-pound satellite (Khrushchev's "grapefruit") had to be substituted for the original 20-pounder to save 17 pounds of weight. Seventeen pounds—out of a gross takeoff weight of some 20,000 pounds—meant the difference between success and failure. Yet now, without any obvious major advances in technique, payloads in excess of a ton can be placed on orbit.

• **Improvement on cost as well as engineering basis**—The primary reason for the improvement, and the reason which can lead one to be optimistic about the future, is that we continuously find means for improving the performance of our equipment on a *cost* basis, as well as improving it on an *engineering* basis. Over the past ten years, the improvement in items critical to the performance of a rocket, such as propellant consumption and structural weight, has not been decisive.

The principal change has been an increase in size, and a reduction in unit cost because of an expanding utility which permits one-time costs to be spread over a larger number of units. This is a self-propagating procedure which leads to explosive growth. An increase in utility spreads out the cost, which in turn opens new spheres of application, and the cycle begins anew.

• **Effects of size increase**—An increase in missile size has two important effects. The first is that the proportion of useful load which may be carried increases. This increase results from the fact that many of the items of equipment which must be carried for a vehicle to fulfill its mission are of fixed size and weight, regardless of the size vehicle to which they are attached. The guidance equipment is a notable example. In addition, there are certain practical limits to the thicknesses of the metal which may be used, imposed by limitations in fabricating techniques. As a result, large structures can generally be made somewhat more efficient than smaller ones.

• **Cost advantage**—In addition to these purely engineering advantages, there is a cost advantage as well. In general, for a given degree of complexity, it costs no more to design a large structure than it does to design a small one. Nor does it usually require a proportionate increase in the testing cost. In the manufacturing phases, the cost increase is not usually in direct proportion to the weight.

Very frequently, although larger machines must be used in the fabrication process—and a larger capital investment is necessary—the labor costs do not go up in proportion. For example, it normally requires one man to attend a lathe, whether this lathe be large or small.

Similarly, when reaching the flight testing or operational phase of a space vehicle program, there are many factors which do not vary with the size of the vehicle, or which vary in less than a direct proportion. In general, the time and manpower required to conduct pre-flight checks is a function of the complexity of the missile, rather than of its size. In erecting and servicing a vehicle, somewhat larger equipment will be required, but usually the increase in manpower will be small.

After a vehicle is launched, many of the functions still to be performed do not vary at all with size. These functions consist primarily of tracking and communications. Certainly it requires no more expensive an operation to track a large missile than it does to track a small one. In fact, cheaper and simpler equipment may sometimes be used for the larger missile.

These are all qualitative factors which tend to justify and explain the past history of increasing size for space vehicles. That history has been so short, however, that the end point cannot be readily perceived. It is interesting to note that the trend toward an increase in size of ships has continued over hundreds, even thousands, of years. The first fifty years of flight have seen a constant increase in the maximum size of aircraft.

It may be argued that the difficulty of transporting a very large space vehicle from its point of manufacture to its launch site may constitute a major deterrent to the construction and use of really large space vehicles. The current *Saturn* vehicle is already too large to be transported either by air or by land. It is perfectly possible, though, to transport the *Saturn* by barge from Huntsville, Alabama, to Cape Canaveral. Similar techniques may be applicable to boosters of vastly larger size.

These facts indicate that an increase in vehicle size may make a major contribution to reducing the cost and improving the utility of space operations. The possibility and potential in this direction should be carefully explored, from an economic as well as an engineering point of view.

• **Reusable boosters necessary**—In

Robert C. Truax, USN (Ret.), is director of the Advanced Developments Division of Aerojet-General's Liquid Rocket Plant in Sacramento. He is a widely-known rocket authority and former national president of the American Rocket Society. He is credited with a key role in development of the Navy Polaris fleet ballistic missile, as well as other long-range missiles. He has pioneered sea-launched rocket vehicles.

an attempt to find additional means for reducing the cost of the space program, the reuse of vehicles must be considered.

The science of space transportation is historically related to the guided missile. In such use, the vehicle is either automatically destroyed at the end of the flight, or is used under such circumstances as to make its recovery extremely difficult.

It is true that space vehicles are, in general, of relatively fragile construction and that they reach velocities and altitudes incomparably greater than those attained by any other vehicle. Nevertheless, if we examine the technical problems of providing a multiple use capability, these difficulties do not seem insurmountable. In the case of the first stage of multi-stage rockets—which, because of their size, represent a major faction of the total investment—recovery and reuse seem relatively simple.

Since the velocities acquired by succeeding stages are progressively greater, the difficulties associated with their recovery and reuse also increase. In all cases, however, the loss of payload which results from the incorporation of recovery provisions can be offset by the economic gain associated with reuse of the vehicle, provided that the reuse factor is sufficiently high.

Current indications are that the number of flights required to effect this amortization of recovery provisions is far below that associated with normal aircraft operations, for example. Since final stages frequently contain complex payload equipment, a disproportionate share of the total cost is contained in these final stages.

As an intermediate phase in the development of completely recoverable vehicles, we may find that three-stage combinations in which first and last stages are recoverable and the intermediate stage expendable, may find wide utility. In such a case, of course, the intermediate stage should be made as cheap as is consistent with reasonably good performance.

There is, throughout the industry, a gradual awakening of interest in recoverability. In most studies made to date on the economic recovery associated with the physical recovery, it appears that the missileman's point of view has dominated the thinking. In some cases it has been assumed that the missile would have to be entirely rebuilt, returned to the factory, completely disassembled, defective or damaged parts replaced, reinspected, retested, and shipped again to the launching site. The cost saving associated with such a procedure is naturally relatively small.

Whether rocket vehicles will ever attain maintenance schedules comparable on a time basis with aircraft may be open to question. There is sufficient similarity of a general nature between aircraft and rocket structures to make it unwise to disallow such a possibility, however.

A rocket vehicle designed to be reusable may differ markedly from an expendable one, or the differences may be in detail only. Depending on what manner recovery is to be effected, a booster vehicle may have wings and auxiliary air-breathing power plants, and may be very much more like an airplane than a rocket. Or it may be designed very much as it has been in the past, and equipped only with parachutes, braking rockets, or other auxiliary devices to increase the probability of successful recovery.

• **Simpler recovery methods look best**—Because of the large financial investments associated with airplane type recovery systems, it appears probable that the simpler methods of booster recovery will be investigated first. In considering the recovery of first stages by parachutes and retro-rockets, it would appear that a booster designed to be recoverable would place rather heavy emphasis on simplicity and reliability—at the expense of performance if necessary—since it appears probable that the total number of flights attainable would be a direct function of the reliability.

Even granting the development of very large recoverable vehicles, it may still be difficult to visualize space operations being routinely conducted on a large-tonnage basis. The rocket vehicle appears to be such an enormous thing for the amount of payload carried.

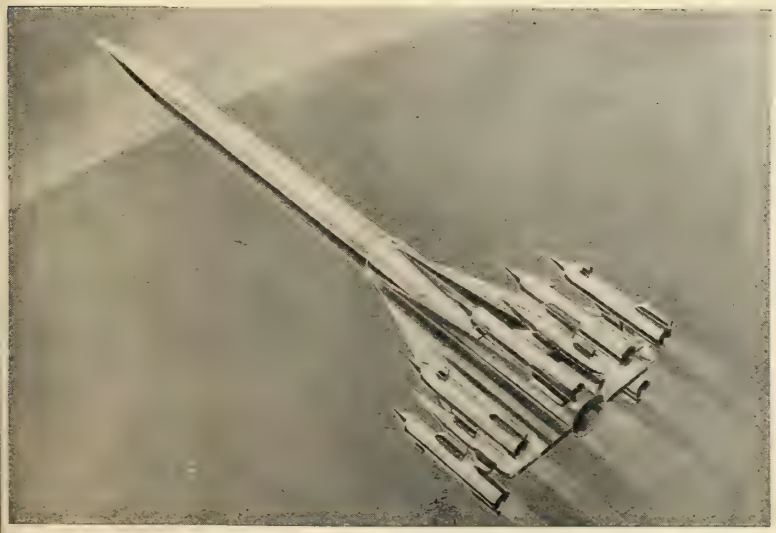
It should be noted, however, that 80 to 90% of the total mass of the rocket is propellant which, at least in the case of conventional liquid-fuel rockets, is very cheap indeed. Liquid oxygen and kerosene, such as are used in *Atlas* and *Titan* missiles, are available in unlimited supply, at a cost in the neighborhood of two cents a pound. Even with our present relatively inefficient vehicles, the propellant cost per pound of payload put into orbit, for example, is less than two dollars. Were this the only factor, beefsteak could be obtained at our satellite commissaries for less than three times the price at a terrestrial supermarket, a quite modest increase under the circumstances.

As stated earlier, the successful exploitation of space will depend on an increase in utility and a decrease in the cost of space operations.

The decrease in cost-per-ton mission will stem first from an increase in vehicle size which will give increased payload without a proportionate increase in cost.

A second major cost reducing factor will be an alteration of concept, abandoning the use of one-shot vehicles and going to those which are suitable for hundreds, or even thousands, of flights in the course of their normal lifetimes. This ascending spiral of utility and economy will make possible the support of hundreds of people at extra-terrestrial locations in the foreseeable future.

Nuclear Turbo-Ram-Rocket Concept



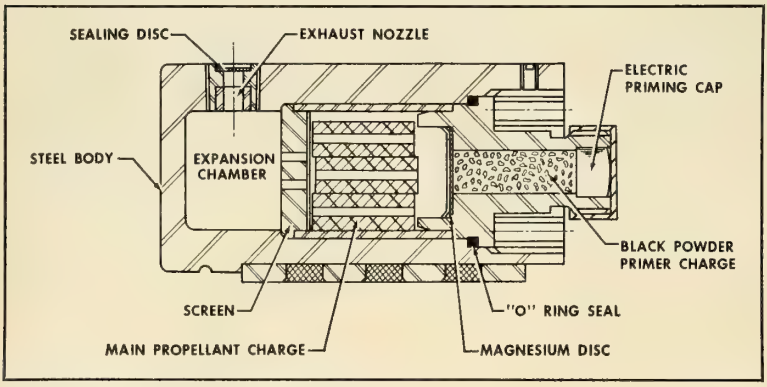
GE ARTIST'S CONCEPTION of a nuclear-power, turbo-ram-rocket in flight. Main nuclear powerplant is center of cluster of booster powerplant. Boosters could be dropped off at 100,000 ft.

Tiny Rocket Yields Big Charge for Tests

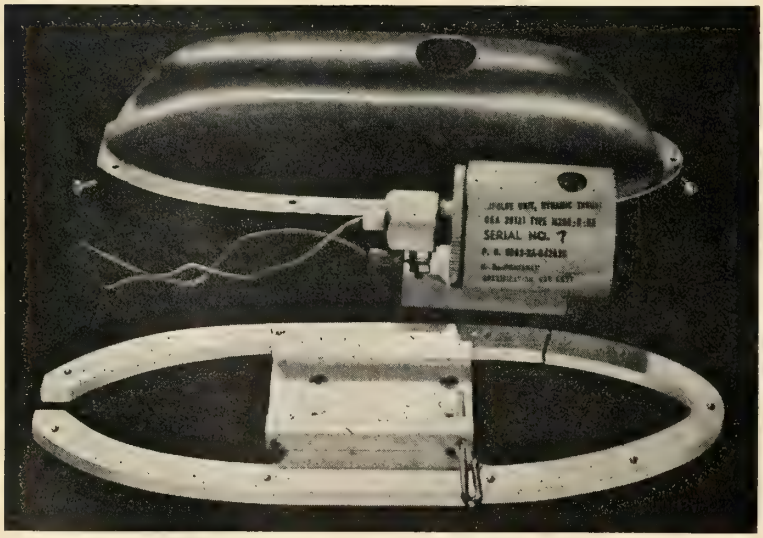
LOS ANGELES, CALIF.—The miniature rocket motor pictured here is not much bigger than a shotgun shell but delivers nearly 10 times the recoil. It has been used by the Columbus Division of North American Aviation, Inc., for impulsive excitation during in-flight vibration testing of the Navy's Mach 2 A3J Vigilante. (M/R, July 11, p. 39).

The cartridge is fabricated out of 4140 steel in two pieces. One is a base unit which is bonded directly to the aircraft structure. The other is the motor unit which is attached by means of a shoe fitting to the base.

North American says the two-piece design minimizes the exposure time of both the aircraft and personnel to the live rocket motors. The propulsion units can be stored in a magazine until just prior to the test flight.



SHOTGUN SHELL-SIZED motor is fabricated in two pieces. Propellant grains are carefully selected and sealed from combustion chamber by metal discs.



EXCITER PRODUCES between 200 and 800 lbs. of thrust for between seven and 150 millisecs, permitting adequate in-flight vibration testing.

• **Versatile design**—The design also permits a high degree of interchangeability as well as simple replacement of the rocket motors after firing.

Propellant (M-2) consists of several cylindrical single-perforated grains. Total charge weight varies from approximately 1.1 grams for short duration impulse units (7 to 9 milliseconds) to 2.8 grams for longer duration impulses (28 milliseconds). This compares to approximately 3 grams of propellant in a typical 12 gauge shotgun shell.

Propellant grains are individually selected by hand to minimize burning irregularities and each grain is oriented in a special direction to the rocket motor.

To achieve a maximum burning rate of the propellant prior to the release of energy, the main propellant is sealed from the combustion chamber by an aluminum disc. Between the aluminum disc, which ultimately ruptures, and the exhaust nozzle is a screen to prevent plugging of the nozzle by propellant particles.

Ignition is by an M52A3 electric primer (lead styphnate) which becomes unstable when an electric current is passed through it and triggers a black-powder igniter charge (type A4BP), which in turn ignites the main propellant.

• **Improvement by delay**—A thin magnesium disc separates the igniter charge from the main propellant. By delaying release of the energy generated by the igniter until a more complete burning of the charge occurs, the disc serves to improve the repeatability of ignition time. It also provides a moisture seal for the black powder igniter.

When the seal is ruptured, the igniter sets off the main propellant.

An aerodynamic fairing around the motor reduces drag. Latest units provide peak thrust values between 200 and 800 pounds and thrust durations between 7 and 150 milliseconds. Approximately 700 units have been fired during the program.

V. L. Beals and S. R. Hurley of the Columbus Division reported on the test program at the recent meeting of the Institute of Aerospace Sciences in Los Angeles. They said the use of the rocket motors provide a completely adequate in-flight vibration test. They indicated that problems encountered in Britain and France in development of acceptable rocket motors for this technique have been overcome.

Basic ordnance engineering of the rocket motors was done by Ordnance Engineering Associates, Inc., Chicago, Ill.

Polaris Has Fast Umbilical Cutoff



HIGH-SPEED camera catches umbilical disconnect sequence in 200 millisecs.



Photo at left shows connector in pre-launch position. Contact head is free of



electrical pins. Connector (right) moves to retracted position.

LOS ANGELES—A drastic departure from usual ballistic missile umbilical connector design has been applied to the *Polaris* system by E. B. Wiggins Oil Tool Co., Inc.

The connector—which could be more accurately described as a contactor—utilizes no electrical pins to enter the missile frame. Instead, a sliding plug utilizing spring leaf contacts is used to effect a reliable contact between the missile and its submarine.

Mechanical contact is made between the launch equipment and the flight vehicle through a latch pin in the center of the plug. The plug retracts completely in substantially less than 200 milliseconds within the first half inch of missile movement upward.

Incorporating a large number of unique design features, the unit attaches to the shoulder of the *Polaris*, just above the second stage. Contacts consist of 126 pins (4 through 20 contact size) and two ½-in. water methanol cooling lines for the electronic systems within the missile.

A special wheel-like tool is used to connect the umbilical to the missile, at the same time pulling the internal contact face against the flush-mounted receptacle in the skin.

Release of the latch pin at launch frees the external umbilical to be snapped into its housing by cam action of the missile's shoulder and also allows spring action to disconnect the internal contacts from the inside surface of the receptacle.

Pat Stone, product manager for the system, concedes that this "dead-face" function adds expense to the umbilical, but says this is more than offset by elimination of the need for switches on individual circuits within the missile. The dead-facing therefore serves the function of a master switch bank.

Use of spring leaf contacts was adopted because of the anti-contaminant insurance afforded, as well as the insurance of having at least four contact points available for each connection, instead of the one or two available from a pin and socket design. Upon making contact, the spring leaves wipe the surface of the connector, insuring a clean contact.

The complete device consists of the mounting bracket, cable and spring leaf inserts all molded into a single unit.



Circle No. 6 on Subscriber Service Card.

Navy Balks at Pre-packaged Torpedoes

NSIA committee urges switch to fixed ammunition concept but service insists that one-shot 'fish' await better reliability

by Donald E. Perry

Some designers are pushing for solid state guidance and the "fixed ammunition" concept as in the *Bullpup* program for torpedo development, but so far the Navy officially doesn't consider the proposals—to use an old torpedo firing phrase—"hot, straight and normal."

A recommendation that Navy torpedoes be pre-packaged under the fixed ammunition concept for immediate use without further testing was made recently by the Anti-Submarine Warfare Advisory Committee of the National Security Industrial Association.

The recommendation was championed and authored by Thomas E. Lynch, general manager of Clevite Ordnance and principal designer of the Mark 43, Mod. 1 torpedo.

It's Lynch's contention that the complexity of the modern homing torpedo is making impractical demands upon the skill and training of shipboard operators. He, and other torpedo engineers, believe that torpedo performance is more degraded than enhanced by the present Navy practice of repeated check-out and testing, where a well-trained shop will produce a good hit record and poorly trained technicians a poor hit record. They further contend there are no technical obstacles standing against an entirely sealed torpedo, featuring primary battery propulsion and solid state electronics.

But Navy acceptance of this is entirely another matter. The ASW Division of Bureau of Weapons' RDTE, takes the position that the torpedo can not be a one-shot weapon with only one firing in its entire life. BuWeaps personnel stress that the one-shot fish is not in sight yet because Navy hasn't achieved sufficient reliability through inwater testing.

• **Checks not enough**—"We have to have more than one run," according to Cdr. L. H. Keater and G. R. Moltrup of the ASW Division. Moltrup, the division's chief engineer, doubts very much if the Navy can depend on just manufacturing checks.

"The key in torpedoes is numbers. If we were building thousands—which we are not—we perhaps could just rely on strict quality control and checkout at the manufacturing site," he said.

So the Navy relies on what is termed production proofing. It has three phases performed at Navy Test Stations. In the first phase, let's say 24 torpedoes are each run about three times. Through this Navy gets a small hint of reliability, the likeness of runs and the characteristics of the lot. This allows the Navy to further firm up proofing specs.

In the next phase, a number of fish are divided into groups with each fish being run once. Out of this might come an allowance of three failures out of, say, 40 firings. In this phase, speed, depth criteria are pretty firmly established for proofing.

Now if the production quantity is large enough, proofing will enter a third phase, a sampling process where say, 10 out of a lot of 100, will go

(Continued on page 46)

NATO's Standard ASW Plane



France plans to buy 27 Breguet 1150 Atlantic antisubmarine patrol planes within the next four years. Well over 100 of the aircraft will be produced for NATO member countries.

The Atlantic will be a land-type plane with a semi-low wing, having a cruising speed of about 323 knots and able to fly at very low speeds. It will be fitted with electronic gear and the latest ASW kill weapons, and powered by two Rolls Royce turboprops.

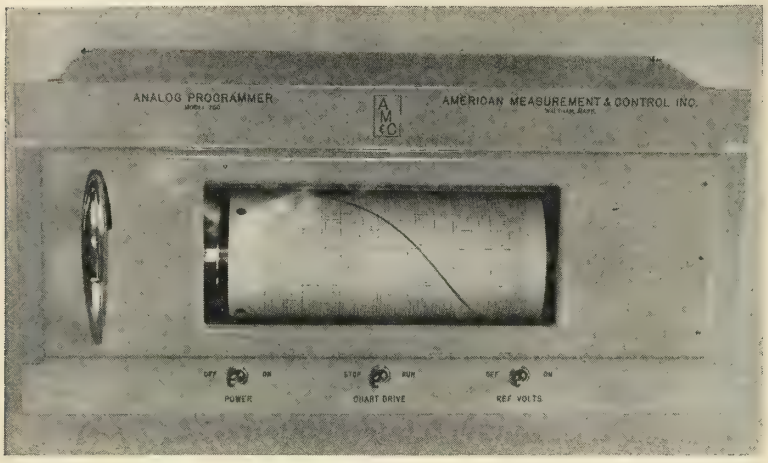
NATO announced last January that the Atlantic was chosen over a British proposal developed by Avro. NATO had opened the competition for a standard ASW aircraft in 1958; some 18 projects were submitted by 26 companies representing eight nations.

When the prototype is completed, Fokker Co. in Holland will take over the entire development of central wing section and nacelles. Dornier in Germany will be in charge of rear section and tail unit. Sud Aviation in France will provide the wing. ABAP in Belgium will be responsible for series production. Breguet will be in charge of nose section, fuselage, general assembly and flight test.

Special Feature: An ASW Glossary

The following glossary of ASW terminology was compiled as a service to MISSILES & ROCKETS *readers. The editors realize that it may be far from complete, since new words are being coined all the time in this field. Readers are invited to contribute words and expressions—and their definitions—which have been omitted, for listing in subsequent glossaries.*

Able. See Weapon ALPHA.
antisubmarine attack. (1) **coordinated.** General term covering all possible types of ASW attacks involving the coordination of more than one ship, submarine or aircraft. (2) **creeping.** Coordinated attack involving a noiseless approach wherein all target information is furnished by an assisting ship. (3) **deliberate.** An attack on a submarine made when the tactical situation allows time to obtain accurate attack data. (4) **urgent.** A harassing attack on a submarine delivered with maximum rapidity, made when the enemy submarine is in an immediately menacing position.
antisubmarine screen. Arrangement of ships or aircraft, or both, around a force or convoy to protect it against submarine attack.
array. A group of hydrophones arranged so that incoming signals may be processed and/or correlated.
Asroc. Minneapolis-Honeywell surface-to-underwater rocket-assisted torpedo or depth charge for deployment on destroyers and cruisers.
Aster. Ford Instrument ASW rocket launched from surface ships; marriage of **Terrier** and torpedo.
Astor. Westinghouse underwater-to-underwater rocket torpedo, nuclear warhead.
ASW. Antisubmarine warfare.
bathythermograph. Device that automatically records water temperature as a function of water depth.
BDI. Bearing deviation indicator. A system that permits a sonar operator to determine with a single echo whether his transducer is trained to right of target, left, or squarely on target.
Betty. Airborne atomic depth charge.
bottom bounce. A technique for increasing sonar range by directing the transmitted signal down so that it reflects off the ocean floor, thereby minimizing refraction losses.
cavitation noise. Sounds from collapsing voids or cavities in water. Propellers "cavitate" as a function of speed and depth.
classification. Examining the sonar and other data inputs and determining their probable origins, particular attention being given to enemy submarine sources.
datum/datum time. The last known position of a submarine is the datum, and the time at which the submarine was at the datum is datum time. If a ship has been torpedoed, and no additional information is available, the position and time of the torpedoing are respectively used as the datum and datum time.
detection. Process of determining presence of submarines.
ensonify. To sensitize a sea area with sonar detection gear.
fixed system. Group of hydrophones arrayed on sea bottom, terminating in a shore facility that processes the incoming data. System used for ocean area surveillance.
Hedgehogs. Multiple ahead-thrown bombs generally used by destroyers to lay out a bomb pattern.
Hold down. An operation designed to keep a submarine submerged, thereby limiting it to its submerged capabilities for gaining intelligence and for communicating and winning attack position, and also forcing the vessel to use up battery power.
HUK operations. Hunter-killer operations. Offensive ASW operations in a submarine probability area, combining the best available searching, tracking and attacking capabilities of air and surface units in a coordinated action.
hydrophone. Underwater transducer for converting acoustic energy to electric energy.
hydrophone effect. Impingement on hydrophone of underwater sounds originating from own shipboard sources, sounds such as screw beats, machinery noises, etc.
layer depth. Depth from ocean surface to the top of a water layer of sharp temperature gradient.
layer effect. Interference with echo-ranging detection by a water layer of sharp density gradient resulting from a pronounced temperature and/or salinity change. Targets in or below this layer are partially or completely obscured.
localization. Pinpointing the position of an enemy submarine.
MAD. Magnetic airborne detection; magnetic anamoly detection. Detection of magnetic materials in the sea through the distortion they produce in the normal magnetic field of the earth. Although MAD gear has a relatively short range of initial detection, the equipment is useful for developing contacts originally made by other means of detection or intelligence.
Mark 37. Westinghouse acoustic-homing torpedo.
Mark 44. General Electric acoustic-homing torpedo.
Mark 57. Submarine-laid antisubmarine mine.
RDT. Rotational direction transmission. A modification to existing fleet sonar equipment which, by concentrating the outgoing acoustic energy, increases the detection range of the equipment.
refraction. Bending of sound waves owing to changes in water density, salinity or temperature.
reverberation. Energy returned to the listening transducer or hydrophone by reflectors other than the target, for example, by the ocean's floor, surface, etc.
SAR. Search and rescue. Use of aircraft, surface craft, submarines and other equipment for search and/or rescue of personnel.
SAU. Search attack unit. Surface unit composed of two or more ships separately organized or detached from a formation to localize and destroy submarines.
scattering. Loss in propogation of acoustic energy caused by reflections by foreign bodies in the medium.
shadow zone. Region where refraction excludes an echo-ranging signal.
snorkel. A retractable air-intake and exhaust tube permitting submarines that operate on diesels to charge batteries while craft cruises at periscope depth.
Sofar. Signaling method. Aircraft or ships in distress drop small charges set to explode in a sound channel. Hydrophone listening in same channel can pick up acoustic energy as far as 2000 miles away from its source.
sonar. Sound navigation ranging. A system analogous to radar in which underwater acoustic energy is used chiefly for detection and locating underwater objects, and for communications.
sonar, active. Echo-ranging sonar which sends out a single short pulse of acoustic energy, usually at an ultrasonic frequency. Upon striking a target, the energy is reflected back to the source as an echo. Time taken for transit is a measure of the range.
sonar, passive. Direct-listening sonar which depends upon the target to generate its own sound, usually in the form of machinery noise, propeller cavitation, flow noises, etc.
sonar projector. Underwater transducer for converting electric energy to acoustic energy, and then radiating this energy out.
sonar range, effective. Range used for selecting screen plans and for determining sonar sweep width. It is based on predicted range but represents a reduction of predicted range (200 to 500 yards under average conditions) to compensate for human errors, ship's speed and weather conditions.
sonar screen spacing. Distance between ships in sonar screening and search operations. The standard plans for both screening and search call for a ship spacing of 1¾ times the effective sonar range.
sonobuoy. A buoy-mounted instrument used for detecting underwater noises and transmitting them for radio reception.
sound channel. Horizontal water zone bounded by layers where the speed of sound is greater than any place in the zone. Zone traps and channels acoustic energy. Phenomenon accounts for instances of extremely long-distance sonar ranges.
submarine operating depths. (1) **periscope depth.** Operating with periscope or radar exposed. (2) **semi-surfaced.** In the process of diving or surfacing. (3) **snorkeling.** (4) Operating with the snorkel exposed. (5) **submerged.** Fully below water surface. (6) **surfaced.** Fully above water surface.
submarine speeds. (1) **high.** Capable of submerged speeds of 20 knots or more. (2) **medium.** Capable of submerged speeds up to 20 knots. (3) **slow.** Capable of maximum submerged speed of about 9 knots, the speed of conventional early World War II submarines.
Subroc. Goodyear underwater-to-surface-to-underwater missile, nuclear warhead.
Tenoc. Ten-year contract research program on oceanography started by Navy in fiscal year 1960.
turn count. Method of estimating target's speed through the water by counting the rpm of the vehicle's propeller. Sonar equipment brings in the propeller noise.
VDS. Variable depth sonar or echo-ranging sonar. System uses a transducer at end of cable.
Ventriloquist. An ASW countermeasure.
Weapon ALPHA. Avco 500-pound surface-to-underwater rocket-propelled depth charge deployed on destroyer escorts. Formerly called **Able.**



Voltage Generated From Graph

The Model 750 Analog Programer manufactured by American Measurement & Control, Inc. is an arbitrary function generator wherein any single valued function (Y) drawn on graph paper with conductive ink is converted to a proportional voltage as a function of time (X). The unit has an accuracy of ± 0.5% and a response time of less than 10 microseconds to full scale.

An external reference voltage is applied across the potentiometer and a portion of this voltage is picked off at the point of contact between the potentiometer and the drawn, conductive function curve. Thus, at any specific instant of time, the output voltage (Y) is proportional to the drawn curve.

The X axis varies linearly with time when the drum is driven by the constant speed synchronous motor provided. However, a servo motor can be incorporated to provide the driving force and the drum position can then be a function of an independent variable.

Circle No. 225 on Subscriber Service Card.

Component Heaters

Constant-temperature component ovens for computer and test equipment applications are available from Palmer Instruments.

A stability of ±1°C is assured in a range of –20°C to 10°C below setting temperature.

With a maximum power consumption of 15 watts, heaters can be wound to accommodate input supplies of from 20 to 115 volts. Boosters are also available.

Circle No. 226 on Subscriber Service Card.

Dual Output Battery

A new, dual battery in a single case is available from Cook Batteries. The two battery sections in the Model P82A provide for a heavy peak current demand as well as a steady power supply for equipment with non-fluctuating requirements. One section handles fluctuating loads with less than 5% voltage variation.

A 20-cell section provides a current of 25 amp. at 28 v. Maximum current is 100 amp. with a discharge time of 4 min. at 25 amp. Capacity is 1.7 amp./hr.

The second 20-cell section supplies 28-volt power at 46 amp. Maximum current is 125 amp. Discharge time is 4 minutes at 46 amp. Capacity is 3 amp./hr.

Circle No. 227 on Subscriber Service Card.

Frequency Divider & Clock

A frequency divider and clock, which makes possible precise time comparisons between stable oscillators and standard WWV or other transmitted time signals, is now available from Hewlett-Packard Co.



The clock has a 10 microsecond time comparison capability, resulting primarily from the use of a directly calibrated, precision phase shifter and a unique, jitter-free optical gating system. Regenerative dividers, a phase-stable motor and precision gear train provide fail-safe operation not attained by pulse counting systems.

Circle No. 228 on Subscriber Service Card.

Blind-Mounting Locknut

A blind-mounting aircraft and missile locknut is being marketed by Standard Pressed Steel.

Called the Davis Press Nut, this one-piece self-locking threaded fastener is installed from the one side in a single drilled hole by a simple pressure tool. The nut is embedded flush in one surface of the metal while gripping the other by a swaging action.

Made of austenitic stainless steel, it is intended for use with 125,000-psi tension and shear bolting such NAS 333,517 and 1303 and AN-3 series.

Circle No. 229 on Subscriber Service Card.

Tiny Pressure Transducer

A pressure transducer only three-fourths inch in diameter, one-third inch high and eight grams in weight has been developed by the Transducer Div. of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co.

Pressure ranges are from 10 to 100 psi absolute, 2 to 100 psi gage, and ± 2 to ± 50 psi differential. Pressure limit is 1.5 times rated pressure without calibration shift and two times rated pressure without permanent damage.

Circle No. 230 on Subscriber Service Card.

Rosette Strain Gage

A single plane rosette strain gage has been developed by Electronics Instrumentation Division of Baldwin-Lima-Hamilton Corp.

It is a very thin gage thus minimizing errors encountered in bending measurements. It has a maximum of sensing elements in a given area.

The gages are made from materials specifically selected and treated to minimize temperature effects when bonded to several different types of materials.

Circle No. 231 on Subscriber Service Card.

Pressure Regulators

Grove Valve and Regulator Co. has available a line of compact, light-weight

pressure regulators which are designed to handle an unusually broad range of pressures.

The new regulators are available for pressure reducing, back pressure, and combination pressure reducing and relief service.

Pressure reducing models, produced in sizes ranging from ¼ in. through ½ in., can be used for inlet pressures as high as 10,000 psi and adjustable controlled pressures up to 6000 psi.

Circle No. 232 on Subscriber Service Card.

Tiniest Gearhead

A tiny "size five" gearhead and speed reducer unit weighing only a few grams and measuring three-fourths in. in length, has been developed by Bowmar Instrument Corp. It is capable of producing step-up or step-down ratios of from 10:1 to 2025:1.

Circle No. 233 on Subscriber Service Card.

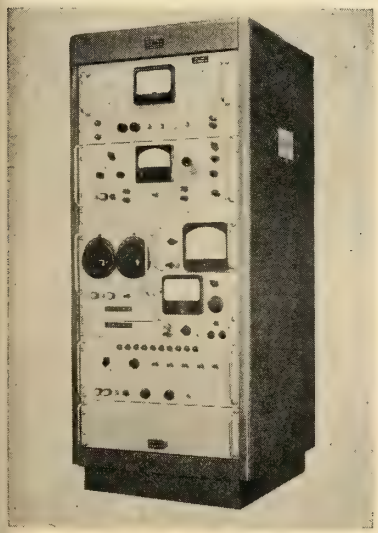
Pressure Relief Valve

A valve, model PRV-29, which relieves excess pressure in small solid-propellant gas generators, is available from Marotta Valve Corp. It features close cracking-to-reseat characteristics and an adjustment which allows the valve to be set at any cracking pressure between 1250—1650 psig, with operating line temperatures to 2000°F. The outlet fitting can be positioned to any angle in a plane parallel to the base of the valve.

Circle No. 234 on Subscriber Service Card.

Test Console

Kearfott Division of General Precision, Inc. is producing a semiautomatic console which performs tests on 400 cycle resolvers, synchro transmitters, differentials, and control transformers. The unit consists of a phase sensitive voltmeter, filtered vacuum tube voltmeter, relay module, signal module, transformation ratio module, and power supply module.

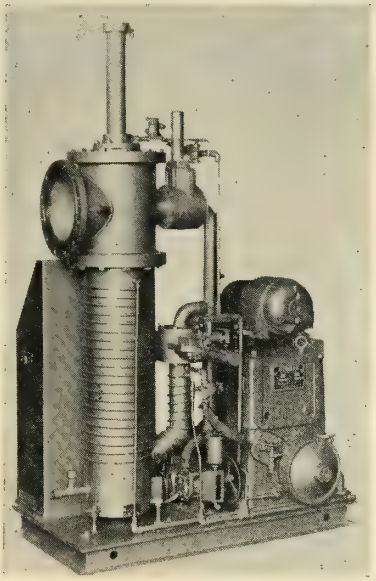


Circle No. 235 on Subscriber Service Card.

Packaged Vacuum Pumps

A series of "packaged" vacuum pumping systems is available from F. J. Stokes Corp.

The systems are composed of an oil-diffusion pump or an oil-booster pump, plus a mechanical backing pump, mounted together on a common baseplate, along with a fully-instrumented control console and all interconnecting to the customer's water, air, and electricity supply lines.



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DC Power Supply Unit

The Potter Company has available a high voltage dc power supply unit that provides infinitely variable output from 0 to 30,000 VDC at 1.0 MA rated current output. Designed for operation up to 85° C, the unit, model PHV30-1M60V, has all components immersed in high quality oil and sealed to insure long life, minimize corona and provide dependable operation.

Circle No. 237 on Subscriber Service Card.

Molding Composition

Crane Packing Co. is producing a molding powder of DuPont's Teflon 100-FEP Resin compounded with inorganic reinforcing materials.

Very similar to Teflon-TFE, Teflon 100 has been primarily developed for injection molding.

Circle No. 238 on Subscriber Service Card.

new literature

FLAW DETECTOR—Ultrasonic flaw detection is the subject of Bulletin T200, offered by Branson Instruments, Inc. The booklet includes operation, techniques, and a complete list of specifications for the Sonoray® 5 flaw detector. In addition to describing techniques, such as use of straight beams, angle beams, and surface waves, the bulletin discusses application of contact, immersion, and water column testing methods. All recognized pulse inspection techniques are applicable to the Model 5 Sonoray, and some of the most commonly used are tabulated for easy reference.

Circle No. 200 on Subscriber Service Card.

ELECTRON BEAM WELDING—A 12-page catalog has been released by Air Reduction Sales Co., Special Products Dept., on its newest welding technique, electron beam welding. Illustrated throughout, the brochure covers all of the salient features of electron beam welding, how the process operates, the principal advantages, and the equipment required. A full page schematic drawing of the electron beam gun is of particular interest.

Circle No. 201 on Subscriber Service Card.

ALLOY PREFORMS—A booklet on Designing for Alloy Preforms is available from Lucas-Milhaupt Engineering Co. More than a booklet, it is actually a treatise on design considerations and examples of metal joints which lend themselves to use of brazing alloys in preformed shapes.

Circle No. 202 on Subscriber Service Card.

CHEMICAL MILLING—Reprints are available of a comprehensive article on the state of the art in chemical milling from Chemical Contour Corp. The four-page, two-color reprint describes how chemical milling is now used in processing steel and other metals on a mass-production basis.

Circle No. 203 on Subscriber Service Card.

AIR FILTERS—A booklet describing the uses of air filters in the missile industry has been published by the Cambridge Filter Corp. Definitions, schematic drawings and specifications are included. High-efficiency filtration techniques are described.

Circle No. 204 on Subscriber Service Card.

ELECTRICAL CONNECTORS — A series of Electrical Connectors designed and developed for heavy-duty environmental usages under military standards is described in Bulletin 2711 from Crouse-Hinds Co. Engineering data and charts are included.

Circle No. 205 on Subscriber Service Card.

(Continued From Page 42)

through a stipulated number of runs. In many fish, Navy says higher performance comes in the third run. All proofing is separate testing before fleet evaluation by Commander Operational Test and Development Force.

Many torpedo designers, on the other hand, agree that proofing supplies data, but add it's merely because many torpedoes have been run. They say there is little or no data supporting a conclusion that torpedoes are better or more able in their final job becausing of this proofing.

• **Proofing activity**—Some designers agree that proofing allows the Navy to know more about them, a very desirable asset. However, they say the training and confidence is built up in the wrong place—in the proofing activity rather than with the users, the fleet.

These designers recommend that more fleet runs be made. If the torpedo is pre-packaged and expendable there is no problem, they contend. And even if it isn't, it could be sent back to a shore establishment for reworking. They add that performance data should be done in Navy's Operational Test and Development Force because proofing will not do it.

Lynch believes if production must be monitored it could be done with a 10% selectivity. This 10% would be assigned to a fleet quality control activity, capable and assigned to derive from the proofing runs a projected performance level. Fleet experience would then be checked against this derived level. "Oh, what a wonderful set of figures you would obtain," he said.

Navy says the cost of torpedo proofing varies widely and with limited production quantities—300 to 400 in a lot—proofing can not be eliminated. They point out that the torpedo's targets require longer range and faster running and the expensive Cadillac-type torpedo is needed for the kill.

With more cost involved to get this kill capability, production numbers will be going down rather than up, Navy says. And with a dependence on internal storage of data, expendable torpedoes have budgetary considerations against them.

On the other hand, designers say Navy must face the fact that when a torpedo fails to work when it should, it is indeed expensive. They say the question is not the dollar and cents saving which would be inherent in the encapsulated torpedo. They maintain the question is whether function—which is influenced by the budget—is better served by the concept of fixed ammunition.

• **More torpedoes per dollar**—It is also the opinion of some designers that the number of torpedoes per dollar would be nearly doubled if the fixed ammunition concept were adopted, and torpedoes were designed solely for function. They say this approach could be particularly attractive if used torpedoes were salvaged, permitting recovery of expensive components.

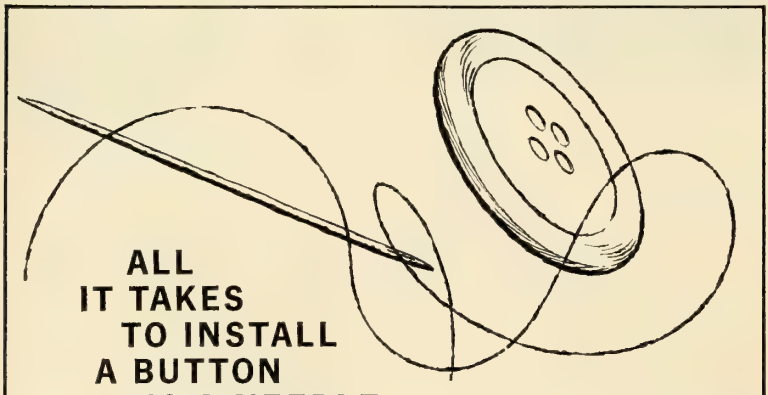
Navy today, however, is buying some of the fixed ammunition concept because of the difficulty in training and adequately equipping the fleet-at-sea to handle the newer and more complex devices. It feels that torpedoes should be delivered to launching vessels without further checkout. Even on tenders and shore stations, Navy says it doesn't want its personnel performing repairs on critical items such as gyros, depth mechanisms, etc. Rather it wants critical items furnished, preferably for modular replacement.

But some in the Navy—the designers term them "graybeards"—question whether solid-state electronics is far enough advanced for torpedo guidance. Nevertheless, Navy is conscious of the problem and today has two solid-state torpedoes in early development stages, although not fully encapsulated. While industry is maintaining Navy should make a quick shift to encapsulated solid state torpedo components, Navy, on the other hand, maintains it is doing as much as possible, within complex circumstances of the problem.

But design engineers still maintain that a solid state device permanently encapsulated is about as dependable and foolproof as the hand and mind of man can produce. They cite the swing to the solid state device by the computer people, the telephone people, and yes, the military. But they add there's reluctance by the Navy for such acceptance in torpedo development.

Designers say there are no circuits in modern torpedo guidance and homing which cannot be done in solid state, with the possible exception of the transmitter where the power level may be a bit high. And even here they question whether transmitter power should be vacuum tube developed, feeling there are newer and better ways.

The problem of the encapsulated, solid-state torpedo has many sides. Many designers feel torpedo development within 10 years will be all fixed ammunition and solid state guidance. But the "when" of starting the task, they say, will have to be decided by the Navy.



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contracts

NAVY

$1,700,000—**Telecomputing Corp.**, Los Angeles, for airborne radar systems.

$195,135—**B. F. Goodrich Aviation Products**, Rialto, Calif., for labor, material and facilities to load and assemble 5 in. rocket motors.

$144,305—**Ampex Data Products Co.**, Los Angeles, for magnetic tape recorder/reproducer.

$65,814—**Northrop Corp.'s Radioplane Division**, Van Nuys, for target drone engineering services.

$52,075—**United Electrodynamics, Inc.**, Pasadena, for telemetry system for *Terrier* fuze.

$48,345—**CalVal Research and Development Corp.**, Woodland Hills, Calif., for services, material, facilities for research study on launching systems.

$44,983—**Measurement-Standards, Inc.**, Phoenix, to design, develop and evaluate electrical, electronic, electro-mechanical and optical measurement systems, techniques and apparatus.

$40,000—**Leach Corp., Inet Division**, Compton, Calif., for precise power generating equipment to check out instrumentation of missiles.

AIR FORCE

$2,400,000—**General Electric's Electronic Specialty Capacitor Products Section**, Irmo, S.C., for research and development of materials and methods to produce extreme-high-reliability capacitors for the *Minuteman*.

$1,200,000—**The Marquardt Corp.**, Pomona, Calif., for development of two missile launch trains for the *Green Quail* and the *Hound Dog*.

$283,000—**General Precision, Inc., GPL Division**, Pleasantville, N.Y., for modification of radar navigational sets.

$125,334—**Aerojet-General Corp.**, Sacramento, for design and development of special LOX H2 injectors and thrust chambers.

$125,000—**Leeds & Northrup Co.**, Philadelphia, for highly specialized temperature and dew point indicators and resistance thermometers to be used in a network of weather stations. Subcontract from **The Winslow Co.**

$96,226—**Bendix Corp., Pioneer Central Division**, Davenport, Iowa, for propellant utilization systems.

$75,000—**Hughes Aircraft Co.**, Culver City, for engineering services and supplies for F-106/MA-1 SAGE integration program.

$52,059—**Thiokol Chemical Corp.**, Elkton, Md., for universal metal container applicable to the *IM-99* missile.

$38,720—**Thiokol Chemical Corp., Reaction Motors Div.**, Denville, N.J., for propellant shutoff valves.

$33,000—**General Electric Co.**, Cincinnati, for uncooled rocket thrust chambers.

$28,800—**The Garrett Corp.'s AiResearch Mfg. Co. Division**, Los Angeles, for LOX converters.

$27,880—**Aerojet-General Corp.**, Azusa, for rocket thrust chambers.

ARMY

Nuclear Development Corporation of America, White Plains, N.Y., for an investigation of specialized methods of thermal protection or rocket nozzles. Amount not disclosed.

$18,000,000—**Western Electric Co.**, New York City, for furtherance of work on the *Nike-Zeus* missile system.

$181,088—**Cornell Aeronautical Laboratory, Inc.**, Buffalo, for research and development services covering the study of properties of ultimate ballistic missile target.

$149,027—**The W. L. Maxson Corp.**, New York City, for preparation of the technical manuals for the XM90E1, *Hawk*, adaption kit.

$138,730—**Eastman Kodak Co.**, Rochester, for missile infrared acquisition system including scanning optics system.

$138,668—**Hayes Aircraft Corp.**, Birmingham, Ala., for engineering, design, computation, illustration and drafting services on rocket and guided missile systems.

$111,580—**Melpar, Inc.**, Falls Church, Va., for application of dynamic tester T12 to *Nike* system.

$106,992—**Western Electric Co., Inc.**, New York City, for *Nike* spare parts and components.

$105,000—**ITT Laboratories**, Nutley, N.J., for modifications to ground stations for *Courier* communication satellite system.

$100,000—**California Institute of Technology**, Pasadena, for developmental engineering program relating to the *Sergeant* missile system.

$98,100—**Librascope Div., General Precision**, Glendale, Calif., for prototype, digital computer.

$95,378—**Lockheed Aircraft Corp., Missiles and Space Div.**, Sunnyvale, Calif., for basic research in field of fuel cells.

$89,990—**The Martin Co.**, Orlando, for *Lacrosse* engineering services.

$84,975—**University of Southern California**, for research program on "Radiation produced by hypersonic objects in the upper atmosphere."

$83,743—**Telemetric, Inc.**, Gardena, Calif., and **J. Arnoux Corp.**, Los Angeles, for camera remote control programer system for use with "Drone Program."

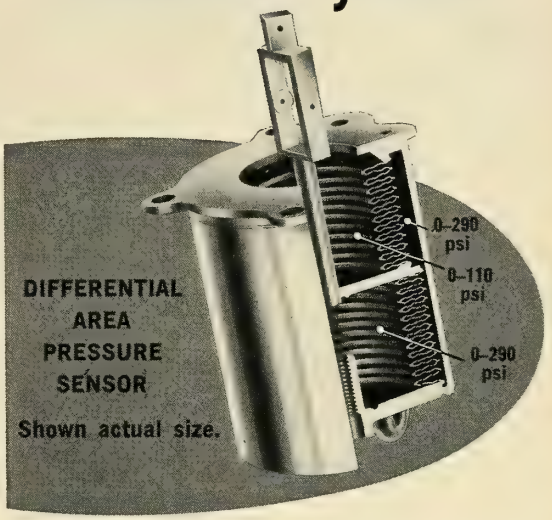
$76,524—**The Martin Co.**, Orlando, for technical representatives for *Lacrosse* weapon system.

$76,140—**Western Electric Co., Inc.**, New York City, for *Nike* spare parts and components.

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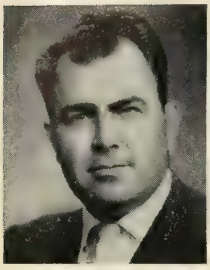
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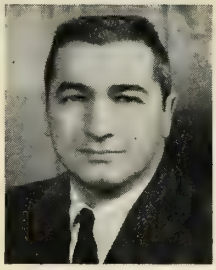
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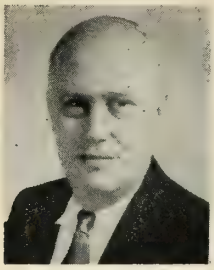
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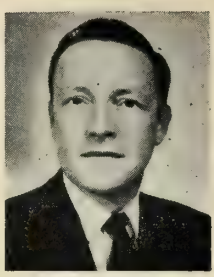
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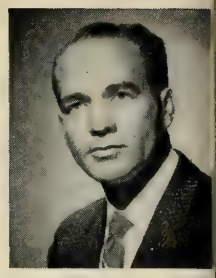
names in the news


HOPKINS


DELUCA


HULL


TINDALL


REA

Gene Hopkins: Named vice president-marketing for Avien, Inc., responsible for all marketing operations including aero-space, undersea and missile systems programs. Was previously executive vice president of the Electrada Corp., and prior to that corporate manager of the midwest office of the Martin Co.

Frank P. DeLuca, Jr.: Who joined Acoustica Associates, Inc., in 1957 as project manager for the company's *Atlas* missile program and more recently executive vice president, elected president of the corporation and its subsidiaries.

Frederick B. Hull: Joins the Process Equipment Division of the Bethlehem Foundry and Machine Co. as a process engineer. Was formerly a chemical engineer in the research department of the U.S. Naval Propellant plant at Indian Head, Md.

Kenneth V. Tindall: Recently appointed systems marketing specialist for Data-Control Systems, Inc., has been placed in charge of the firm's new Washington, D.C. office.

J. R. Rea: Named manager of the Joplin, Mo. plant of the Aero Hydraulics Division of Vickers, Inc., a division of Sperry Rand Corp. Previous activities included production management of the *Nike Hercules* missile APU program, *Goose* missile generator drive program and the *Minuteman* missile APU program.

Dr. Stanley Grand: Former director of research and development for the Radiation Research Corp. joins Vitro Laboratories as head of the Chemistry and Arc Research Dept. **Richard W. Griffiths** has also been named director-western marketing and will head the firm's newly established west coast facility in Los Angeles.

Lyle A. Jakus and **James C. Evans:** Appointed senior scientists in the newly formed systems laboratory at Hughes Aircraft Company's ground systems group. Jakus will be in charge of the laboratory's communications systems staff and Evans is assigned as the system laboratory's technical field coordination office representative to USAREUR headquarters, Germany.

Richard G. Walsh: Former director of engineering elevated to vice president-engineering at Titeflex, Inc. Prior to joining the firm was manager of engineering test and design engineering departments of the Aircraft Engine Division of Ford Motor Co.

John F. Scully: Appointed manager, Computer Systems Design Department, Information Technology Division, Lockheed Electronics Co. Previous posts: Group leader of the Digital Systems group of Vitro Laboratories and special projects manager of Monrobot Laboratory.

A. Franklin LaBarbara and **John C. Schmidt:** Appointed Customer Liaison Engineers for the Military Products Division of Tempo Instrument Corp.

Dr. Nicholas E. Golovin: Elected vice president and general manager of Rabinow Engineering Co. Inc. Dr. Golovin has been Deputy Associate Administrator of NASA.

Charles W. Bozarth: Joins Telemeter Magnetics Inc. as sales manager of their Components Division replacing **R. David Miner,** resigned. Was formerly with Sanders Associates, Inc. and Minneapolis-Honeywell Regulator Co.

C. Harold Hannan: Promoted to the position of director of research at Miniature Precision Bearings, Inc. directing activities of the firm's new Research and Development Laboratory and the Special Engineering Dept.

David M. Snow: Joins American Electronics, Inc. as corporate director of industrial relations, succeeding **Robert L. Mathews,** who has resigned. Was formerly director of administration for Hallamore Electronics Division of The Siegler Corp.

D. G. Wilson: Appointed manager of the Torrance, Calif. plant of the Aero Hydraulics Division of Vickers Inc. division of Sperry Rand Corp. Was formerly industrial engineering manager of the firm's division in Detroit.

Murray Ginsberg: Named chief engineer, development, for Loral Electronics Corp. Previously held engineering management positions with Republic Aviation Corp. and project engineering and advanced planning posts with Weapons Systems Division of Wright Air Development Center.

George Clement: Formerly with the National Aeronautics and Space Administration, re-joins the staff of The Rand Corp. as assistant to the president in the Santa Monica offices. He spent one year with NASA as scientist for vehicle design in its office of Program Planning and Evaluation.

Richard P. Gaunt: A senior member of Space Electronics Corp.'s technical staff for the past 12 years, elected assistant to the vice president.

Howard B. Van Dagens: Joins Century Electronics & Instruments, Inc. as assistant chief engineer. Was formerly associated with the Instruments Division of General Time Corp.

Daniel E. Keller, Jr.: Joins Amcel Propulsion Inc. as the firm's Washington marketing representative responsible for technical liaison on missile and ordnance programs with contractors and government agencies. Was formerly chief of the Propellants, Fuels and Lubricants Branch, Propulsion Division of ARDC.

Richard J. Hanschen: Former field sales manager, named marketing manager for Texas Instruments Inc., succeeding **James F. Carland,** now head of the Semiconductor-Components division, International Operations.

Vice Adm. Harry Sanders (USN-ret.): Member of MISSILES AND ROCKETS editorial advisory board for Underseas Technology, promoted at Chance Vought Aircraft to corporate director of ASW Engineering, responsible for ASW in CV's five divisions.

James R. Kerr: Named executive vice president of Avco Corp. in charge of a newly formed Defense and Industrial Products Group which include the company's Crosley, Lycoming, Nashville and Research and Advanced Development divisions.

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DSD **DEFENSE SYSTEMS DEPARTMENT**
A Department of the Defense Electronics Division

GENERAL ELECTRIC

Northern Lights Office Building, Syracuse, New York

editorial . . .

How Bold, How Imaginative?

THERE has been a great deal of talk in recent political forums, and there will be a great deal more, about the need for "bold imagination" in the free world today.

To put things in proper perspective, here are Webster's definitions:

Bold: "Forward to meet danger; venturesome."

Imagination: "The power to form mental images of things not present."

Since the phrase "bold imagination" is almost invariably applied to national survival—military, economic and ideological, a composite definition might be:

"The power to sense new and unknown dangers and to meet them with attack (rather than mere defense)."

We offer for consideration an idea:

Let's equip our proven allies with atomic weapons sufficient to enable them to do their share in defending the freedom of the world—while we devote more of our time and money to exploring and defending the freedom of space.

Too bold? Too imaginative?

For several years the United States reigned supreme as the only atomic power in the world. Then Russia stole the secret; today she probably at least equals our nuclear strength. Britain became the third atomic power, and this year France joined the club.

Now, we are reliably informed, Sweden is imminently expected to announce that she has developed a nuclear capability.

Neither Britain, France or Sweden are wealthy nations, compared to the United States. But we stood by and let them spend the money necessary to develop atomic power.

The fact that they did this seems ample proof that almost any of our NATO allies, at least, could achieve the same development on their own, if they so wished. Should we, then, stand stiffly aside and let them go it alone—or should we use a little bold imagination and help them?

Working either through NATO (M/R, July 25, 1960) or with member nations individually, we could create a free world nuclear force so diverse and so widespread that no enemy could either wipe it out or defend against it.

Overly cautious planners might argue that increasing the number of nations with atomic weapons would intensify the danger of a general, nuclear war. We do not believe that this fear is realistic, when applied to our NATO allies.

Is Belgium, for instance, or France or the Netherlands, more likely to precipitate a nuclear attack than we are? Knowing the certain consequences—and with their first-hand knowledge of war's horrors?

After the initial expense of proving that we trust our friends, the United States should be able to reallocate a sizeable chunk of the defense budget into exploring and, if you will, conquering space.

VIRTUALLY all military men believe that the nation which controls space will find some way to use that control to dominate the world. We don't want to dominate the world—certainly not by force, but neither can we permit anyone else to do so. We must always be strong enough to prevent any other nation from denying us free access to space. One way to do this is to get established there first. This takes money—money and bold imagination.

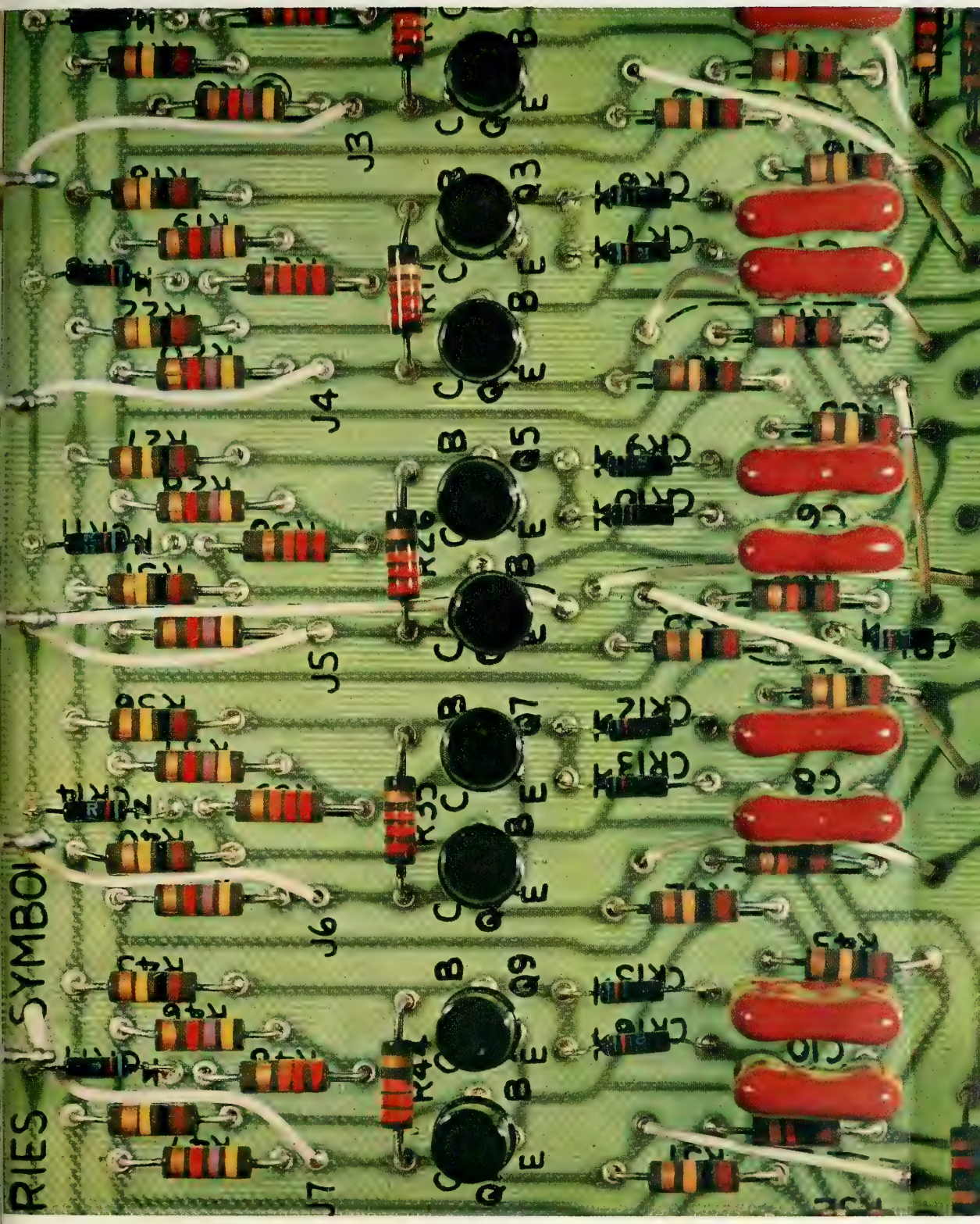
We have NATO and SEATO. We listen to plans for group defenses. Are any of these really worth a whoop as long as we, unimaginatively, keep most of the real strength locked in our own forces?

Is it too bold, excessively imaginative, to say to our allies, "We'll help, but you hold off Russia for a while—and we'll concentrate on space exploration for all of us"?

Think about it.

Clarke Newlon

At 00h 00m 01s GMT, August 1, 1960, Martin logged its 624,156,000th mile of space flight



Without electronics it is impossible to design, build, test, launch, guide, track or communicate with a missile. That is why **40% of Martin's 7,500 engineers are electronic/electrical engineers.**

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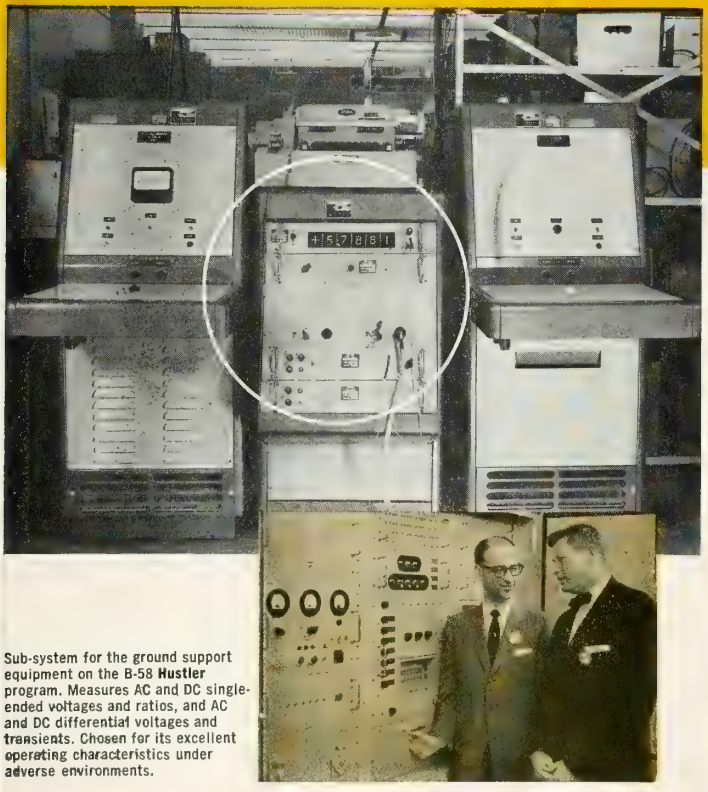
Systems shown here are typical of more than 200 designed and built by EI and now in use. They range in complexity from data logging systems for automatic scanning, measurement and recording of data from multiple transducers...to high speed, automatic checkout systems for missile and aircraft...to systems for automating industrial processes.

Because of the EI modular design approach, many of these systems can be delivered on virtually an off-the-shelf basis, eliminating the long delivery times usually associated with system development. This approach also results in a low cost system because the modules are manufactured in large quantities. Cost is almost a linear function of performance capabilities desired.

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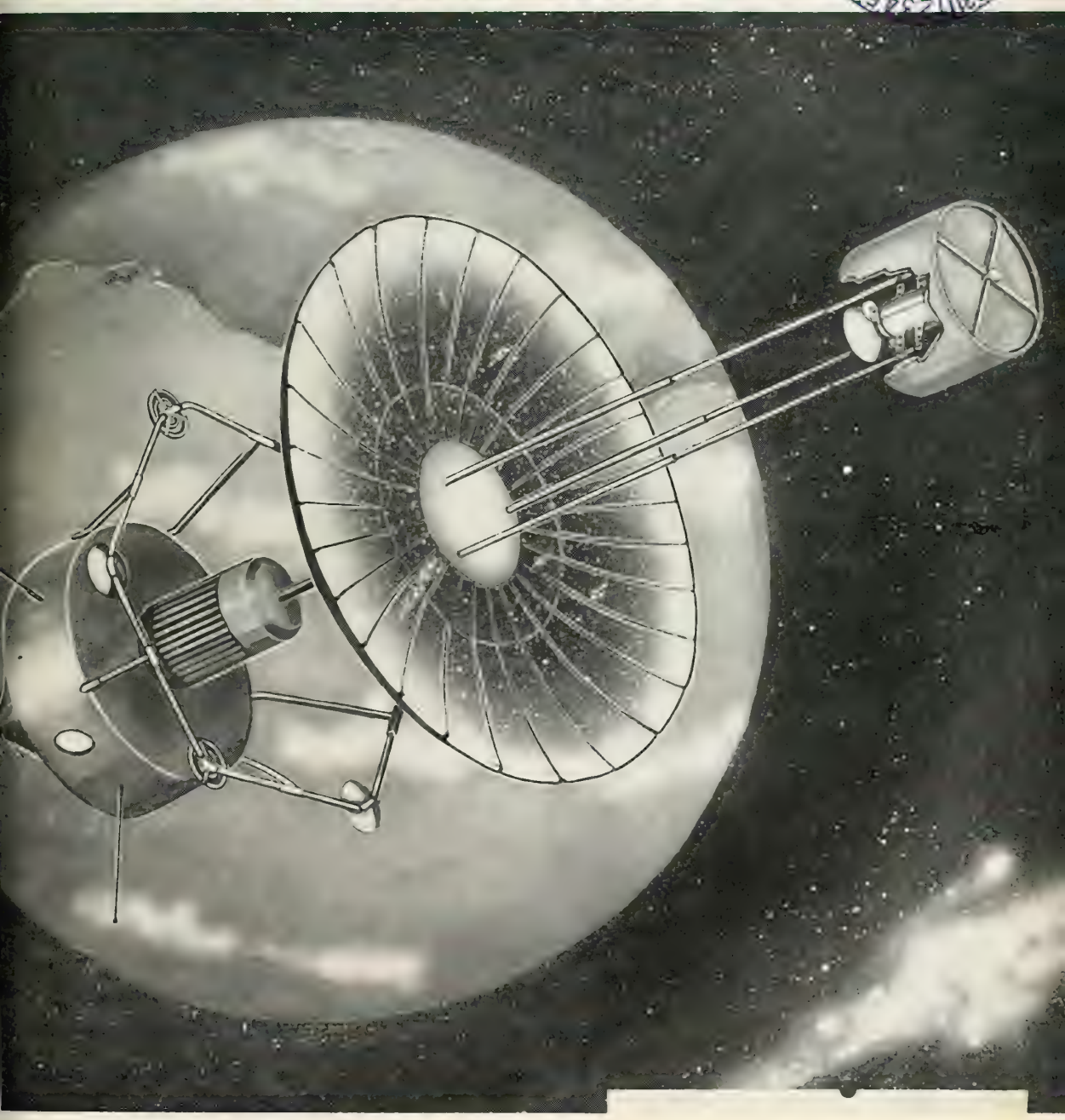
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AUGUST 15, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

AUG 19 0
HOUSTON PUBLIC



15-kw Solar Mechanical Engine

Is Mercury Headed Toward Disaster? . .
Special Report: Solar Mechanical Power
NERV to Probe Lower Van Allen Belt . . 30

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THE SMALLEST GYRO PACKAGES AVAILABLE

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FM10 Miniature, non-floated, two-axis free gyro with synchro pickoffs and torquers on both gimbal axes.

VA10 Miniature, non-floated, air erected vertical gyro with potentiometer pickoffs on both axes. Verticality—operating or non operating—without separate caging mechanism insures (1) greater inherent reliability (2) simplicity of operation (3) lower cost (4) smaller size and (5) less weight.

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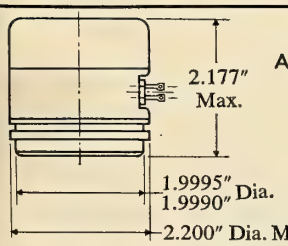
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Beneath the wings of its B-52 intercontinental bombers SAC now packs a formidable new weapon—the GAM-77 HOUND DOG air-to-surface missile. The first operational unit to carry the supersonic HOUND DOG is the 4135th Strategic Wing, based at Eglin Air Force Base, Florida.

This B-52/GAM-77 union greatly extends the useful life and striking power of SAC's long range bombers and adds to the command's operational flexibility.

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THE MISSILE DIVISION OF **NORTH AMERICAN AVIATION, INC.**

Downey, California

THE MISSILE / SPACE WEEKLY

missiles and rockets

August 15, 1960 Volume 7, No. 7

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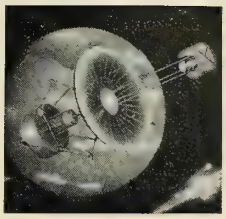
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THE COVER

Biggest solar mechanical engine being developed is 15-kw system extending from satellite at top right in Sundstrand artist's drawing. See report on p. 24.

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Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*



Report No. 9
TMC 601 LOX Tanking Computer System

Typical of our extensive participation in missile fuel management is our TMC 601 the main building block in the process of obtaining a completely automatic propellant loading system for missiles. It accurately measures, controls and indicates the level of liquid oxygen in missile tanks. The computer monitors the weight of the propellant aboard a missile, compares it with the desired weight, allows for tank diameter and propellant density correction and controls the flow of propellant to the missile. A two mode control system facilitates the rapid and accurate loading of the missile. The first mode permits extremely high pumping rates until 98% capacity is reached. The second mode then controls a precise proportioning valve which fills the tank to within 0.1% accuracy and provides for continuous topping. Entirely encased in a protective cover to withstand the extreme conditions generated by a firing, the TMC 601 measures the static head of the liquid in a tank by means of a highly refined pressure transducer.

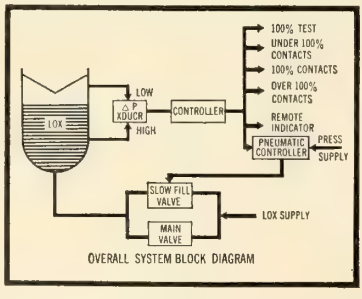
The TMC 601 does not require calibration after installation and can be easily and rapidly modified for new missile or tank configurations.

Typical Performance Specifications

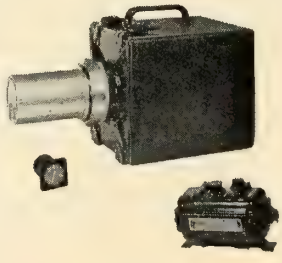
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28 volts D.C., 2 Amps.
115 volts, 60 cycles, 100 watts (heater)
25 PSIG—clean, dry air-pneumatic supply to TR 2013

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2) Line Pressure 50 PSIG
3) Proof Pressure 90 PSIG

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—when and where—

ASME-AIChE Heat Transfer Conferen and Exhibit, Statler-Hilton Hotel, Bu falo, N.Y., Aug. 15-17.

XIth International Astronautical Congres IAF, Stockholm, Aug. 15-20.

Cryogenic Engineering Conference, Un versity of Colorado and National Bu reau of Standards, Boulder, Au 23-25.

Western Electronics Show and Convention Los Angeles Memorial Sports Aren Aug. 23-26.

International Union of Pure and Applie Physics, International Conference o High Energy Nuclear Physics, Un versity of Rochester, Rochester, N.Y Aug. 25-Sept. 3.

The German Rocket Society, Annua Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh An nual Basic Statistical Quality Contro Institute, Storrs, Aug. 28-Sept. 9.

The Combustion Institute, 8th Interna tional Symposium on Combustion California Institute of Technology Pasadena, Aug. 29-Sept. 2.

10th International Congress of Applie Mechanics, Congress Bldg., Stresa Italy, Aug. 31-Sept. 7.

SEPTEMBER

Society of Instrument Technology an British Interplanetary Society, One day joint symposium on Rocket an Satellite Instrumentation, Manson House, London, Sept. 1.

13th General Assembly of the Interna tional Scientific Radio Union, Univer sity College, London, Sept. 5-15.

Society of British Aircraft Constructor Show and Flying Display, Farnbor ough, England, Sept. 6-11.

Electronics Industries Association, Secon Conference on Value Engineering, Dis neyland Hotel, Anaheim, Calif., Sept 7-8.

Joint Automatic Control Conference Massachusetts Institute of Technology Cambridge, Sept. 7-9.

American Chemical Society, 138 Nationa Meeting, New York City, Sept. 11-16

Second International Congress in the Aeronautical Sciences, Zurich, Switz erland, Sept. 12-16.

IIIrd International Congress on Surface Activity, Cologne, Germany, Sept. 12 17.

Electronics Industries Association, Fall Conference, Sheraton-French Lick Hotel, French Lick, Ind., Sept. 13-16.

Engineering Management Conference, sponsored by American Institute of Electrical Engineers and American Society of Mechanical Engineers, Mor rison Hotel, Chicago, Sept. 14-16.

Armed Forces Chemical Association, 15th Annual Meeting, Sheraton Park Hotel, Washington, D.C., Sept. 15-16.

Institute of Radio Engineers, National Symposium Space Electronics & Telemetry, Shoreham Hotel, Washing ton, D.C., Sept. 19-22.

ASME-AIEE Power Conference, Belle vue-Stratford Hotel, Philadelphia, Sept. 21-23.

Anti-Euphoria

To the Editor:

Many thanks for writing your July 25 editorial ("Khrushchev—How Long, Oh Lord?"). What you say has been said before, but it needs to be said over and over again until we move off this euphoric dead center and begin to address ourselves to our national responsibilities.

You are to be congratulated for this editorial, particularly because of its timing. This is the "special week" (week of July 25) in which anyone who feels that we have made mistakes over the past eight years is being regarded as an enemy of the people and almost a traitor. It took real editorial guts to come out as strongly and clearly as you did at this time.

T. F. Walkowicz
New York City

Truth about Polaris (cont.)

To the Editor:

Recently, I sent you a letter (M/R, Aug. 1, p. 49) giving some information in rebuttal to a syndicated newspaper column of July 21. As you may recall, the columnist in question had some rather derogatory remarks about the *Polaris* missile program, and I attempted to point out some areas in which he was wrong.

After rereading my letter, and in the light of some additional information received from the West Coast, I would like to clarify a point or two.

I believe that I may have done Rear Adm. W. F. Raborn, *Polaris* Program Director, somewhat of a disservice in implying that the program had been advanced three years because of technical breakthroughs accomplished by Aerojet-General. Actually, the rapid progress of the *Polaris* program is due directly to Admiral Raborn's relentless drive and insistence on going to the interim 1200-nautical mile configuration. The Admiral's leadership and his energy have been the driving force in bringing the *Polaris* program to its present, early-successful status. The three technical breakthroughs by Aerojet, i.e., the propellant, the thrust termination and the thrust vector control successes, undoubtedly helped the Admiral in making the decision to advance the program.

In my letter, I referred to the A1a model. I have been informed that this model, although discussed, has never been designed or contracted. I was misled by the columnist's reference to the A1a model. In my letter I said the A1a would be capable of a 1500-nautical mile range. However, it is the A2 model that is designed for this extended range. The A2 model has been test-fired and will soon be committed to flight test at Cape Canaveral. The A2a model is in a feasibility study but has not reached the flight test stage.

As the purpose of my (original) letter was to give you facts in opposition to the fictions in the newspaper column, I thought this letter was in order. Although the first letter is essentially correct, I felt that you should have the most accurate information possible.

Walter G. Winslow
Public Affairs
Aerojet-General Corp.
Washington, D.C.

Pickup

To The Editor:

Everybody here was pleased with the Kiwi story in the July 18 issue. It picked up our spirits to see Los Alamos given the kind of credit we feel our scientists deserve.

Edward A. Connolly
Public Relations Office
Los Alamos Scientific Laboratory
Los Alamos, N.M.

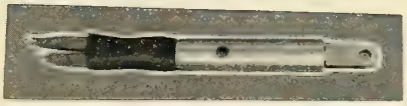
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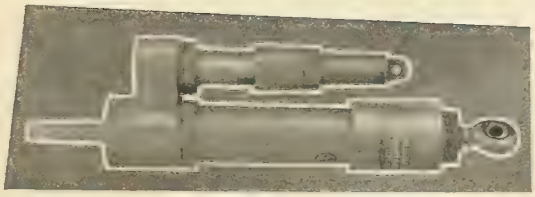
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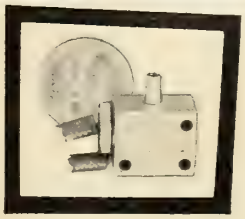
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CAPABILITIES FOR DEFENSE



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Westinghouse is investigating many new electrical power systems, but primary efforts are directed in six important areas. These are: 1. Thermoelectric; 2. Thermionic; 3. High-efficiency solar cells; 4. Photoemission; 5. Magnetohydrodynamic; 6. Rotating magnetic generation. This work is being performed by the Aircraft Equipment Department, Lima, Ohio, supported by the Central Research Laboratories and the Astronuclear Laboratories, Pittsburgh.

Space power requirements—in not too many years—will be measured not in watts or kilowatts, but in megawatts. This need presents formidable technical problems.

We are making progress toward their solution.

Westinghouse

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Moon, age 14 days
Spiral nebula in Ursa Major
Spiral nebula in Virgo
Space
Spiral nebula in Andromeda
Spiral nebulae in Canes Venatici
Filamentary nebula in Cygnus
Globular star cluster in Canes Venatici
Saturn and ring system
Head of Halley's Comet
Nebula in Sagittarius



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Bristol Siddeley Engines Limited produce the Thor ramjet. Two Thors power the missile in the Bristol/Ferranti Bloodhound guided weapon system. This system forms the most effective defence against air attack at very low, up to very high altitudes. And the great flexibility and development potential of the ramjet ensure that Bloodhound will be able to intercept any attacking aircraft for many years to come.

The ramjet is the simplest air-breathing engine that has ever been devised and the Thor is virtually a stainless steel tube which can be lifted by two men. A thrust of over 20,000 lb at Mach 3 can be expected from a typical ramjet of the Thor's size.

At speeds of Mach 2.5 and upwards, the ramjet has a lower specific fuel consumption and a lighter weight than any other prime mover, and the higher the speed the greater its efficiency. In fact, it is the most efficient powerplant for long-range flight at high supersonic speeds within the earth's atmosphere.

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The Bristol Siddeley Maybach diesel engines power Britain's fastest express train—the British Railways "Bristolian".

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The Countdown

WASHINGTON

Another Discoverer Up

The Air Force on August 10 successfully launched the 1700-lb. *Discoverer XIII* satellite into polar orbit from Vandenberg AFB.

Mercury Mystery

NASA experts are still perplexed over the July 29 blow-up of an *Atlas-Mercury* 65 seconds after launch. Telemetry shows that 1½ sec. before it exploded, the *Atlas* booster made an unexplained spurt in velocity.

Thor Production Continued

The Air Force will buy 21 more Douglas *Thor* rockets for satellite and space probe use—11 for the AF's *Discoverer* program and 10 for NASA. All will have the new 165,000-lb.-thrust Rocketdyne engine and will be modified to accommodate the Lockheed-Bell *Agena B* second stage. Of the 21 ordered, 14 will be new rockets and seven previously ordered as tactical missiles will be modified for the space task.

Panama Protector

Decision by the Army to send two *Hawk* battalions to Panama is considered by some people in the Pentagon to be a defensive move against Red-tinged Cuba. COUNTDOWN hears that some U.S. strategists fear Castro might try to strike at the Panama Canal—possibly with unmarked Soviet-made jets.

The Future Lies Ahead

Some documents now being circulated through the NATO headquarters in the Pentagon bear a new classification stamp: COSMIC TOP SECRET.

Slippage, Slippage, Slippage

AEC has postponed until late September the test of its *Kiwi A3* reactor for the *Rover* nuclear rocket, previously scheduled for mid-August. Information gained in the *Kiwi A-Prime* test last month necessitated minor design changes. Also hampered by delay was NASA's Project *Echo* balloon-in-space launching—from Aug. 9 to Aug. 10—and then to Aug. 12.

INDUSTRY

Doubts on Dyna-Soar

The Air Force is putting all its *Dyna-Soar* re-entry eggs in the heat-ablation basket, reports Dr. Walter Dornberger of Bell, who favors two other parallel approaches —refractories and internal cooling.

GSE Sales Pitch

One factor which may push an uprated (1000-mile) *Pershing* into the role of leading contender as a NATO MRBM: an offer to let Europeans manufacture most of the GSE. NATO at present is said to believe it should have an operational MRBM by 1963.

Optical Guidance Perfected

Chicago Aerial has developed SOLO, the first known optical guidance system—with which a missile can follow a target image. Martin will test the system for an advanced version of *Bullpup,* which now uses visual reference and command guidance.

Taped Vibration Trick

Rocketdyne is using tape recordings of the actual vibrations of the *Saturn* H-1 engine to test components. They are played into a shake-table which simulates the engine at full thrust, thus providing a simple method to test for component reliability.

Mahogany Row

Rested up from his defense "crusade," former Convair exec Thomas Lanphier is joining Fairbanks-Whitney Corp. on Sept. 1. He will be VP-planning. About 5% of the business of Fairbanks Morse (one of F-W's divisions) is in the defense field.

Antiradar Still Hot

Navy interest in radar-seeking missiles is far from dead—despite cancellation of the Temco *Corvus.* The Navy is still working on *Cobra,* an antiradar, air-launched missile. It has an antiradar missile study going called ARM. (So does the Air Force.) And there are some *Corvus* test birds available for possible R&D work.

RP-76 Motor in Production

Qualification tests are completed on a new solid motor, developed by Standard Oil of Indiana, for the Army's RP-76 drone, produced by Radioplane. Amoco Chemicals Corp., Seymour, Ind., Standard's production subsidiary, has begun motor production.

INTERNATIONAL

British Polaris Sub?

Britain is toying with the idea of building a nuclear-powered submarine capable of carrying eight *Polaris* missiles. If approved, the money would come from other sectors of the defense budget (such as the recent one-third cutback in the Handley Page Victor Mark II bomber).

New British Ramjet

Bristol Siddeley Engines Ltd. has developed a new ramjet for missiles. The BSRJ. 824 engine is 99.6 in. long and 18 in. in diameter and burns kerosene.

French Mount Satellite Program

The new French budget earmarks about $20 million for some special space projects. They include instrumented satellites, which may be launched within the next 12-18 months.

Argentina Space Colloquium

A big effort is under way to attract top rocket men and organizations to a space colloquium at Buenos Aires in November. Hosts for the event are the National Commission for Space Research and the Argentina Interplanetary Association.

'latter Vanguard' . . .

Is Mercur

by James Baar



Mercury capsule would burn like meteor on reentry if not correctly positioned. Pilot gets one try.

NASA's MERCURY manned-satellite program appears to be plummeting the United States toward a new humiliating disaster in the East-West space race.

This is the stark conclusion that looms in the minds of a growing number of eminent rocket scientists and engineers as the *Mercury* program continues to slip backward.

These experts, many of whom are already calling *Mercury* "a latter-day *Vanguard*," contend:

–The program today is more than one year behind its original schedule and is expected to slip to two. Therefore, it no longer offers any realistic hope of beating Russia in launching the first man into orbit around the earth —much less serve as an early stepping stone for reaching the moon.

–Despite precautions and improvements, *Mercury* continues to be a technically marginal program that could easily end in flaming tragedy. *Mercury*, at best, is a technical stop-gap justifiable only as an expedient. It is no substitute for what is needed sooner or later—a manueverable spacecraft similar to the Air Force's much hampered *Dyna-Soar*.

–*Mercury* originally had the supposed advantage of being cheap, an attribute that made it particularly attractive to the Administration. However, *Mercury* has proven to be a trip down a dead-end road that U.S. taxpayers are finding themselves paving in gold. Appropriations have reached a quarter-billion to date. They may double.

Dissatisfaction with *Mercury* has grown each time the program has slipped. The latest snag occurred on July 29, when an *Atlas* booster carrying the first production model of the *Mercury* capsule blew up 65 seconds after it was launched.

The program fell behind two more months through lack of a back up.

• **Rumbles on Hill**—Alarm has spread to Capitol Hill. Rep. Overton Brooks' House Space Committee is considering plans for a full-scale investigation of the *Mercury* program. Hearings probably would begin in January.

Meantime, scientists and congressmen are casting worried looks at Russia. The next item on the Soviet space schedule is expected to be a soft landing on the moon or the orbiting of a manned satellite. Oct. 4, the third anniversary of the launching of *Sputnik I*, is considered to be a likely date.

NASA's latest secret schedule calls for launching the first manned *Mercury* capsule into orbit about mid-1961. But even this is considered by many to be optimistic.

Late 1961 or early 1962 is thought to be more realistic. And, if the program continues to slip as all experience indicates it will, these dates also are too early.

It is because of these dates that many experts have come to feel that *Mercury* already has failed in achieving the principal mission for which it was created—beating Russia into space with a manned satellite.

• **Restive astronauts**—Even the seven *Mercury* astronauts are understood to be bridling under the expected odium of coming in second in the two-nation space race. Some of the astronauts are reported to have privately urged NASA to scrap much of the *Mercury* test program and take the much greater risk of attempting an early launching.

Such a plan would run directly counter to NASA's present policy of taking every possible precaution to insure the safety of any man launched into orbit in a *Mercury* capsule.

No one would agree with this policy more than technical critics of the program.

These experts, none of whom can be quoted by name because of their connection with the government in one way or another, express gravest doubts as to chances of the *Mercury* system operating as planned.

As one engineer put it:

"The capsule's retro-rockets must fire at the right time and the right angle for the capsule to re-enter at the right angle. Otherwise the ablative material on the capsule's blunt end will fail to protect the astronaut and both he and the capsule will be cooked. This timing and angle business isn't an easy thing, either. Look at *Discoverer*. The Air Force has been trying to get capsule's back from *Discoverer* for more than a year. No luck. And another thing: The astronaut gets only one chance. If those retrorockets don't eject him from orbit the right way the

Program Headed for Disaster?

'Yes,' say many space experts, continuing slippage in the only U.S. man-in-space program makes it almost certain that Russia will be first to put a man into orbit

first time, he has had it."

Nor is that all.

"We think of *Mercury* as the adventurous approach," one expert said. "If he lands in the water, he then hopes to be picked up by ship. But this isn't like a nose cone. Who knows where the capsule might land. I'd say the chances of drowning are more than fair."

• **Side show?**—Finally, and most important, is the charge that *Mercury* in the end is only a detour and not the main highway into space.

NASA has consistently defended *Mercury* as a program designed to answer the vital question: Can a man perform a useful function in the weightless environment of space.

The only way to answer the question beyond any doubt is to put a man in space. *Mercury* is designed to do just that. But it will do little more—as NASA itself concedes.

The next big step in manned exploration of space beyond the earth is the orbiting of the moon with a manned spacecraft. George M. Low, NASA's chief of manned space flight, said only recently in a paper written for the Senate Space Committee that the craft needed for such a trip would be a vehicle with aerodynamic surfaces like *Dyna-Soar*.

For this reason, many critics contend that *Mercury* is a waste of time and resources. They argue that the *Dyyna-Soar* program will prove anything that *Mercury* can prove and result in a useful spacecraft as well.

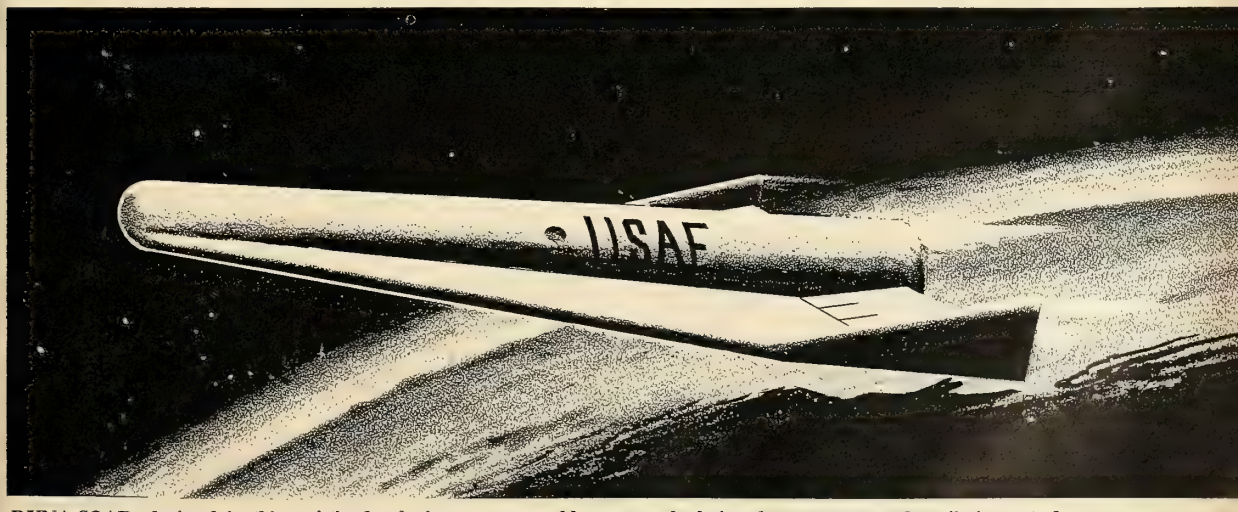
A number of NASA's experts privately agree. But they also are aware of the behind-the-scenes story of why NASA began the development of *Mercury* and they have loyally supported the program.

The story of *Mercury* begins with ARPA.

In the first months after Russia launched *Sputnik I*, ARPA initiated a number of studies to determine the best way to put a man in space. One main approach called for putting a capsule into orbit; the other, for a winged spacecraft.

In April, 1958, Dr. Wernher von Braun, then director of Development Operations of the old Army Ballistic Missile Agency, disclosed to Congress a proposal to send a man briefly 150 miles into space with a *Redstone*. The plan was part of a broad Army program that had been submitted for approval.

"We propose to separate the nose section with the man from the rest of the missile prior to re-entry into the atmosphere," Von Braun said. "The man himself will be in a pressurized capsule which is inserted into the nose section. The latter is equipped with controllable airbrakes which retard the fall as it gets back into the atmosphere. I must add, however, that this program has not received official approval yet.



DYNA-SOAR, depicted in this artist's sketch, is a maneuverable spacecraft designed to re-enter under pilot's control.

How Mercury Launch Times Have Slipped*

EVENT	ORIGINAL PLAN	REVISION NO. 1	REVISION NO. 2	PRESENT PLAN
First Redstone downrange with primate	November, 1959	March, 1960	July, 1960	October, 1960
First Redstone downrange with man	March, 1960	May, 1960	August, 1960	December, 1960
First Atlas downrange with operational capsule (instruments only)	January, 1960	March, 1960	May, 1960	September, 1960
First Atlas Boosting primate into orbit	May, 1960	August, 1960	September, 1960	March-April, 1961
First Atlas boosting man into orbit	June, 1960	December, 1960	March, 1961	August, 1961

**All dates are approximate. The schedule for the Mercury program has been kept "fluid" and secret since its inception.*

I do not know why. ARPA knows about it, but has not yet decided on it. There is a question of money involved, I believe."

• **Year from when?**—Asked how long it would take to complete such a program, Von Braun said one year.

"One year from now?" a Congressman asked.

"One year from the word 'go'," Von Braun said.

Dr. Hugh Dryden, deputy NASA Administrator and then director of the old National Advisory Committee for Aeronautics, said subsequently that the Von Braun proposal was like "shooting a young lady from a cannon." He questioned whether the expense would be worthwhile.

But in October, 1958, one year after *Sputnik I*, NASA opened for business and took over from ARPA and AF a study called Project *Mercury*.

Mercury carried Von Braun's plan only one step further. Instead of launching a man along a ballistic trajectory so that he would experience weightlessness for about five minutes the man would be launched into orbit.

At the same time, the Air Force was permitted to proceed with its studies for *Dyna-Soar*. But funding was at a low level and the program's priority was comparatively low.

Just who said what to whom at the meetings that resulted in NASA choosing the *Mercury* approach over *Dyna-Soar* has been obscured over the last few years. However, all the evidence points unquestionably to two reasons why the choice was made: *Mercury* appeared to be quicker and cheaper.

• **Cost comparison**—Experts familiar with the *Dyna-Soar* program have said an all-out *Dyna-Soar* R&D effort could have produced an early maneuverable spacecraft by about 1963 or possibly late 1962. The cost might have approached a billion dollars.

On the other hand, *Mercury* originally was expected to cost only about $200 million and take well under two years to put a man in orbit.

Appropriations for *Mercury* through FY 1961 have already reached $241 million. NASA officials have estimated that another $100 million will be needed. However, congressional sources expect this to be at least doubled.

These figures do not include such costs as the multi-million-dollar expense of Naval warships and planes needed for recovery and AF tracking facilities.

Mercury has slipped almost since its inception and the space programs that NASA keeps telling Congress are to follow have slipped accordingly.

NASA requested a top priority for *Mercury* in Nov., 1958. The program did not get it until May, 1959. This is generally the way matters have gone.

At present, NASA is still holding out a slim hope that a *Redstone* carrying a manned capsule can be launched downrange by the end of this year—more than a year and a half later than Von Braun said he could do the same thing.

However, the chances of NASA even meeting this new deadline are considered very slight. The result will be that the launching of a manned capsule into orbit will slip again.

But all of the nation's hopes have been put on *Mercury*. And there is no back-up if the program fails.

The Missile/Space Week

No Back-down on Polaris

The United States, in a note to the Kremlin, said it would not be deflected by Soviet threats from giving *Polaris* missiles to NATO. The note refuted Soviet charges that NATO *Polaris* negotiations threatened peace and constituted arming of West Germany.

DOD Unfreezes WW II Science Research Files

The Pentagon is ending the deepfreeze of most of the World War II scientific research documents. Among them are files of new missiles, radar, aerial combat and amphibious warfare techniques. The bulk of the 30,000 documents affected will go to the Library of Congress. Business and Defense Services Administration is preparing indexes to the information.

X-15 Hits Speed of 2190 mph

The X-15 rocket plane sped to a new world's record for manned flight in its latest test run, hitting top speed of 2190 mph. Powered by twin XLR-11 engines developing 12,000 lbs. thrust each, the dart-shaped plane reached maximum speed at 66,000 ft. The entire flight lasted only 10 minutes; top speed was reached after four minutes, fifteen seconds.

Atlas Flies 7000 Miles

An *Atlas* ICBM made its second longest trip to date—7000 miles down the Atlantic—while carrying 1000 lbs. of instrumentation in its 12-ft. Mark III nose cone. Although an *Atlas* flew 9000 miles May 20, the Aug. 9 test was designed to demonstrate versatility. The missile reached an altitude of about 1000 miles and covered the distance in 40 minutes. No attempt was made to recover the nose cone.

How to Recruit a Monkey?

Those pioneers of space—the flying chimpanzees—are not hapless draftees as one might suppose. As a matter of fact, they're volunteers. Brig. Gen. Don D. Flickinger, AF Chief of Bioastronautical Research, told the House Space Committee so. How do they indicate their astronautical urges? Friend chimp is trained to sit on a small stool for several days, then he's offered a banana or an apple. If the simian prefers the banana, he's a volunteer—and they almost always do!

3-Stage Minuteman Shot This Year

Third-stage contract will probably be awarded before firing; Boeing to build complete launch complex at Seattle

by Frank G. McGuire

SEATTLE—The Air Force plans to fire a three-stage *Minuteman* down the Atlantic Missile Range before the end of this year, in a drive to push the solid-fueled ICBM toward operational status by mid-1962.

Boeing Aircraft Co. revealed that the shot will be a full-range effort, with all three stages, rather than a limited-range attempt, and might possibly come before final award of a production contract for the third stage. It is likely, however, that the third stage award will be made to either Aerojet-General or Hercules Powder Co. before the AMR launch.

Boeing says that both versions of the third stage—being developed under separate contracts with Aerojet and Hercules—are fully compatible with the rest of the system.

The version being developed by Hercules is understood to be a greater departure from current practice than the Aerojet version.

Boeing also announced plans to construct a complete *Minuteman* launch complex at its Seattle facilities to test the entire weapon system. No launches will be made from the complex, designated the Seattle Test Program (STP).

T. A. Wilson, Boeing *Minuteman* Program Manager, said the complex will check out all elements of the system, including ground support equipment, to guarantee compatibility and integration of subsystems. He pointed out that the STP will compress the development time period of the *Minuteman* and will save considerable money in design and construction of operational launch sites.

The facility will also serve as a "test bed" for developing procedures and manuals required for training of SAC crews. The STP will include an underground silo, launch control center, tracks for the missile car, and a support building.

Construction is expected to begin this month, with completion of the facility scheduled for the end of the year. Tests will begin next year, after installation of equipment.

Wilson said the early *Minuteman* concept of having capability of launching individual stages of the missile to perform shorter range missions is still being worked on. This concept would allow the third stage to be used alone as a tactical weapon, two stages as an IRBM, or the complete weapon as an ICBM.

• **Upping payload**—"We are looking forward to continued improvement of the missile's performance," he said, "and hope to substantially increase the payload capability, although we don't expect it will ever match the payload of *Atlas* or *Titan*."

A three-part program will begin at Vandenberg AFB to transform the *Minuteman* into an operational strategic weapon. Preliminary work is underway at Boeing's Aerospace Division, and at the Air Force's Ballistic Missile Division in Los Angeles.

Several hundred Boeing employees will be assigned to VAFB next year, after construction of facilities there. Boeing presently has about 8000 employees on the program. When Air Force Plant #77 near Hill AFB, Utah, begins full-scale operation. Plant #77 is to be the *Minuteman* Assembly Plant.

The three part program at Vandenberg will include:

1. Conducting systems engineering to demonstrate installation, operation and maintenance procedures. 2. Training Air Force supervisors and instructors who, will train SAC crews. 3. Assisting SAC crews in launches from both silo and mobile facilities.

First of these SAC crews will be based at Malmstrom AFB, near Great Falls, Montana, in mid-1962.

Boeing revealed that the first two of its tethered silo shots for *Minuteman* at Edwards AFB were enough to supply the basic data for the launch method. Additional shots were carried to make refinements in the system, and the final two were from concrete silos, rather than the flexible research and development type.

Of the sixteen original shots planned, the final eight were cancelled, said Boeing, due to the success of the program. Wilson estimated that this cancellation saved the Air Force well over ten million dollars.

Boeing said production rates on the *Minuteman* are not high, but the overall program acceleration has been very rapid. The production techniques used in the program were proved out at Edwards AFB, and the company plans to use single-line production methods, with the personnel moving along the line of missiles.

The company has made a complete survey of all the planned sites, checking housing accommodations, and other necessities. Its site activation personnel will be used whenever practical and economical, the company said, with associate contractors being called upon for support when needed.

• **Stiff tests**—Components for *Minuteman* are tested at the development laboratories here, where stresses such as load, heat, internal pressures and external air pressures are simulated. The components are shock-tested to at least one hundred times the force of gravity.

The transerector for the missile has a gross weight of over 100,000 lbs., and a length of about 64 ft. The maximum gross weight allowed on California highways is 108,000 lbs., the lowest in the nation, and thus was used as a ceiling on the specifications for maximum gross weight.

Boeing is also conducting tests on the silo lid, which must pop off the silo despite possible interference of rocks, sand, or other obstructions. Compressed air is presently being used, but the operational site may use compressed air or mechanical means. The pop-off time allowed is very short, due to the necessary rapid reaction time.

Full cooperation with AF . . .

How Welling Will Push Base-building

by William J. Coughlin

LOS ANGELES—A hard-driving Army general who says he "operates with the advantage of a narrow military mind" has plunged into America's dragging ICBM base construction program.

Brig. Gen. Alvin C. Welling, commander of the newly created Army Engineers Ballistic Missile Construction Office, summoned his staff together seven minutes after arriving on the job here and ordered them to give full cooperation to the Air Force.

Welling, who has been given carte blanche to draft any Corps of Engineers personnel from anywhere in the world for the job, says he is not interested in the reasons for past delays or charges of interservice friction between the Army and the Air Force.

"I'm not interested in background; I'm interested in the future," he declared in an interview with MISSILES AND ROCKETS.

Welling will work directly with Maj. Gen. Thomas F. Gerrity, who recently took over command of BMC in an Air Force Shakeup of the site activation program.

• **More 'angry men'**—Welling's first action in the new post was to name four Army colonels as directors of construction for each of the missile systems. They correspond roughly to the "12 Angry Men" named by the Air Force. The Corps of Engineers officers are:

Atlas D and *E*—Col. Charles Noble, former district engineer, Louisville District; *Atlas F*—Col. Edward D. Comm, former member of Joint Staff, Joint Chiefs of Staff; *Titan I*—Col. Carlin H. Whitsell, former district engineer, Eastern Ocean District; *Titan II*—Col. Carroll H. Dunn, former head of construction of BMEWS at Thule; *Minuteman*—Col. Noble will take charge after completion of duties on *Atlas D* and *E* programs.

The four colonels will be contracting officers. Present contracts will be brought under control of the new office except in those cases where construction already is so far along as to make such a move impractical, Welling told M/R.

Welling indicated hope that certain limitations on contract awards, such as the requirement that construction contracts must go to the lowest "responsible" bidder, might be changed to enable more effective placing of contracts.

• **New program**—The 50-year-old troubleshooter outlined a 10-point step-by-step program which he is immediately putting into effect:

1. Assure that going projects move forward with utmost urgency and precision, including a vigorous expediting of government-furnished equipment.

2. Arrange details of directing *Atlas D* and *E* operational bases through Corps of Engineers divisions and districts, using direct channels to the area engineers.

3. Prepare to contract for *Titan II* facilities, establishing adequate organization in BMCO and at the area level and arranging for appropriate support from the districts.

4. Do the same for *Minuteman*.

5. Modify if necessary and practical existing arrangements for supplying of government-furnished equipment to all programs.

6. Take over contracts for one *Titan I* operational base, assuming direct command of the area engineer and arranging for support from the district engineer.

7. Do the same for one *Atlas F* base.

8. Take over remaining contracts for *Titan I* operational bases.

9. Take over remaining contracts for *Atlas F* operational bases.

10. Solidify relationships with Patrick, Edwards and Vandenberg AFB's.

Warren AFB Operational

Three Atlas launch positions at Warren AFB, Cheyenne, Wyo., became operational last week, the Air Force reported. The three joined the operational and training base at Vandenberg AFB, Calif., as the only U.S. positions capable of firing an ICBM in anger.

President Releases $476 Million

President Eisenhower retreated in the battle over defense spending last week in an apparent effort to reach a more defensible position.

Under fire in this election year from the Democratic Party and important factions of his own Republican Party, the retiring President approved the spending of $476 million out of more than $1 billion the Democratic Congress had added to his Fiscal Year 1961 budget. And he denied a Democratic charge that he had impounded the remaining $621 million.

At his press conference Aug. 10, Eisenhower attributed his change of heart to the tougher line that Soviet leaders have been taking since he sent his budget to Congress in January. As for the extra funds, he noted that Congress had cut some funds he requested and added in other areas. This makes a complicated problem that can't be solved in a matter of weeks, he maintained.

Thus the prospect is that more money may be released as the political campaign progresses. However, neither Sen. John F. Kennedy, the Democratic presidential candidate, nor Sen. Lyndon B. Johnson, majority leader and vice-presidential candidate who accused Eisenhower of impounding the money, is likely to move for any further appropriations while a substantial amount already appropriated remains unspent.

The Defense Department's revised spending plan calls for total expenditures of about $41.46 billion, an increase of $535 million over the January forecast. Of the increased money, only $150 to $160 million will be spent for hardware this year. More than $210 million of the extra money is earmarked for civilian pay increases.

These items were included in Eisenhower's approval of spending of add-on appropriations:

• **B-70**—About $100 million of the $195 million added by Congress will be used, bringing total spending to about $195 million.

• **Samos**—About $50 million of the $83.8 million added by Congress will be spent, bringing total funding to $427 million. A major portion of the additional funds will be used to provide an alternative approach to certain unspecified critical phases.

• **Polaris**—$312 million of the $382 million added by Congress will be spent, $55 million for procurement of aircraft and missiles, and $257 million for shipbuilding and conversion. Shipbuilding will be increased from three fully funded and nine partially funded submarines to five fully funded and five partially funded. Defense Secretary Gates said a start will be made on development of a longer-range *Polaris*.



How Mauler Will Look in Action

The Army recently released this artist's conception of the *Mauler* air defense missile being developed by Convair Div. of General Dynamics.

The automatic-firing system will be able to track targets and launch missiles from virtually any parked or moving position on its M-113 troop carrier-launcher, being developed by Food Machinery & Chemical.

Raytheon has the contract for the *Mauler's* antenna, which, together with its fire-control equipment, will be stabilized gyroscopically.

The Army announced two other successes in air defense missilery. A Raytheon *Hawk* destroyed a *Little John* over White Sands on July 27. A Boeing *Bomarc-A* caught a *QB-47* over Eglin Gulf Test Range Aug. 5.

Army May Join Weapons A, B

The Army's proposed *Missile A* and *Missile B* may be merged into a single new free-rocket system—*Missile A/B*—because of budgetary considerations. Continental Army Command is now writing military characteristics of the system.

This became known last week at the annual meeting in Washington of the Association of the U.S. Army. The Army is considering several approaches; although the service is divided within itself on which is best, there is almost universal agreement that it will be a free-flight system if the necessary accuracy can be obtained.

CONARC, the user command, wants a single missile that can do both jobs in the 3000-to-75,000-meter range. It's taking a hard look at *Slim John*, the advanced *Honest John* without the bulbous nose; this utilizes the PADA system of spinning within a ring with the ring moving up the launch rail to create the rifling effect. *Slim John* is reported to have much support because it could use existing *Honest John* launch equipment and production tooling.

Another possibility is a modification of *Lacrosse;* although most Army officials would prefer not to go to a guidance system, they appreciate *Lacrosse's* extreme accuracy.

General Electric has systems cognizance of *Missile A*, although the FY 1961 budget carries only $5 million for components buying. There are no funds for *Missile B* in FY 1961; more than 50 firms, however, have submitted proposals for its Qualification Development Requirement Index.

• **Replacements**—Under previous plans, *Missile A*, would have been the division artillery direct support missile, while *Missile B* would have been a general support missile. Both free-flight, solid-propelled missiles could carry atomic warheads in the low-yield bracket—in addition to chemical warfare and high-explosive warheads.

The Army has stressed components development of *Missile A*, hoping that resultant techniques would bring faster development of *Missile B*. Stress has been on use of high-thrust multiple boosters, methods to automatically match thrust and drag, spin and launch techniques, and improved measurement of low-level winds.

The Army had planned originally that *Missile A*, the 105 Howitzer of the missile family, and *Missile B*, the division general support missile, together would replace *Honest John, Little John* and, to a large extent *Lacrosse.*

Missile C is to be the follow-on for *Sergeant*. The Army plans to reduce the warhead weight without sacrificing yield, and take advantage of expected advances in solid propellants.

• **Lead-time gap**—Lt. Gen. Arthur G. Trudeau, Chief of Research and Development, told the AUSA meeting that lead time in the United States is running seven to eight years, with the Soviets doing a comparable job in five years. He said this problem can be licked by:

–Faster and more intensive exchanges of information between industry and Army—at every stage of development.

–New procedures for expediting development—such as overlapping and telescoping phases of R&D.

–Conducting user and engineering tests concurrently or on a combined basis.

–Starting production engineering and tooling as early in the development cycle as possible.

Raul Castro Renews Threat Of Russian Rocket Attack

Cuba's Raul Castro is wagging Soviet rockets at the United States.

Speaking to the leftish Latin American Youth Congress in Havana, Major Castro said, with apparent assurance, that the Soviet Union would back Khrushchev's pledge to support Cuba with rockets against any U.S. attack. This has raised speculation that Cuba and the Soviet Union may be ready to announce a military alliance.

Fresh from a trip behind the Iron Curtain, Castro said "If there is no attack, there will be no rockets, but if there is an attack, there will be rockets."

In an apparent rebuttal of reports that Russia may put missile bases in Cuba, Fidel's younger brother said, "If Cuba is attacked militarily, they (the United States) will receive what they deserve not from here but from other places."

No Cuban bases were needed, he said, because the Soviets could launch rockets to the States from its own territory.

Big Test Cell to be Built at AEDC

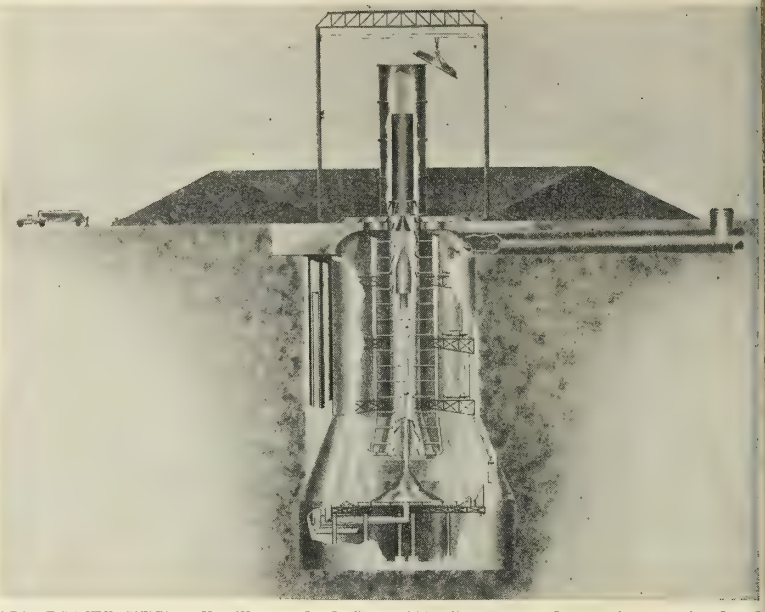
Construction of a test cell for firing rocket engines of up to 500,000 lbs. thrust will begin soon at the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.

The facility, scheduled to be operational in late 1962 or early 1963, will be able to handle both liquid- and solid-propelled engines in vertical positions at simulated altitudes of over 100,000 ft. It will be designed for later modification to handle engines of up to 1,500,000 lbs. thrust.

Completion of the cell will make it possible to study in detail various phenomena encountered by a missile in flight, without sacrificing the missile itself. It will provide space sufficient to permit installation of complete missiles, with engines in position and operating.

An exhaust-gas removal system will be tied in directly with the existing exhausters for obtaining altitude simulation, cooling water system, data reduction units and other auxiliary equipment.

A law providing funds for the cell was signed by the President last month.



HARDENED TEST cell will soon be built at AEDC to test rocket engines at simulated altitudes. Exhaust system is at upper right in artist's conception.

mergers and expansions

AEROJET-GENERAL has established a Spacecraft Division at Azusa, Calif. M. L. Stary, veteran rocket engineer, will be manager. The division is an outgrowth of Aerojet's Systems Division; it will design, develop, produce and flight-test all Aerojet vehicles used in space operations.

AERONUTRONIC DIV. of Ford Motor Co. has entered the automotive electronics field with the foundation of Automotive Electronic Equipment Operations. Lowell E. Krieg, former assistant to the general manufacturing manager of the Ford Division, is general operations manager.

HORKEY-MOORE ASSOCIATES, Div. of Houston Fearless Corp., has expanded its Testing Division facilities to include a fluid contamination analysis laboratory.

SPACE TECHNOLOGY LABS has established a Canoga Park Division to carry on programs formerly assigned to the Signal Equipment Laboratories of Ramo-Wooldridge Div. of TRW. Other R-W programs at Canoga Park will not be affected by the move. Dr. W. M. Duke, STL vice president and director of its research and development divisions, will head the Canoga Park unit. About 250 technical and administrative personnel will transfer from the R-W Division.

MAGNAVOX RESEARCH LABS dedicated their $1.5 million plant in Torrance, Calif. The Magnavox company projects income at $150 million for 1960, one-third of which will come from the Government and Industrial Division.

financial

Martin Co.—First half record sales and post-war record earnings were announced by Martin. Sales rose to $302 million from $248 million in the first half of 1959. Net income was $7.7 million, compared to $6.2 million the previous first half. Second quarter sales and earnings also improved, sales rising to $161.6 million from $126 million, profits to $4.2 million from $3.2 million.

Gabriel Co.—Second quarter reports showed a loss of $161,535 reflecting the write-off by the company of non-recurring charges of $379,488. Sales in the second quarter totaled $9.2 million compared to $7.8 million for the previous year second quarter. Sales for the first six months were $16.9 million compared to $14.6 million. Income showed a loss of $126,801 compared to profit of $472,815 for the first six months of 1959.

Marquardt Corp.—Working in a 28-week period ended June 17, sales were up 7% over the same period last year. Sales were $36.3 million, earnings were $599,597 from $860,647 the same period last year.

Temco Electronics—New contracts for Iconorama radar display systems, aircraft overhaul and aerosystems have almost completely offset the Navy cancellation of *Corvus* missile at Temco Electronics and Missile Company, the company says.

Chairman of the Board Robert McCulloch predicts more new business in the third and fourth quarter resulting from the merger of Ling Altec Corp. and Temco Aircraft Corp.

Ling-Temco Electronics Corp. achieved record sales and earnings for the second quarter ended June 30, with sales of $42.5 million and income of $1.1 million. Six month sales for the company were $76 million and earnings of $1.4 million. The company has a backlog of approximately $111 million.

missiles and rockets

3rd ANNUAL GROUND SUPPORT EQUIPMENT ISSUE

A major editorial round-up covering these important areas:

- Launching and Service Towers
- Tracking Systems
- Fuel Handling Equipment
- Computers and Data Processing Equipment
- Polaris Submarines
- Mobile Launching Equipment
- Power Generation Equipment
- Material Handling Equipment
- Electronic Checkout Systems
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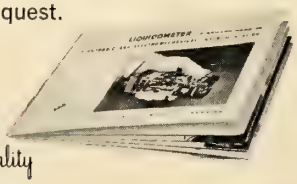
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Technical Countdown

ELECTRONICS

New Illumination Theory

Astronauts may find their instrument panels being illuminated by flickering lights. An Air Force OSR contractor concludes that certain light-dark ratios allow greater visibility than steady light and reduce error probability. Investigators now have recommended specific flickering-light ratios for future use.

Bigger Horn Antennas?

A horn antenna up to three times as big as its present 50-footer is being considered seriously by Bell Telephone Laboratories. Mechanical distortion is one big problem facing designers of the extreme low-noise (2°K) configuration which is working well in satellite communication experiments.

Higher-gain Antennas Being Studied

Several companies are reported working on higher-frequency antennas with gains up to 70 db. Type of construction is not specified, but consensus is that they won't be paraboloidal.

Solid-State Generator Ready Soon

A one-watt, 1000-mc, solid-state power generator will be ready for commercial sale late this year by Pacific Semiconductors. Power level of the new device—slated for primary application in missile/space r-f transmitters—is reported to be 100 times greater than that of any previously available semiconductors for UHF use.

AEC Synchratron Hits 30-BEV Mark

The Alternating Gradient Synchratron at Brookhaven National Laboratory, the world's most powerful nuclear particle accelerator, is now in operation. The half-mile racetrack ran a beam of protons up to 30 billion electron volts on July 29. Cost of the AEC facility was $31 million. Next most powerful particle accelerator—the CERN Proton Synchratron, Switzerland—has been run at 28 BEV.

GROUND SUPPORT EQUIPMENT

Zeus Radar Vastly Improved

Improvements in *Nike-Zeus* target acquisition and tracking radar have contributed to stepping up development of the whole system. Chief gain, the Army says, is increased ability to discriminate, which continues after launch.

One-Point Ground System for GSE

A method for central grounding and radio-frequency shielding of missiles and support equipment has been recommended as standard by a Martin-Baltimore engineer. The one-point ground system, he says, would solve many problems in grounding, shielding, and filtering posed by the increasing complexity of missile electronics.

Agreements Made for Space Tracking Facilities

Goldstone's big 85-ft. space-tracking dish and facility will be duplicated at both Woomera, Australia, and Johannesburg, South Africa. Equipment will be supplied by NASA; JPL will handle construction. Sites will be roughly 120° apart geographically, providing continuous tracking of space probes at all times by at least one station. Recently, Goldstone has been successfully reflecting and receiving radio signals from *Tiros I*—even though "visibility" is only for 10 minutes. (See page 39.)

Auto-Checkout Saves Millions

Automatic checkout of electronics systems due for storage has saved the Air Force $2.5 million in one month. Used by the 2704th Storage Group, a Nortronics' Datica system was rushed into service to sort out serviceable radio gear from a mountainous backlog. The work accomplished would have required 12 months by standard test van.

PROPULSION

Hybrid Rocket Tests Look Good

Marquardt and Grand Central Rocket have demonstrated complete on-off capability with a 1000-lb.-thrust motor in their joint hybrid rocket program. A series of test firings with the first two motors in the program demonstrated that the thrust was packed into a smaller space than in any present rocket, Marquardt says.

Saturn Money Transfer Denied

NASA says there is no truth in the report that $23 million was transferred from the *Saturn* booster program to other space projects. The report followed a decision by the space agency to delay production of booster recovery hardware.

MATERIALS

Re-entry Steels Developed in England

Two new steels suitable for missiles and re-entry vehicles have been developed by Firth-Vickers Stainless Steels Ltd. No details on the composition were disclosed, but the materials are being used in the all-steel Bristol T-188, soon to start flight trials at above 1500 mph.

Lyon Lands Second Case Contract

Reliable motor-case development on a production scale is the object of a $500,000 contract awarded to Lyon Inc. by Detroit Army Ordnance District. It is the firm's second solid-motor chamber contract in 11 days. The first was a $1.45 million deal for *Polaris* second-stage cases. A deep drawing technique will be used to provide one-piece construction.

Alkali Metals Studied For Propellants

Work on the alkali metals lithium and sodium as propellants, with H_2O_2 as oxidizer, is in progress at Arthur D. Little, Inc., for the Air Force.

Combustion Viewed with "Hot" Tracers

Reaction Motors-Thiokol is investigating for the Air Force use of radioactive tracers to study combustion of advanced propellants. The aim is to cut development costs by reducing the number of burned large rocket motors.

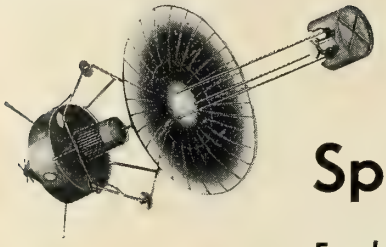
ASW ENGINEERING

Training Outlay to Grow

Here's one to ponder: the Navy estimates it will cost $1.3 billion annually within five years just to train fleet personnel in ASW.

Position Filled for Single Manager

Congress keeps telling the Navy it needs a single manager for ASW. Current Navy rejoinder is that it has one—Admiral Arleigh A. Burke. Reason: ASW spans the whole Navy and he's CNO.



Space Power Needs Urgent

Emphasis shifts toward solar-energized units; solar mechanical systems have time edge over nuclear units

LACK OF a primary electrical power source today is a key drawback in advancing both manned and unmanned space vehicles.

A shift in emphasis from nuclear to solar-energized systems appears to be taking place. The reasons: time factor, power needs, and international concern over the possibility of nuclear contamination. Rapid developments in thrust capability and satellite instrumentation are outdistancing power system progress.

Emphasis has been on nuclear systems such as the NASA/AEC SNAP programs. Early systems employ radioactive isotopes such as SNAP-3's polonium 210. This will be suitable for low-power, long-endurance requirements. Its weight-to-power ratio, however, is roughly 1 lb./watt.

The SNAP-8 program will use a reactor and provide from 35 or 70 kw. Weight will be 1400 lbs. or 2500 lbs., respectively, or 50-60 lb./kw. But the system won't be ready for flight tests for another 5 years.

What several space projects need in a short time, however, are lightweight systems in the 1-20 kw range.

AEC has bent over backwards to prove how safe SNAP-3 is. But there apparently is fear that an OK to fly it may provide carte blanche to the use of future generation reactor systems carrying large "hot" cores, which might be dangerous.

• **Trend to solar types**—The push for solar mechanical systems has been strong.

Thomas Timar, Boeing Airplane Co. suggested before the 14th Annual ARS meeting last November in Washington that solar systems ultimately will weigh well below 20 lbs./kw—10 times less than current state of the art would require.

Solar mechanical conversion systems will meet the demand for a lightweight, reliable sources of electrical power for satellites and space vehicles. So stated Donald H. McClelland, Senior Engineer, Electro-Optical Systems, recently before the National Aeronautical Electronics Conference in Dayton, Ohio.

Such solar thermal systems—where solar radiation is concentrated onto an absorbing surface to provide thermal energy for a heat engine—appear to offer weight advantages in the 1 to 20 kw region. The following various problems and techniques associated with current development work for these advanced space power units were stressed by the EOS expert.

Nuclear system development has encountered problems which indicate that solar systems could be available years earlier. Static converters, thermionic or thermoelectric, offer promise of eventual high efficiency operation—again a time factor.

The only converter system currently capable of providing satisfactory performance and reasonable weight in the 1-20 kw power range is one using a dynamic heat engine and electrical generators.

A typical solar mechanical power system, said the EOS engineer, embodies the following major components and subsystems:

–Concentrator—gathers solar radiation into a small focal image.

–Absorber—Transfers the concentrated solar energy to the working fluid by forced convection.

–Heat Engine—Converts the thermal energy in the working fluid into rotary shaft power.

–Generator—Converts shaft power into electrical output.

–Radiator—Rejects waste heat by thermal radiation.

–Energy Storage—Saves power for use when system is not exposed to solar radiation (shadow-phase operation).

–Control and Regulation Systems—Maintains constant power output, initiates start-up and orbital cycling functions, matches generator output to load requirements and maintains overall system reliability.

–Orientation System—Keeps concentrator aimed at sun.

• **Suitable mirror paramount**—The reflector or concentrator is one of the most important system elements because of weight and early development status. Concentrator size and geometry are directly related to conversion efficiency, power level and maximum cycle temperatures. The ultimate utility of solar power systems depends to a great extent on the ability to construct lightweight, accurate and (for large power systems) foldable solar concentrators.

McClelland, along with most leaders in the field, feels that the best geometrical configuration is the paraboloid-of-revolution reflector. The ability of the concentrator to produce with high efficiency at high temperatures is directly related to the concentration ratio (radiant flux density received by absorber/radiant flux density impinging on concentrator).

The maximum possible concentration ratio is achieved by a paraboloidal reflector. McClelland considered all practical factors into account—including investigations of parabolic cylinders, hemispheres, circular cylinder, conical and Fresnel lenses. He also included degradation of the actual concentration ratio by geometric inaccuracies in the mirror surface.

New materials problems abound in the fabrication of high strength, low weight structural elements for the collectors. The goal is accurate structures weighing 0.3 lbs./ft.^{3} or less having the necessary degree of rigidity to maintain the required geometrical configuration through all phases of construction.

The more promising approaches include—folding mirrors of metal or plastic segments, inflatable structures, foam-rigidized plastic-film mirrors and umbrella structures.

Each type has its problems and so far none have been adequately demonstrated in large sizes.

The surface accuracy of the first

three types is limited by materials properties and manufacturing tolerances. The accuracy of the umbrella is also limited by the number of ribs. But small mirrors using each of the techniques have been built and McClelland sees no great obstacles to the development of large ones within the weight limits.

• **Cavity absorber best**—To quantitatively evaluate the performance of a given concentrator, a determination of the concentrator-absorber efficency must be made. This quantity involves the relationship between the thermal energy transferred to the working fluid and the total solar flux intercepted by the concentrator.

It has been shown, said the EOS expert, that a cavity-type absorber will produce the highest overall concentrator-absorber efficiency. It also is more convenient from the thermal energy storage and heat removal aspects.

These absorbers efficiently pick up incoming solar radiation but inhibit reradiation losses from the heated inner surface because of the relatively small cavity opening. Maximum efficiency demands that the cavity opening be optimized for the particular concentrator and cavity temperature being considered.

• **Rankine efficiency cited**—The Rankine and Stirling cycles are the only thermodynamic cycles considered worth developing for space power applications.

McClelland leans toward the Rankine cycle since it ideally approaches the Carnot cycle in efficiency —the two isothermal processes are approximately achieved because of the constant temperature characteristics of a vaporizing or condensing fluid.

The two practical concessions are the irreversible energy addition to the fluid and the irreversible energy transformation as work out of the fluid.

Its main virtues for space power applications include:

—High heat transfer coefficients in the evaporator and the condenser due to the boiling or condensing liquid.

—Small magnitude of pumping work, since the working fluid is in a liquid state with low specific volume.

—Possibility of using working fluid as bearing lubricant.

A large variety of working fluids are available to provide a broad spectrum of evaporation and condensation temperatures and pressures.

The Stirling cycle consists of two constant temperature processes and two constant volume processes. Several practical approaches to a working Stirling cycle engine have been taken with the most promising being developed by the Phillips Corp., Eindhoven, Holland. The Phillips engine is a reciprocating gas system and it is being studied in this country.

• **Generators compared**—Two types of generators may be considered for solar-mechanical power systems—electrostatic and electromagnetic.

The electrostatic provides the lowest weight but it must operate in a vacuum. Thus, some means of lubrication must be devised together with either rotating seals or a magnetic coupling between the generator and the turbine.

The electromagnetic can be hermetically sealed in the same unit as the turbine. Furthermore, says McClelland, the working fluid can carry away the heat produced by losses in the generator. This generator is somewhat heavier than the electrostatic type.

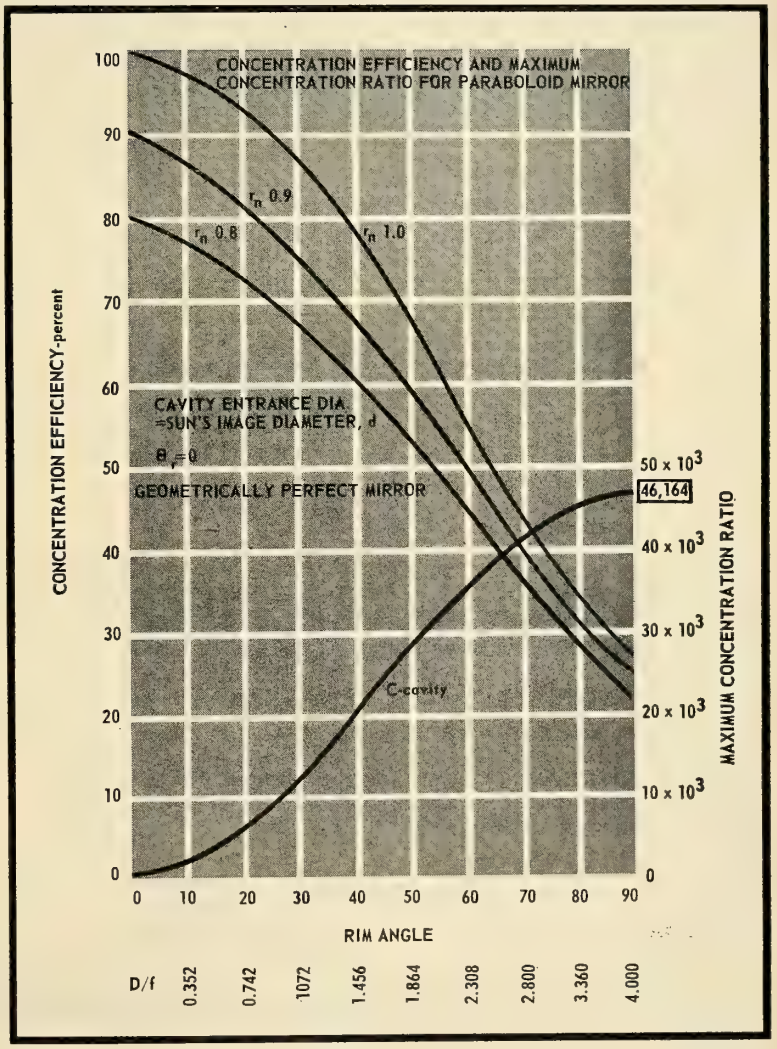
• **Thermal vs. electrochemical storage**—Because a solar power system must supply power while in shadow operation, some sort of storage system must be available. Of the two types considered, electrochemical and thermal, McClelland feels that the latter offers the greatest potential at the present stage of development.

Thermal storage units are generally fabricated as part of the absorber and utilize heat of fusion of a material. Overall system weight of such a unit is lower than the chemical type. It also is smaller in size and has a greater storage capacity.

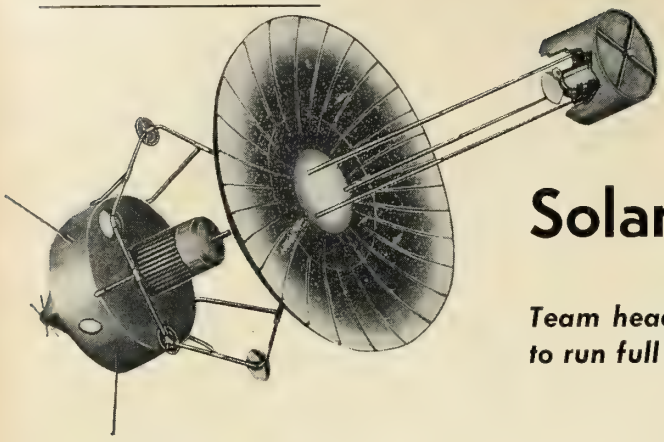
Lithium hydride (HF-1600 Btu/lb.) is the best known material for a thermal storage unit. LiH will limit maximum cycle temperature to something less than 1250°F—if higher temperatures are desired another material must be used.

The heat storage capacity of LiH

(Continued on page 29)



MAXIMUM POSSIBLE concentration ratio of a geometrically perfect paraboloid of revolution reflector is shown together with its concentration efficiency.



Solar Mechanical Engin

Team headed by Sundstrand developing system to run full year; later potential may be enormous

by Charles D. LaFond

DENVER—The biggest solar mechanical engine currently under development by the United States military is being designed by Sundstrand Corporation. It will fill a serious gap in the space-hardware development table.

Announced in June, a $1-million contract from the Air Force ARDC's Wright Air Development Division, makes Sundstrand's Denver Division responsible for research, design, and development of a breadboard 15-kw power system for space-vehicle applications. The potential of such a system could be tremendous in later production phases because of the diverse applications possible.

The contract was awarded to a team, of which Sundstrand is prime. Other companies participating in the 15-month program include Ryan Aeronautical Co., Goodyear Aircraft Corp., and Jack & Heintz. Ryan and Goodyear are principals in a 6-month development competition for the solar collector concentrators (mirrors). Ryan is developing rigid metallic dishes; Goodyear will design plastic inflated concentrators. Jack & Heintz will provide brushless alternators.

Expected to weigh 819 lbs., the solar mechanical engine will be designed to operate continuously and unattended for approximately one year, according to WADD.

Essentially, this will be a closed Rankine-cycle power conversion system, using rubidium as the working fluid. Rubidium was selected to achieve from 500-800°F increase in operating temperature over mercury, which is used in more conventional systems.

The Sundstrand system is similar in concept to NASA's Sunflower I 3-kw power system, in that both systems utilize the closed Rankine cycle with a combined shaft unit (turbine, generator, and pump on a common shaft). However, a unique system design approach, and use of the more advanced working fluid in the USAF 15-kw system, are believed to offer a significantly lower specific weight (55 lb./kw vs. Sunflower I's 233 lb./kw).

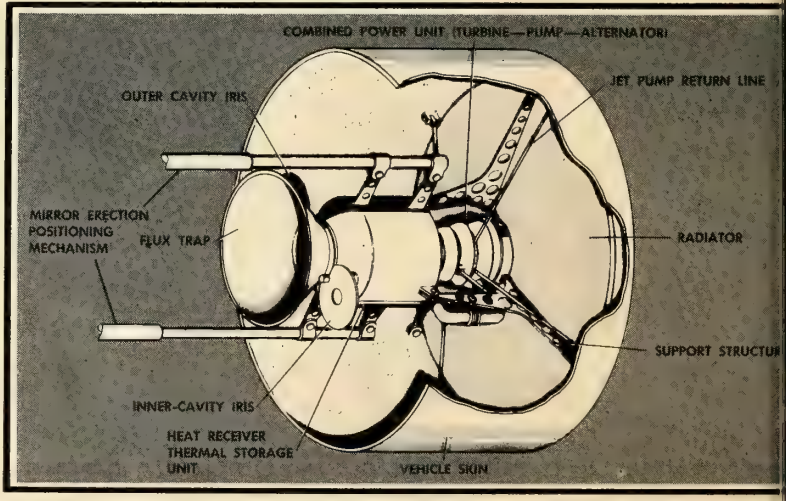
Use of solar energy in the past has been limited by the need for an efficient thermal storage unit. This problem also is being investigated by Sundstrand under a separate WADD contract. On the outcome of these investigations hangs much of the success of all similar power systems of the future, according to WADD.

• **40-ft. dish used**—As shown in the artist's conception, the power system when deployed will use a 40 ft. solar radiation concentrator. The big paraboloid, located between the satellite payload and the power unit, will be folded during transit and must be opened and oriented as soon as the orbit is established.

During deployment, the concentrator will be unfolded and the engine extended to a precise position for maximum operating efficiency.

Orientation of the concentrator and power package will be accomplished by a sun seeker, accurate to within 0.1 degree. Solar energy can then be directed by the concentrator to the power package for engine operation. A thermal storage unit in the power package will absorb sufficient solar energy to continue engine operation as the satellite passes through the shadow phase of its orbit.

A major unit in the system, the concentrator also is a major headache. Two mirrors are now being considered for use with Sundstrand's engine. Ryan is developing a deployable, rigid metal-leaf concentrator which uses lightweight aluminum construction. The second dish under consideration is a folded inflatable type, developed by Goodyear. At command, this package will be inflated in space and a para-



15-KW SOLAR ENGINE package will be extended from satellite and concentrator precisely erected for deployment in orbit. A sun-seeker will control orientation.

o Give 15 KW

boloidal portion rigidized by foaming. After rigidization, the unused portion of the balloon can be burned off.

Both types of concentrators show promise for this application. Each subcontract calls for delivery of 10-ft. models to the Air Force for exhaustive testing at the end of 6 months. The winner will continue development of the full-size dish.

Principal design problems to be faced in developing the big deployable mirrors are: 1) weight restrictions, 2) packaging, 3) deployment and space orientation, 4) maintaining accurate paraboloid after deployment, and 5) development of efficient reflective surface to withstand one year in space environment.

• **Solar flux trapped**—The power unit is a complex energy converter. Chief components of the engine are a cavity-type double boiler and flux trap, combined shaft unit and condenser-radiator. The flux trap and double boiler are both recent Sundstrand proprietary developments.

Serving as a kind of 1-way valve, the flux trap is the solar energy intake. The quantity of energy admitted into a specific size boiler opening can be increased by 20 to 25%, with a suitable flux trap. Size of the boiler opening is critical because of re-radiation losses. It's conceded that a larger opening would permit a greater amount of energy to enter the boiler; but it's noted that this would also allow an excessive amount of energy to escape. Thus, the more energy admitted through a minimum size boiler cavity opening, the greater the net gain.

Another advantage of the flux trap, Sundstrand believes, is realized in the geometric design tolerance of the concentrator. Fabrication cost of a concentrator increases rapidly with an increase in the required concentrator accuracy. The funnel effect of the trap diminishes this requirement.

In designing the double boiler, the primary aim is for high operating efficiency during collection of solar energy and optimum heat storage for use during the shadow phases of operation. Fabricated with an inner and outer cavity, the inner volume of the boiler is used for first-stage superheat and second- and third-stage reheat of the working fluid, rubidium. Sodium fluoride contained within the cavity provides for high-temperature heat storage.

The outer cavity, constructed around the inner cavity, is used as the initial boiler for the working fluid. Lithium hydride is contained within the outer cavity to provide for low-temperature heat storage. Through the proper arrangement and use of both inner and outer heat storage materials, a decided weight reduction of the system will be effected, company engineers say.

• **Superheated to 1750°**—Operation of the double boiler begins when solar energy, directed from the concentrator and flux trap, impinges against the walls of the inner and outer cavities. With the transfer of energy to the working fluid, its temperature is raised first to approximately 1200°F in the outer cavity and then to 1750°F in the inner cavity.

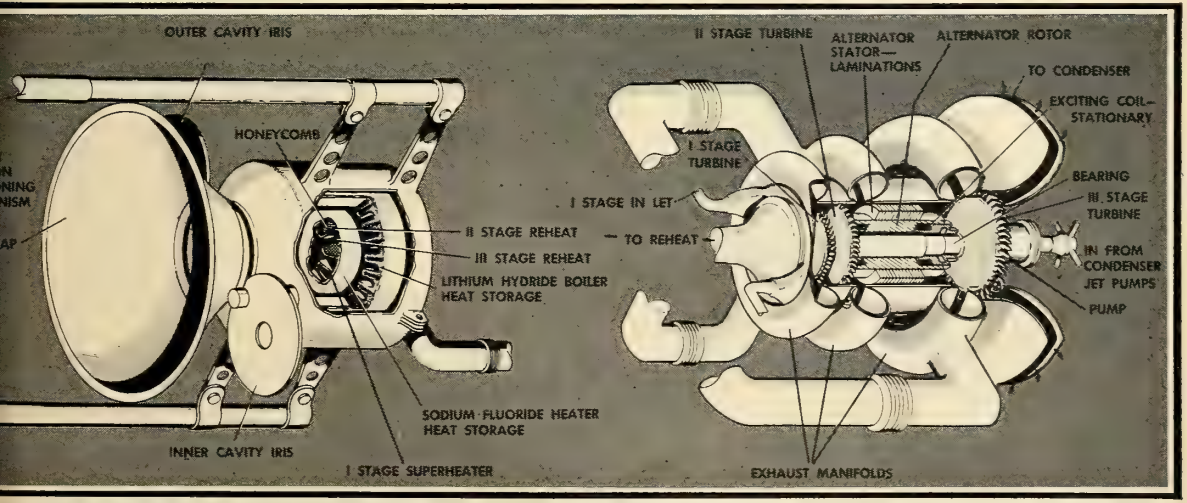
During the reheat cycles, the temperature is increased to 1600°F for the second-stage turbine and 1450°F for the third-stage turbine. These temperatures are maintained to prevent condensation of the working fluid during expansion and to assure efficient turbine operation.

During shadow-phase operation, the heat storage materials supply the energy required to maintain operating temperatures.

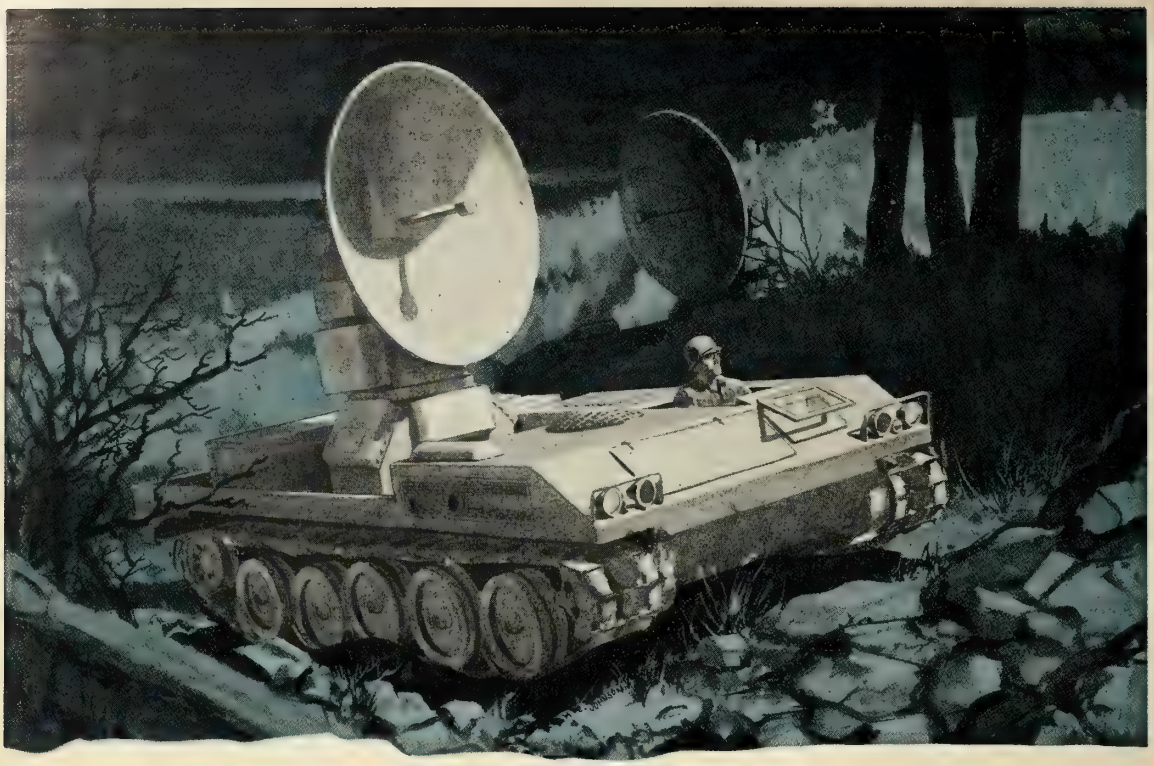
Solar flux directed to the boiler often may be greater than the energy needed to meet engine requirements. To control solar energy intake to the cavities, two irises are mounted between the flux trap and boiler—one independently operated iris for each cavity. This permits accurate temperature control of the working fluid and constant flow and pressure throughout the system. During shadow-phase operation, the irises are closed to prevent heat loss through the boiler opening.

Turbine configuration, said Sundstrand, must be well balanced and compact to enable one-year continuous operational life of the system. The turbine will be a three-stage, axial-flow, high-temperature unit.

For design simplicity, the first and second stages are mounted at one end of a common shaft, the generator is located between the second and third



MAJOR SUBSYSTEMS of Sundstrand's solar power unit: (Left) flux trap, heat absorber, and lithium-hydride thermal storage. (Right) the alternator and turbine assembly. Early design provided efficiency of about 21.7%; better performance is predicted.



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Illustrated below are the M-113 and five vehicle adaptations of this basic tracked vehicle. All of the vehicles use the same military standard equipment, including engines, power train, and suspension components; thus reducing the military logistic burden and R&D costs in weapons systems.





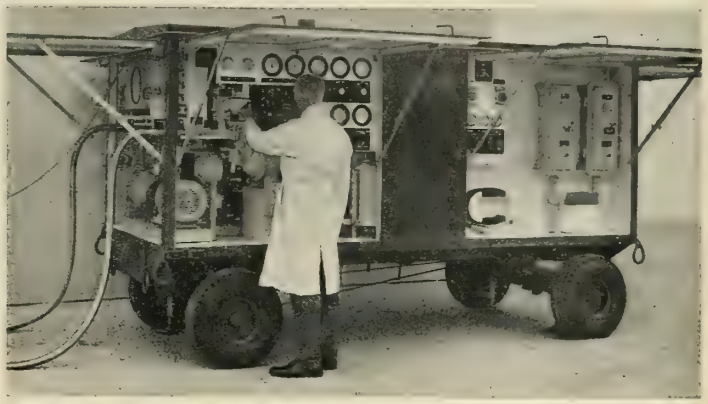








FMC's New Liquid Propellant Metering System Achieves Accuracy to ±0.1%



Mobile metering and control unit for fueling liquid propellant missiles.

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Food Machinery and Chemical Corporation's Ordnance Division has recently developed a mobile liquid propellant metering and handling system which promises to solve many missile fueling problems. The advantages offered by this unique new system are many.

Accurately measures and records the amount of fuel delivered to the missile tanks. Original specifications called for a metering accuracy of ±0.2%. Extensive tests, recorded by precision test equipment, show that the system is capable of metering and delivering missile propellants with far superior accuracy—to ±0.1%.

Automatically compensates for factors influencing fueling accuracy. The fuel is continuously sampled and the flow corrected for variations in temperature and density. In addition, the fuel which vaporizes in the missile tanks is returned to the system, condensed, measured, and an equivalent amount added by the metering unit.

Adaptable to many different missile fuels. The system is designed to handle such storable liquid propellants as hydrazine, nitrogen tetroxide, Dimazine® (UDMH) and nitric acid.

Economical to manufacture and safe to operate. To reduce development, manufacturing and operating costs, the system makes maximum use of standard, interchangeable, and commercially available components. The simple and safe design eliminates human errors and danger to operating personnel.

Mobile and compact. All metering, pumping and control equipment is mounted on a single, portable trailer. The complete unit may be easily transported, rapidly positioned, and provides a single station for the monitoring of fueling operations.

The successful development of this mobile metering and handling system by the engineering staff of FMC's Ordnance Division is another achievement made possible by utilizing the unique combination of chemical and mechanical engineering talent available at Food Machinery and Chemical Corporation.

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stages, and the centrifugal pump is located at the end of the shaft after the third-stage turbine. Pump location at this point on the shaft will benefit from the relatively low ambient temperature.

The complete rotating assembly of the combined shaft unit is mounted on two sleeve bearings, located outboard of the generator and inboard of the turbine wheels. This provides for an even load distribution on the bearings. Bearing lubrication as contemplated in the initial design will be accomplished by using the rubidium working fluid from the centrifugal pump.

Condenser-radiator location in the power package is just aft of the third-stage turbine. Attachment is directly to the turbine discharge ducting to permit immediate processing of the working fluid as it leaves the third-stage turbine.

Vanes between the side plates of the condenser will direct the working fluid toward the collection area at the outer periphery. This also provides the maximum heat radiation surface required for efficient condenser operation. The company believes that careful condenser design should eliminate intricate plumbing problems and weight associated with more conventional condenser construction. Four jet pumps, symmetrically positioned at the outer periphery of the condenser, will assist and direct the working fluid flow to the centrifugal pump. Jet pump operating fluid can be received from the generator cooling system.

Subcooled (675°F) working fluid from the condenser and jet pump will then be directed to the centrifugal pump which, in turn, supplies working fluid to the generator cooling system for bearing lubrication and to the boiler for system operation.

Generator cooling will be accomplished by directing coolant through channels in the housing around the electrical generator section. The coolant is then directed to the jet pumps and returned to the centrifugal pump.

• **Efficiency to be increased**—Alternator output at the nominal turbine speed of 24,000 rpm is 15.3 kw. This allows for 0.3 kw to be used for actuating flux-trap irises and control mechanisms in the power package. The alternator is a brushless, magnetic type unit with an all-metal rotor. Specifically designed by Jack & Heintz for high-temperature operation in a space environment, it employs ceramic insulation throughout.

In its earlier design state the solar engine efficiency was calculated to be approximately 21.7%. With recent state-of-the-art advancements such as the flux trap and double boiler, more efficient systems can be developed in the future, said Sundstrand.

• **Problems**—There are many problems to be surmounted in developing any solar thermomechanical space power system of this type. Foremost among these are the unknown properties of rubidium and the design and materials for the solar concentrators.

Rubidium, one of a family of alkali metals, has extremely desirable characteristics as a working fluid. Theoretically, a rubidium system can be built with an operating temperature approaching 1800°F at reasonable pressures.

But physical and chemical characteristics of the metal vapor are not fully known. For example, what will be its long-term effects on shaft bearings which depend on the fluid for lubrication? Also, what effect will it have on the alternator if leakage occurs?

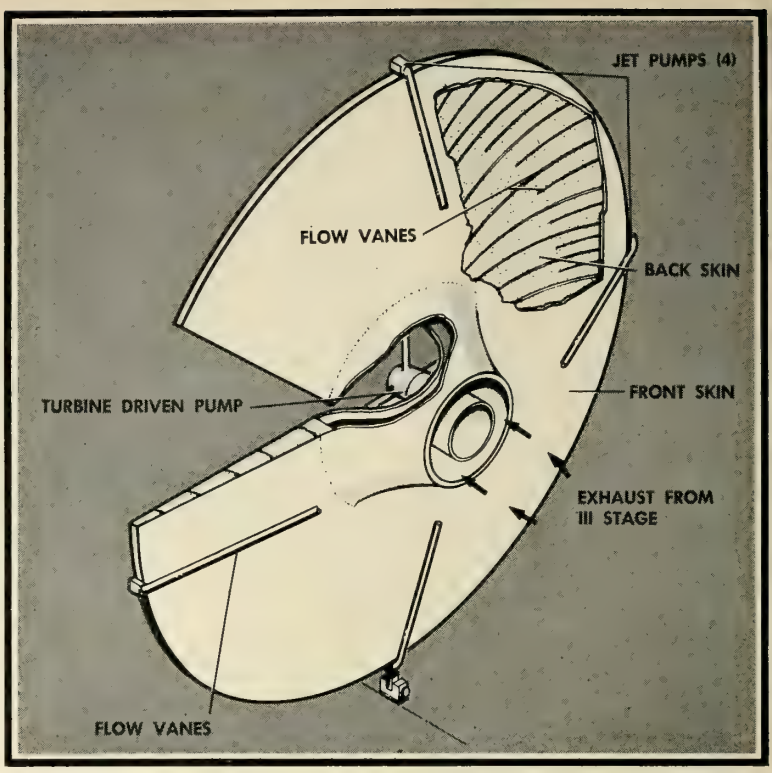
Concentrator development offers more unknowns. Meteorite puncture effects probably can be made negligible. But sublimation in a space environment could be disastrous. Precise orientation must be maintained.

How will these units be tested? We can go only so far in the laboratory, even with the environmental test facilities available to the Air Force. The only true test will be with a fullsize satellite system in orbit for one year.

Sundstrand, Electro-Optical Systems, and many others feel the solar mechanical power system approach will bear early fruit.

Nuclear proponents take issue with this hypothesis. They feel it will take five years just to develop a suitable turbogenerator for an operating system. Nuclear power systems will be flying before then, they say.

The consensus is that both types of space power systems are needed—and that the "who'll-be-first" attitude may best serve to spur more rapid development of each.



DISC-TYPE condensor-radiator assembly forms the aft section of the engine package (shown on p. 24), attached directly to the turbine discharge ducting.

Specifications For Sundstrand Solar Mechanical System

Electrical output:	15 kw
Total system weight:	819 lbs.
Working fluid:	rubidium
Boiling temperature:	1200°F
Superheat temperature:	1750°F
Condenser temperature:	675°F
Cycle efficiency (turbine shaft):	0.260
Over-all electrical efficiency:	0.217
Solar concentrator parameters:	
Diameter:	40.5 ft.
Mirror/boiler efficiency:	0.74
Total weight:	315 lbs.
Condenser disk diameter:	7 ft.
Turbine speed:	24,000 rpm

SOLAR POWER

(Continued from page 23)

is several times that of any other material which utilizes only solid-liquid phase changes. An appreciable volume change occurs upon freezing, which must be figured into the design.

• **Radiators mandatory**—The one large problem in the heat rejection process in space is the zero gravity condition. In addition, the rejection must take place entirely by radiation.

If the radiator is considered apart from the condenser, surface design problems relating to properties and meteorite puncture arise.

In the case of a direct condensation process where the condenser is an integral part of the radiator, induced centrifugal force and viscous drag have been considered as a means of insuring liquid delivery to the pump.

This also is desirable, he believes, from a thermodynamic standpoint since it enables the radiator to dissipate heat at the highest possible temperature consistent with given cycle fluid temperatures.

The disadvantage is that it may be subject to unstable and erratic flow. But this can be overcome by using a 1.5-loop condenser-radiator system in which the vapor from the turbine enters a mixing chamber where it is condensed by a stream of subcooled liquid. This provides a positive separation of condensate. Another possibility is a two loop system using a condenser-heat exchanger.

Satisfactory solutions to each of these appear to be forthcoming he said.

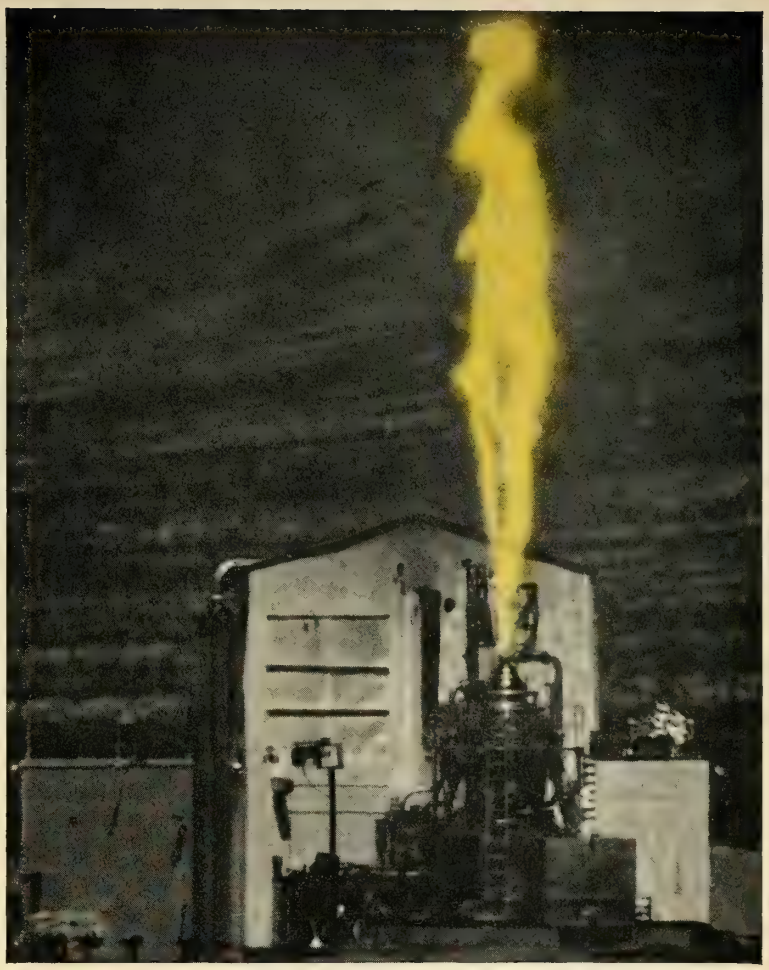
• **Remaining requirements**—The control system presents little or no difficulty since its functions can be accomplished with known techniques. Directional devices are another matter.

McClelland called for two types of orientation systems—a rough and a fine. The initial rough orientation must be capable of finding the sum even though there is complete misorientation during launch. A fine system is required to insure adequate performance throughout the life of the entire energy conversion apparatus.

The environment of space creates the usual materials problems. Plastics are subject to radiation and may sublime in the hard vacuum. Inflated structures face a very short life because of meteorite puncture.

According to McClelland, there are many problems yet to be solved before a reliable solar mechanical system will fly. But the order of difficulty seems no greater and possibly less than other proposed popular conversion schemes.

Systems under development today and those of the near future should provide the answers.



Space Propulsion for the future . . .

from the KIWI family of Nuclear Reactors



Los Alamos Scientific Laboratory has the major responsibility for research, development and testing in the AEC-NASA Rover program . . . another of the many investigations at Los Alamos into peacetime uses of nuclear energy.

PHOTO: First field test of a KIWI nuclear propulsion reactor.

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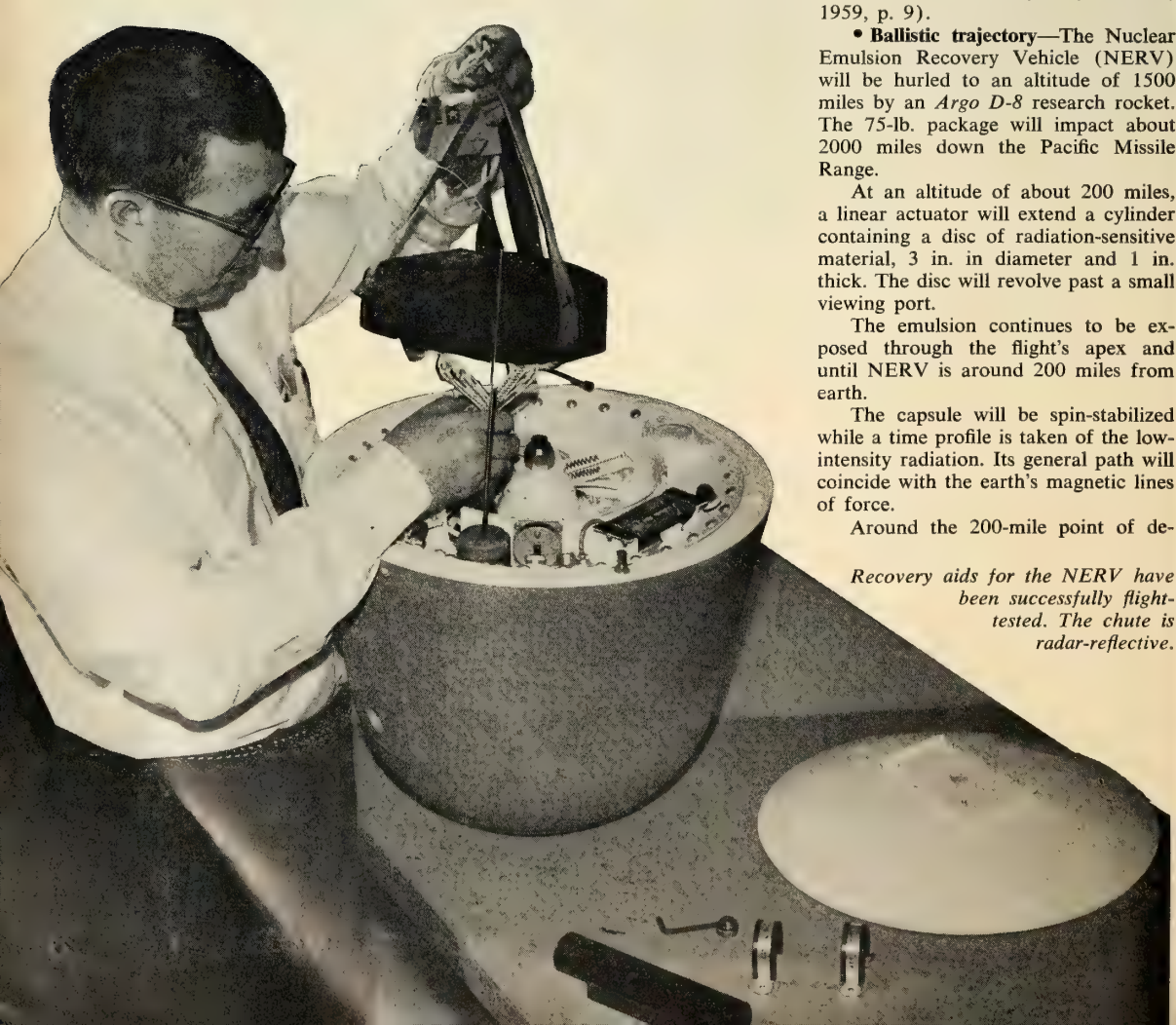
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Lower Van Allen Belt To be Examined by NERV

Low-intensity radiation will cut trace on sensitive disc; man-in-space program is expected to benefit; payload is unique

by John F. Judge



Recovery aids for the NERV have been successfully flight-tested. The chute is radar-reflective.

THE WORLD'S highest-flying recoverable payload is expected to be launched from the Pacific Missile Range sometime next month by the National Aeronautics and Space Administration.

Designed to measure low-level radiation intensity in the lower Van Allen Belt, the probe has the unique ability to expose its payload to the surrounding space environment 1500 miles out —and then return it safely to earth.

Once beyond the atmosphere, the vehicle will telescope a 21-layer nuclear emulsion. Ionization particles in the 10-to-150-Mev range will cut a trace or this emulsion. These particles cannot be suitably measured by a Geiger counter. The need to analyze the emulsion after the flight precludes the possibility of telemetering the radiation data.

The information gleaned from the experiment will be added to that collected by past probes and satellites.

In August, 1959, NASA awarded a $560,000 contract to General Electric's Missile and Space Vehicle Department for four recovery vehicles designed to house the emulsion (M/R, Nov. 9, 1959, p. 9).

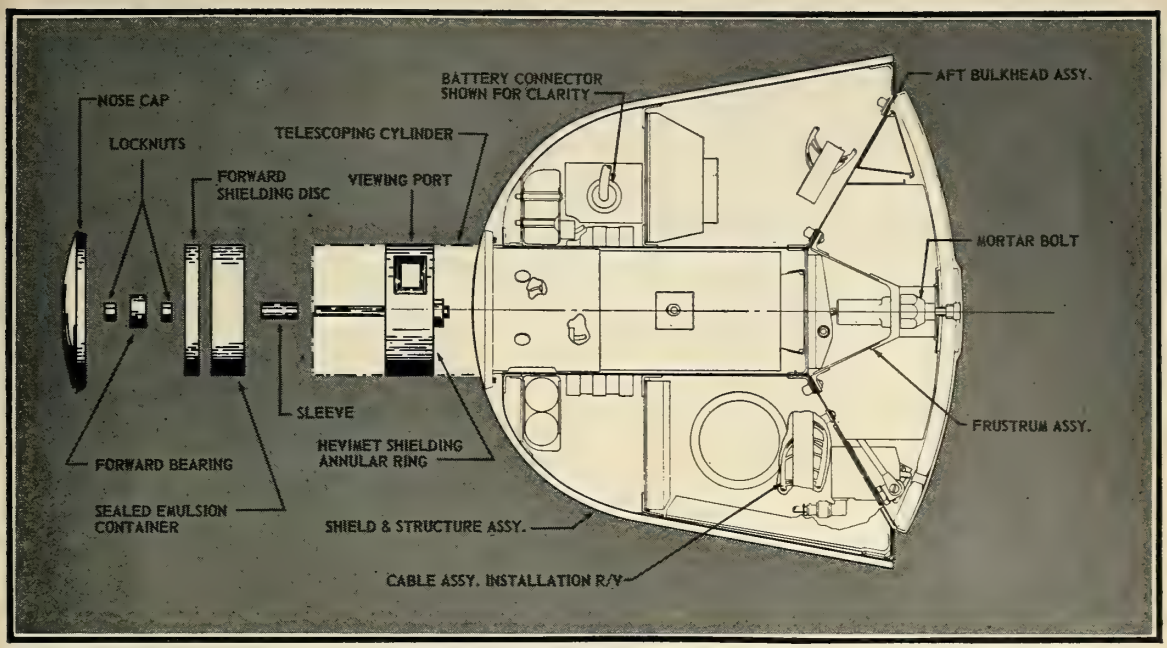
• **Ballistic trajectory**—The Nuclear Emulsion Recovery Vehicle (NERV) will be hurled to an altitude of 1500 miles by an *Argo D-8* research rocket. The 75-lb. package will impact about 2000 miles down the Pacific Missile Range.

At an altitude of about 200 miles, a linear actuator will extend a cylinder containing a disc of radiation-sensitive material, 3 in. in diameter and 1 in. thick. The disc will revolve past a small viewing port.

The emulsion continues to be exposed through the flight's apex and until NERV is around 200 miles from earth.

The capsule will be spin-stabilized while a time profile is taken of the low-intensity radiation. Its general path will coincide with the earth's magnetic lines of force.

Around the 200-mile point of de-



EXPLODED VIEW of the removable telescopic cylinder containing the emulsion. Package is heavily shielded, except for small view port which allows particles to enter and strike revolving emulsion. Re-entry protection was not described.

scent, the emulsion will be retracted for protection during re-entry. Just prior to re-entry, the vehicle's spin will be decreased so that the nose enters first. This will be accomplished by a set of weights on 9-ft. cords.

The Navy will pick up the package from the water. Because the emulsion would be damaged if exposed to the sea, the vehicle is waterproof.

• **A grain of sand**—The possible number of impact points covers a vast area of the Pacific. In view of this, a variety of location aids have been built into the vehicle and its launcher.

Just prior to lift-off, a radar tracking beacon in the fourth stage of the rocket will be activated. This is designed to provide a fairly accurate point-of-impact prediction.

At the 40,000-ft. descent mark a parachute will be deployed and a considerable amount of radar chaff will be ejected. The alternate gores of the chute will be radar-reflective. A high-intensity strobe light will be activated simultaneously with a radio beacon.

After water impact a fluorescein marker dissolves to further aid the searchers.

• **Recovery system checkout**—A successful water drop test was performed at Eglin Air Force Base, Fla., last December. In another test, an Air Force F-104 Starfighter dropped the package from an altitude of seven miles. The parachute retardation, programing and recovery aids all operated as planned. The probe contained the emulsion, but it was not extended during the drop and the water impact did not damage it.

The information from NERV should help determine the design factors involved in protecting man from radiation in deep space flights. In addition, it is anticipated that the emulsion will give a complete radiation profile, showing intensity versus altitude and the type of radiation.

General Electric says that later flights may use the *Scout* rocket. The presence of a guidance system would expedite recovery and the increased payload capacity of the *Scout* would be an added advantage.

The possible applications of the NERV telescopic system extend beyond the emulsion experiment. Such a vehicle would be ideal for sampling the atmospheres of planets. There is also the possibility of environmental tests in the hard vacuum of space. Material samples could be exposed under specified conditions in deep space and then brought back to earth for examination.



NERV with extended cylinder.

Blast Wave Simulations Reach A-Bomb Proportions

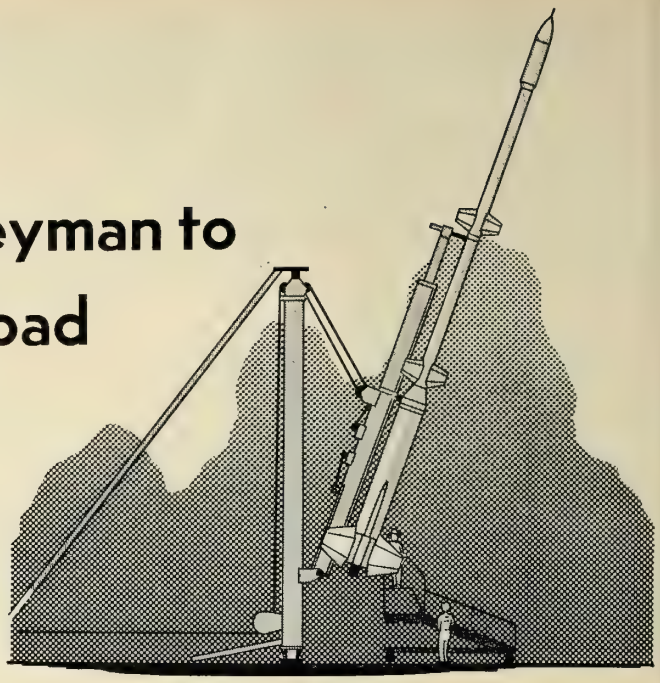
High-explosive blast waves similar to those generated by the Atomic bomb at Hiroshima may be produced under controlled laboratory conditions with relatively small charges.

The effect is the result of detonating a small charge in the apex of a conical tube. Scientists at the Naval Ordnance Laboratory, Silver Spring, Md., have found that the blast wave from such a device represents a sector of a spherical shock-wave generated by a much larger charge fired outdoors.

An amplification factor is used to determine the size of the charge required to simulate an open air blast. This is figured as the ratio between the solid angle of a sphere to that of the solid angle of the cone. The factor can, in theory, be increased to 160,000 to 1 by using a cone of 0.5°. Heat and friction loss will reduce the efficiency.

A-bomb simulation would require a cone 2000 ft. long with an angle of 0.5° and, because of an expected 35% efficiency, a 1000-lb. charge of T.N.T.

Four-stage Journeyman to Carry NERV Payload



Artist's drawing shows Journeyman being erected for launching

THE NERV PAYLOAD will be propelled by the *Journeyman*, a new four-stage sounding rocket developed by Aerolab Development Co., a subsidiary of Ryan Aeronautical. Aerolab calls the rocket *Argo D-8*.

First stage of the vehicle is a cluster of a Thiokol *Sergeant* and two auxiliary *Recruits*. Second and third stages are Grand Central *Lance* rockets. The final stage is the Hercules Powder Co.-Allegany Ballistics Laboratory *Altair*.

The *Journeyman* is capable of lifting a 60-lb. package to an altitude of 2100 miles, or a 120-lb. package to 1500 miles. The September firing will be the first for *Journeyman*.

The first-stage engine is the XM-20, used in the earliest model of the *Sergeant* missile. Although its exact specifications are classified, the thrust and burning time are known to be in the neighborhood of 45,000 lbs. and 25 seconds. Each of the *Recruits* generates about 35,000 lbs. for 1.5 second, giving the vehicle total takeoff thrust of 115,000 lbs.

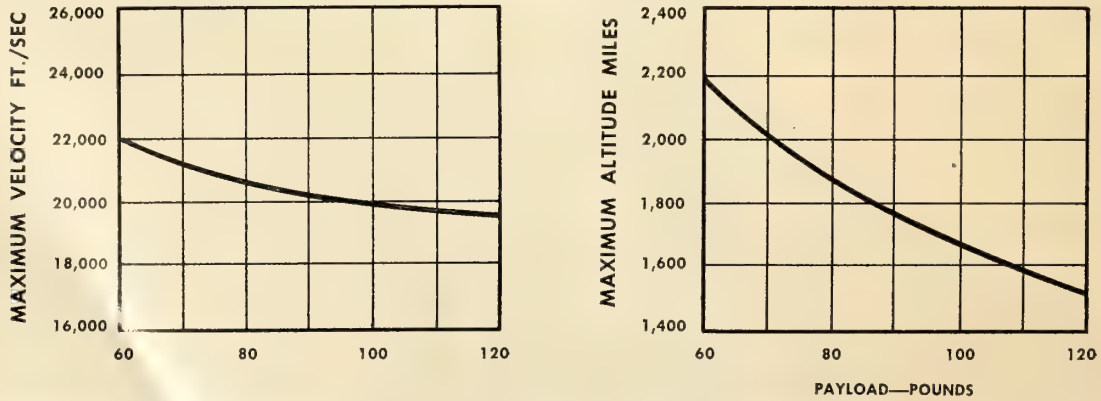
The second and third-stage *Lance* generates 38,800 lbs. thrust for 6.65 seconds plus a 1.35-second tailoff. It weighs 1682 lbs. loaded and 490 lbs. empty.

The *Altair*, also known as *X248*, generates vacuum thrust of 3060 lbs. for 38 seconds.

The vehicle stands 62 ft. high and weighs 13,932 lbs., exclusive of payload. Maximum acceleration occurs at third-stage burnout. With a 60-lb. payload, the maximum is 41 g's. The time from burnout to splash is 41 minutes.

The first launching next month will be from the Pt. Arguello, Calif., launching site on the Pacific Missile Range. The vehicle will travel south along the lines of force of the earth's magnetic field.

Navy ships will attempt recovery of the payload after re-entry is accomplished with the help of a parachute. Impact point will be calculated from the ballistic trajectory. Recovery is necessary because emulsion information is not telemetered.



CHARTS SHOW CAPABILITY of Journeyman's combination powerplant. It can push a 60-lb. payload to about 22,000 ft./sec., or a 120-lb. load to approximately 19,500 ft./sec.; take 60 lbs. to an altitude of 2100 mi., 120 lbs. to 1500 mi.

Turbopump Key to New X-15 Engine

Unit insures controllability and adequate fuel flow for Thiokol's XLR99 powerplant; turbine overhangs shaft

by William Beller

Key component in the rocket engine that will attempt to push the *X-15* spacecraft to 4000 mph late this fall is the turbopump.

This device accounts for the most significant flight feature of the 50,000-pound-thrust engine, its controllability.

The turbopump also satisfies the engine's enormous appetite for propellants—a ton of liquids a minute.

This controllable rocket engine is the XLR99, developed by Thiokol's Reaction Motors Division. The XLR99 is the only high-thrust engine in America designed and test-proven for manned space vehicles.

The engine comprises a turbopump, thrust chamber, gas generator, valves and an electrical control system, all compactly grouped. The overall package measures about 80 in. long, 40 in. in diameter.

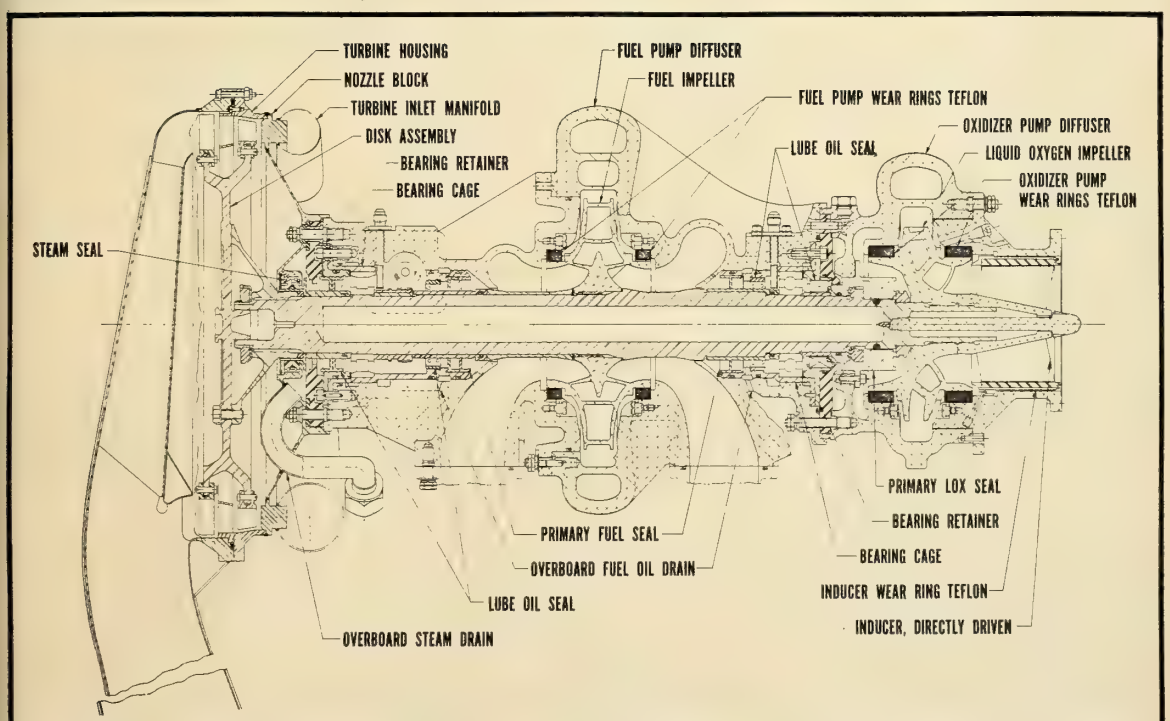
The turbopump is directly driven by a decomposed hydrogen-peroxide-powered turbine overhanging one end of a shaft. At the other end is a single-entry oxidizer pump. Midway along the shaft is a double-entry fuel pump.

The liquid propellants are fed from low-pressure, lightweight tanks through the turbopump into a regeneratively cooled thrust chamber and injector. The fuel used is anhydrous liquid ammonia, temperature –50° to –28°F. The oxidizer is liquid oxygen at –316° to –275°F. The monopropellant for the pump drive is 90% hydrogen peroxide, temperature 50° to 120°F.

Last June, an XLR99 was installed in an *X-15* when a hydrogen peroxide tank blew up during engine tests, severely damaging the craft. Probable cause was said to be a fuel leak or spark. Another XLR99 was subsequently flight-rated and delivered to NASA and the Air Force.

• **Engine characteristics**—During flight, the engine is under full control of the astronaut. He can throttle it to as low as 50% of full thrust, shut it down, restart it, and build the thrust back up to full value.

The thrust is controlled by altering the turbopump's speed, thereby affecting the propellant flow to the thrust chamber. The turbopump's speed is changed by means of a throttling valve upstream of a catalytic bed. Hydrogen peroxide passes over this bed and is



CROSS-SECTION OF TURBOPUMP for 50,000-lb. variable thrust rocket engine shows steam-driven turbine overhung on left end, double-entry fuel pump for anhydrous liquid ammonia at mid-shaft, and inducer and LOX pump at right end.

hangover benefits . . .

decomposed before entering the turbine, which drives the turbopump. Thus, a control linked to the valve is all that is needed to vary the engine's output.

Describing the design features of the turbopump to an American Rocket Society audience recently, RMD engineer Stephen R. Matos said the device can accept most propellant combinations safely. Thus it can be used on many engine systems and needs "no basic design changes or redevelopment" for such installations.

• **Clearance of parts**—One design problem was to prevent metallic contact between the aluminum oxidizer impeller and its magnesium casing over a wide temperature range. The solution, which was also dictated by safety considerations, was to provide generous axial clearances between the impeller and casing.

Wherever small radial clearances between a rotating and a stationary member were needed, a plastic shroud and wear ring were used. Matos cited this solution as a RMD design concept and development.

An example of its use is seen at the junction of the inducer shroud and the impeller wear ring. Here the running radial clearances vary from 0.001 in. to 0.004 in. and, although rubbing contact has been experienced, Matos reported that "there has never been a turbopump malfunction from this cause."

• **Turbine characteristics**—The turbine wheel is a single-disc, two-row impulse type. The cast blades are mechanically attached to the disc by pins. A lightweight, high-strength disc is achieved through using the relatively new Udimet 500 material.

Placing the turbine in the middle of the shaft was discarded early because of the problems of thermal stresses and expansions, pressure deflections, bearing failures, and hazardous rubbing conditions where axial clearances are critical.

Therefore, the disc was overhung at the shaft's end. It is stabilized by a supporting cone, another RMD development.

Many advantages accrue. Because the disc has no center hole, the stress distributions are uniform. Seals and bearings are accessible from the turbine end, thereby considerably easing the problem of inspection and parts replacement. Even under extreme conditions of turbine operation, the disc stays centered with respect to the shaft.

A safety feature is the liberal clearance between the turbine wheel and its housing.

• **Pump characteristics**—The oxidizer pump is a conventionally designed single-entry centrifugal impeller. It operates in conjunction with a direct-driven inducer. The inducer operates at a suction specific speed of 40,000 at a relatively low pump inlet pressure of below 50 psi.

The fuel pump, also of conventional design, is a single-stage double-suction centrifugal device with a volute casing. This case is made of magnesium alloy; the centrifugal impeller is an aluminum casting.

• **Bearings and lubrication**—Bearings used are stainless steel 440-c ball and roller types. Matos said that the radial clearance of the ball bearing is greater than standard to allow for differential expansions of the races at liquid oxygen temperatures.

A positive displacement pump provides recirculating oil at 40 psig to each of the bearings, which run flooded. Cooling is not needed because the heat is drained off into the turbopump casing.

At standby ready periods the displacement pump and pump lines stay at a primed condition so that the pilot can get an immediate reaction from his powerplant. At these times heat is added to the lubrication system. For this reason, even at idle, the oil pressure is never below 7 psig. This sustaining pressure also eliminates boiloff of the oil even at extreme altitude.

The XLR99's turbopump has already attained an enviable performance record. It has experienced without malfunction or safety infringement more than 38 hours' running time in 4100 test runs. These have been made on a total of only 25 assemblies.

What is most striking is that in the entire development program, the XLR99 engine, including its turbopump, experienced only one design cycle. After this, nothing was altered in the engine. In effect, the testing program became one of confirming standards of design performance, reliability and safety.

This development cycle contrasts sharply with the one of design, re-evaluation and re-design, characteristic of most turborocket programs.

Low-cost Rocket Designed

Rocketdyne Division, North American Aviation, has entered the weather sounding rocket market with a low-cost solid capable of propelling a 6-lb. payload to 230,000 ft.

Rocketdyne's Solid Propulsion Operations at McGregor, Tex., reported this week it has designed a 73-lb. rocket with 44 lbs. of ammonium nitrate propellant that would produce 660 lbs. of thrust for 12.7 seconds.

Outside diameter would be 4.125 in. Total length with payload would be 105 in. The star-shaped grain was designed to burn progressively—so as to provide low acceleration through the dense portions of the atmosphere.

The rocket would be shipped in a reinforced plastic shipping container that would serve also as a launching tube. The tube and rocket could be loaded into a standard 5-in. gun for firing, or one person could set it up and fire it directly from its shipping container, Rocketdyne said. Four 18-in. folding fins would fall into place to stabilize the rocket on leaving the tube.

The payload would be separated by use of a two-position latch unlocked by acceleration, followed by a spring action at 28,000 ft., at the end of the boost phase. Acceleration would rise from 6 g's at launch to a peak of 29.4 g's at burnout.

The extruded propellant, designated RDS-127A, has a specific impulse of 181 seconds (sea level, 1000 psia). The rocket case of mild steel and the cast nozzle weigh 22.46 lbs. The head closure is a metal stamping riveted with 10-1/8-in. rivets. Pyrotechnic pellets are used for ignition.

Rocketdyne gave these other data:

Performance

Acceleration, g's	
30 milsec after ignition	120
At burnout	29.4
Max. Chamber pressure, psia	800
Average thrust, lbs.:	660
Duration, sec.:	12.7
Total impulse, lb.-sec., 70° F.	7800
Nozzle throat area, sq. in.:	0.85
Nozzle expansion ratio	5
Flame temp, F	2340°
Payload velocity at burnout, ft./sec.:	4600

Dimensions, in.

Case diameter	4.125
Payload diameter	3
Propellant length	82
Propulsion system length	87.25
Total rocket length	104.75
Fin span	18.75
Fin length	10
Fin width	1.5

Weight, lbs.

Case and hardware	22.46
Propellant	43.00
Restrictor	1.54
Payload	6
Total initial	73

Continuous Mix Slashes Labor Costs

Aerojet uses Baker Perkins Ko-Kneader to cut Polaris propellant production force, enhance safety

The continuous mix method of producing *Polaris* propellant has reduced labor costs from 18 to 3 cents a pound, Dr. Karl Klager of Aerojet-General declared last week.

Klager, who heads the company's Propellant Development Division at Sacramento, said the unit cost can be reduced further with higher output.

Aerojet uses a Ko-Kneader machine manufactured by Baker Perkins Inc. of Saginaw, Mich. The machine confines mixing to a maximum of 20 to 25 lbs. of propellant at any one time in a 5-in.-diameter metal cylinder. Under the previous batch-mixing process, 2200 lbs. of propellant were mixed at a time.

The machine mixes material with an interrupted screw through the water-jacketed barrel at 5000 cps viscosity. Temperature is controlled at 80°F. The pasty mixture then passes four stream analyzers that check the quality of the mix.

Aerojet and Baker Perkins said the process produces a higher-grade product with greater safety and reduces the labor force required from 28 to five men. The process also has a shorter "down time" for maintenance. A Ko-Kneader mixing screw and barrel can be replaced in a day or so while a batch mixer requires a week for dismantling and reassembly, Baker Perkins said.

The machine shifts propellant manufacture from a slow, stop-and-go procedure to a closely controlled, continuous stream-flow operation, as in liquid or gas processing, Baker Perkins said. Volume of output can be increased in a ratio of three-to-one over the previous method. The Navy said the process is the "first large-scale application of the continuous mixing process."

An additional safety feature is the fact that material is retained in a continuous mixer for a matter of minutes, rather than the hours required in a batch mixer. Critical areas in the system are under constant observation by closed-circuit television.

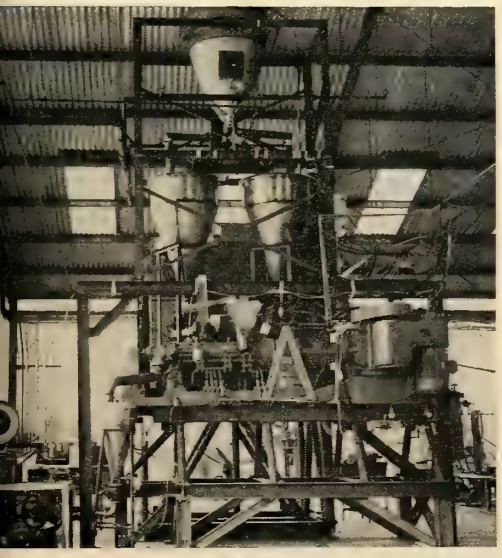
Aerojet propellant engineers calculated that the facility cost for a new continuous installation will be the same or less than that for batch processing at production rates over 500,000 lbs. per month. Operating costs for maintenance and labor are less for continuous mixing at rates exceeding 250,000 lbs. per month.

Several propellant manufacturers are developing continuous mixing processes.

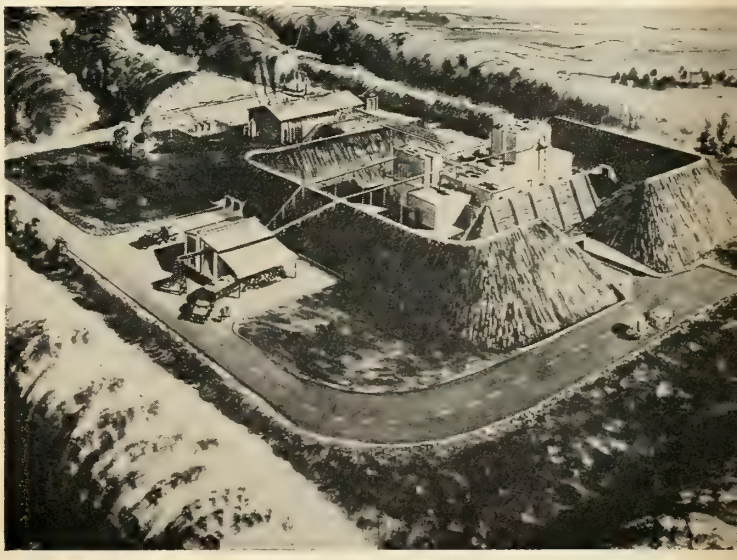
In addition to Aerojet, Thiokol has a plant in development at the Army's Longhorn Ordnance Works, Marshall, Tex., and Rocketdyne is at work on another at an Air Force-owned plant it operates at McGregor, Tex.

The Thiokol process is reported to be under evaluation as a method of producing motors for the Army's *Pershing* Medium Range Ballistic Missile. Rocketdyne's system, based on its high-velocity QuickMix, may be combined with electronic data equipment for completely automated control.

All of the competing processes greatly reduce production costs and improve uniformity of the product.



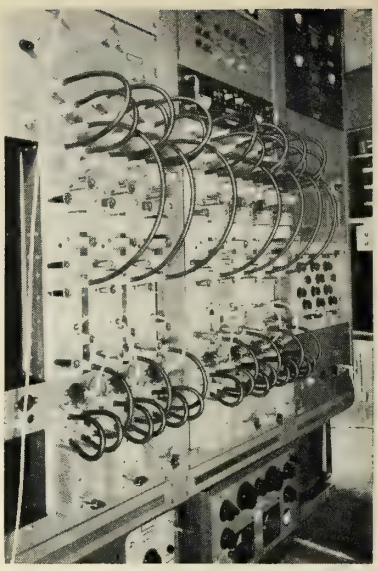
PILOT PLANT was developed in 40 weeks. Horizontal shape (above platform) is "barrel" of Baker Perkins Ko-Kneader.



ARTIST'S CONCEPTION of Aerojet-General's new continuous mix facility, activated for manufacturing Polaris fuel.



UNIQUE SYSTEM using seven 5-element Yagi antennas in conjunction with an electronic scanning device will be employed soon by NBS to observe ionosphere.



ON TRAILER near Yagi array is system's electronic rapid scanning device.

electronics

NBS Antennas Scan Electronically

New array will soon be used at Boulder Labs to study ionospheric phenomena; high resolution promises many other uses

A new unique electronic-scanning antenna array, says the National Bureau of Standards, will be an invaluable research tool in communications and meteorology.

Developed by the Bureau's Boulder Laboratories, near Denver, the high-resolution VHF receiving antenna system employs a narrow beam which sweeps rapidly over a 42° azimuthal arc. The continuous sweep is handled purely by electronic phasing control, says NBS—no mechanically moved parts are used.

• **Elements to be increased**—The array consists of seven 5-element Yagi antennas. These are optimized for a 30-db max. front-to-back ratio. (Side lobes are limited to below –20 db by using Dolph-Chebyshev distribution.)

Full sweep and return, at 1 mc with a 5.8° beam, takes 0.1 second. Since phase shift is changed rapidly, the main lobes rotate uniformly like fan blades and also move through the scanned sector one after another.

An oscilloscope, synchronized to an incoming signal, permits visual readout. Each 5° in azimuth is represented by 1 centimeter on the scope viewer.

To obtain a 1.5° beam width, NBS is now increasing the Yagi elements to 25 each.

• **Broad use seen**—The scanning array will be used primarily to study various ionospheric phenomena, said a Boulder scientist.

Particularly useful in support of ionospheric-scatter communication links, it can be used to pinpoint the direction of the transmitted scatter signal—a feat heretofore impossible. It will also be very useful in determining the best paths for the link.

In this type of VHF radio propagation, the transmitted energy is returned to earth via some combination of reflection and refraction from the relatively dense concentrations of electrons in the lower ionosphere. These scattered signals are weak and may arrive at the receiver site from any number of directions. This, plus the problem of multipath, makes it very difficult to finitely determine the precise direction of transmission.

Many thousands of miles of military scatter circuits have been installed during the last few years because their resistance to polar-blackout fading and other natural degrading influences permits an unusually high reliability.

With this array it would be practical to obtain instantly bearings of ionized meteor trails. The principle, said NBS, is applicable to a design of an antenna array for riometers used in cosmic noise research.

With some modification, the system could be used for multi-directional transmitting and receiving—its chief advantage being the small space requirements for the Yagis. And the high-resolution characteristic of the array offers high potential for many other uses.

OpDevFor Has Make-or-Break Power

by Donald E. Perry

NORFOLK—A severe shortage of test platforms—surface ships, aircraft and submarines—is delaying test and evaluation of many promising Navy R&D programs, particularly in ASW, from six months to more than a year.

This is the word from Headquarters, Command Operational Test and Evaluation Force here, the Navy's consumer research organization.

Industry and national defense are suffering because the work of this important Naval command has been stifled; only through OpDevFor can equipment deficiencies be corrected early, to avoid costly rejections, and only with its go-ahead can volume production be initiated.

Furthermore, this serious lack of tools to do the test and evaluation job is being aggravated by industry itself, the Navy says, in two important areas:

1. Time schedule requests for platform availability are frequently unrealistic because they are based on the assumption that there will be some engineering breakthrough in the state of the art of a program or an equipment.

2. Engineers fail to design for a Navy environment—with the average sailor in mind.

• **Power to make or break**—Oddly, there are many in industry who are unaware of ComOpDevFor's role in the Navy's mammoth management cycle for weapons development—even though the command's decisions usually make or break many industrial plans for going into production. Technically, it does not have the final decision on production; the Chief of Naval Operations can reverse a decision. But there are few such reversals on record.

In simple terms, ComOpDevFor is the organization which receives all Navy products of research and development, tests them in their operational environment and recommends that they be accepted for service use—so that largescale production and installation can be initiated. As such it represents the consumer—the Navy. It is not a development organization, but a partner in development.

Its officers and men are not technical or scientific people; they are experienced fleet-operating personnel. Its mission—and heaven help the company which doesn't realize it—is to insure that equipment, components, systems and weapons can be operated and maintained by the men and officers of the fleet.

"Too many in industry design equipment for the Navy which would take a scientist or a very skilled technician to operate and maintain it," says Capt. C. Blenman, chief of staff.

Capt. Blenman and others in the command feel strongly that simplification in design is too often neglected. Simplification is wanted for several reasons. Navy equipment, probably more than that of the other services, has to be quickly trouble-shooted. This means immediate checkout to locate faults; it's highly desirable that equipment be supplied in modules so that it can be replaced quickly.

• **Demand for technicians**—Most of all, the Navy has a personnel problem. Good technicians are hard to come by; the Navy doesn't have, and possibly never will have, enough of these specialists.

"Industry can help immensely if it realizes that its equipment must be (built) so the average technician and officer can operate it, trouble-shoot it, and maintain it," Captain Blenman says. He adds that industry is doing a commendable job in simulating the operational environment, but he cautions that "it would be good if the design engineer got some field engineering experience."

Navy has programs now to give its Civil Service laboratory and bureau design engineers this experience. There are a number of billets for them to ride ships and aircraft to give them a feel for the operational environment. However, the same can't be done for industry: the Navy feels that one firm would get an advantage over another if representatives observed different types of equipment, whose data must be privileged information. Industry's only recourse is to proselyte the experienced field technicians of Navy bureaus and labs—often by offering them bigger salaries.

ComOpDevFor is a four-pronged service organization. It's concerned with these areas:

1. Antisubmarine warfare (which absorbs 33% of its projects work and about 50% of its time) and manpower services.

2. Surface warfare.

3. Air warfare not applicable to ASW.

4. Combat direction systems (radar, CIC's, etc.).

• **How it evolved**—Rear Adm. William D. Irvin, ComOpDevFor, who probably will add another star soon with his new assignment as Chief of the Defense Communication Agency, explains that the Navy arrived at its present structure for the evaluation process by evolutionary movement.

During the last war the Navy was forced to mass-produce in step with development—a costly practice. It was also forced to develop tactics for utilization of new gear after it was in the hands of the user. Often, there were dire consequences.

In 1945, as the war was ending, the Navy organized a composite task force to develop methods of combatting the devastating Japanese Kamakazi. When the war ended it grew logically into a new organization—the Operational Development Force.

In May, 1959, almost concurrently with establishment of the Deputy Chief of Naval Operations (Development), the present Operational Test and Evaluation Force was erected from the structure of its predecessor.

• **Far-flung operations**—The force is made up of various types of operational ships and aircraft, assigned to and working under operational detachments. The latter are located geographically in areas best suited for their specialties.

Directing headquarters are on the Naval Base here. At San Diego, there's a headquarters staff division responsible for all test and evaluation activity in the Pacific Fleet. This organization also serves as an operational detachment for ASW project work carried out by Pacific Fleet ships. Four ships are under continuous command of this detachment; additional fleet ships are assigned on a temporary basis as the project load varies.

At New London, Conn., OpDevFor maintains a detachment in headquarters of the Underwater Sound Lab. This detachment, with five ships of destroyer and smaller types, gives fleet services to sound laboratories in the Middle Atlantic and New England states. Secondarily, it assists the bureaus in technical evaluation work in

(Continued on page 42)

Satellite Communication Demonstrated

Bell conducts successful moon-relayed voice conversation with JPL in California; advances proven

by Hal Gettings

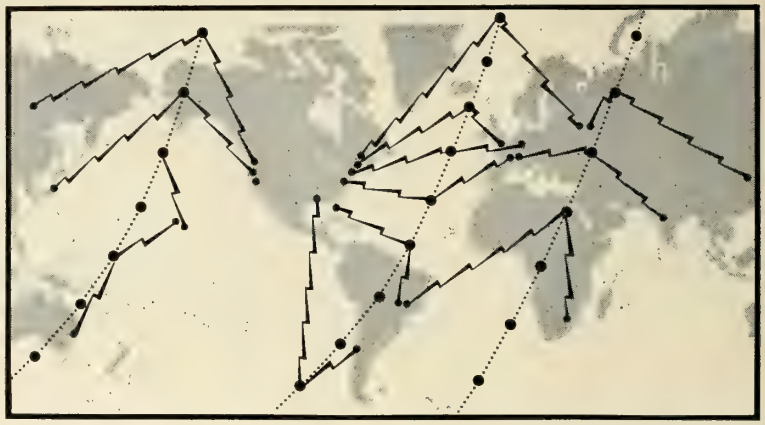
HOLMDEL, N.J.—A new era in commercial communications was foreshadowed here last week when Bell Telephone Laboratories successfully demonstrated the progress it has made on a communication satellite system.

Using the moon as a relay point, Bell engineers carried on a transcontinental two-way voice conversation with Jet Propulsion Laboratory in Goldstone, Calif. An operational system would use artificial satellites—either active or passive—as a relay link.

Equipment used in the initial demonstration was basic, but represented advances made very recently. Transmissions from Holmdel were made using a conventional 60-ft. parabolic antenna at a frequency of 960 mc. JPL transmitted on 2390 mc and used two 85-ft. antennas. The reciving antenna at Holmdel was BTL's recently developed parabolic horn (M/R, 4/11/60).

For the demonstration, the antennas tracked automatically by means of a programed tape. Antenna positions were corrected at one-minute intervals to keep them aimed at the moon. Tracking can also be accomplished by slaving the antennas to a radar or to a telescopic sight.

The high-sensitivity receiving equipment used represented three major advances in low-noise techniques.



GLOBAL NETWORK proposed by Bell would use 50 satellites in random orbits. It could be employed for world-wide commercial and military communications and TV.



HOLMDEL TRANSMITS signals with 60-ft. parabolic dish antenna. Horn antenna (right) is part of low-noise receiving system. Signals received by horn are amplified by ruby-maser amplifier located in cab at apex of horn.

The movable horn-reflector antenna —50 ft. long with a 20 x 20 foot opening—is the largest yet built. Side and back-lobe rejection is extremely high, resulting in minimum pickup of earth noise. Noise temperature of the antenna—when pointed above ten degrees in elevation—is in the neighborhood of 2°K. Comparable conventional systems have a noise temperature of around 1000°K.

A synthetic-ruby maser amplifier is used in the receiving system to further enhance its sensitivity. Noise generated by the maser is approximately one-hundredth that of ordinary electron-tube amplifiers.

Another improvement is a special demodulation circuit developed for space communications. This is an FM feedback loop in the receiver circuitry which gives a hundred-fold increase in signal-to-noise ratio.

Overall noise temperature of the complete receiving system is about 20°K—many times more sensitive than any ordinary system.

• **Large investment**—Bell has already invested over a half million dollars in its satellite communication system. Its research is aimed at establishing a global communication network with 50 relay satellites in random orbits at 3000-mile altitude. The satellites would serve as microwave relays to carry TV signals and hundreds of telephone calls around the earth. Facsimile mail and other services not yet foreseen

might also conceivably be handled by such a system.

Based on present trends, Bell anticipates that present communication facilities will soon be woefully inadequate. Overseas telephone calls—which totaled 3,000,000 in 1959—are expected to reach 100,000,000 by 1980. Such an increase would require 50 undersea cables across the Atlantic.

Worldwide television is impossible with present techniques. But satellites could provide global TV coverage and handle all requirements for commercial and military communications as well.

A global system, including TV capability, would cost an estimated $170 million. A system linking Bonn, Paris, London, and Hawaii with the United States would cost an estimated $82 million.

Present plans favor active repeaters over passive reflectors such as the NASA *Echo* satellites. Early experiments, however, will be run with the passive type.

The active repeater being considered is a four-ft.-diameter sphere weighing about 50 lbs. It would have a one-watt transmitter using a traveling-wave tube with a useful life of 10 years or more.

Power supply for the receiver and transmitter equipment would probably be nickel-cadmium storage batteries and transistor inverters. Batteries would be recharged by solar cells.

• **Work started 30 years ago**—The choice of Holmdel as the site of the experiments was particularly fitting. It was here 30 years ago that the late Karl Jansky set up the first radio telescope to discover the origin of solar noise. His work led utimately to the science of radio-astronomy.

The first serious proposal of artificial satellites for communications appeared in a British electronics magazine in 1945. Specific satellite communication possibilities were set forth by a Bell scientist in 1955—two years before a satellite had been put into orbit.

The probable extent of atmospheric noise at various frequencies and its effect on space communications was defined in 1957; in the same year, the first solid-state maser was built.

Since that time solar cells have been improved and have demonstrated their practicality as a satellite power source. Work has continued on the development of high-frequency, long-life transistors and longer-life microwave tubes for possible use in satellites.

It will still be some years before we have a satellite communication network, but the groundwork has been laid. Last week's experiments prove that such a system is no dream; it is, in fact, the next step in practical and profitable worldwide communications.

Goldstone Uses Now-silent Tiros I for Bouncing Signals

by Richard van Osten

CAMP IRWIN, CALIF.—Goldstone Lake Tracking Station has been bouncing radio signals off the still-orbiting-but-now-silent *Tiros I* weather reconnaissance satellite since late last spring.

The project began as an early evaluation and checkout by Goldstone operators, Jet Propulsion Laboratory and National Aeronautics and Space Administration, of basic systems to be used in Project *Echo*.

The most recent demonstration was a two-way conversation on Aug. 3 between this windy desert site and the Holmdel, N.J., facility of Bell Telephone Laboratories, in which voice signals were bounced off the moon.

The *Tiros*-reflected experiment was one of Goldstone's most difficult tasks to date, although the station has been heavily involved with space probes since it began tracking operations about two years ago. The *Tiros*-bounces also were among the first uses of the site's newly constructed transmission system which became operational early this year.

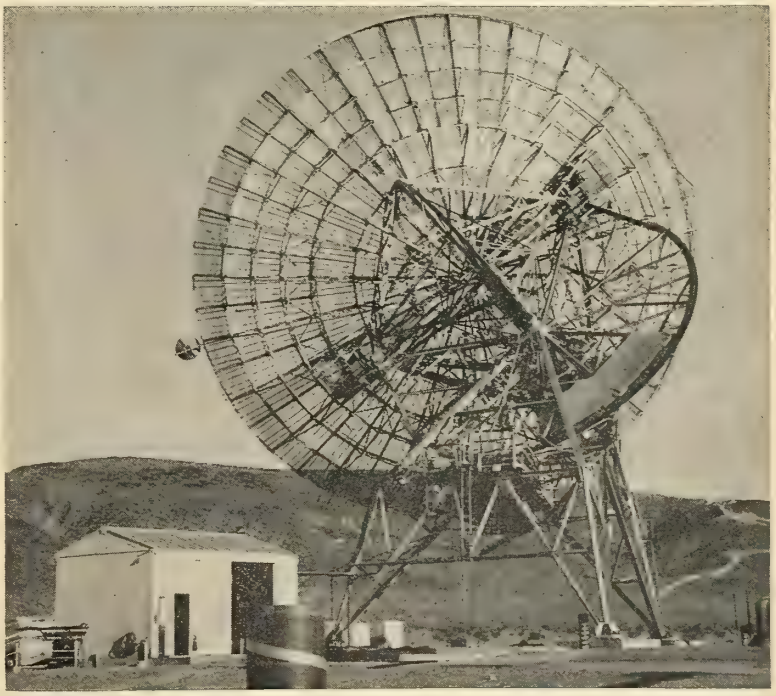
The relatively low orbital path of *Tiros,* something just under 500 mi., limits Goldstone's visibility of the satellite to about 10 min. when the vehicle's track over the earth brings it near the site's range. Lacking time to scan and acquire *Tiros* itself, Goldstone uses acquisition information supplied by the Vanguard computation center in Washington, D.C.

With the almost exact point-in-space of *Tiros* known, Goldstone's systems are able to track the satellite during its pass from horizon to horizon. While not always perfect, the percentage of success has been high.

The computed tracking data is punched into a paper tape. Playback of the tape supplies the input for positioning both the transmitter and receiver antennas.

Goldstone's new transmitting antenna is an 85-ft.-diameter parabolic dish. Mounted on an Az-El (for azimuth and elevation) mount, the antenna may be rotated 360° in azimuth and 91° in elevation.

Simultaneous tracking and operation of both antennas is simplified by slaving the transmitting antenna to the receiving antenna by servomechanisms. This automatically places the transmitter on the same target as the re-



RECEIVING ANTENNA at Goldstone is 85-ft. polar-mounted unit. Small antenna on left side of dish calibrates larger unit. Exclusive M/R photo by Richard van Osten.

ceiver. To correct for parallax and change coordinates from hour angle-declination to azimuth-elevation a special computer system was designed. Both antennas have a TV camera system which provides an optical means of checking antenna positions in relation to their target.

The transmitter is driven by a 10kw klystron power amplifier, working through a feed horn mounted above the antenna saucer to illuminate the parabola. Excitation of the power amplifier can be furnished by a crystal oscillator or self-excited oscillator. Frequency output of these units is multiplied 75 times and used to excite the klystron final amplifier.

• **Power varies**—Nominal output frequency is 2390 mc, as used in the moon-bounce conversation. *Tiros* bounces, however, are usually conducted at 2388 mc. At the 2390 mc frequency, beam width of the transmitter signal is about 0.25° spreading out to 2160 mi. in width at moon distance—almost equal to the moon's diameter.

The transmitter's nominal power is rated at 10Kw, but more often than not only about 8Kw is used. In the case of the moon-bounce, power was close to the full 10Kw. This was split down the middle into 5Kw carrier and 5Kw single side band.

Return signals, either from the moon or from *Tiros*, vary in strength in relation to the reflecting object's distance as well as other conditions. Despite the small size of *Tiros* (about 19 in. x 42 in.), strength of the reflected signal is fairly close to that reflected from the moon's surface. The difference in distance from the earth compensating for the relative diameters of the two surfaces.

In both cases, the weakest signal return has been barely 35 dbm (decibels below 1 milliwatt) above the threshold of the present equipment which is on the order of –145 dbm or 2×10^{-18} watts. This condition will be improved greatly in the future with installation of a more advanced low-noise amplifier.

Signals reflected from *Tiros* vary from 10^{-17} watts at the low end to 10^{-14} watts on the stronger side.

Bounces from the moon vary little with the frequency used. In the transcontinental telephone communications, Goldstone transmitted on 2390 mc and received on 960 mc from BTL. JPL engineers say that, under average conditions, the reflected signal is approximately –113 dbm at 2390 mc and –117 dbm at 960 mc.

• **Are you there?**—An interesting aspect of space travel communications was demonstrated by the time delay in the voice signal's return. For a simple, two-way transmission between an earth-based station and a space vehicle located at about 225,000 miles from earth, there is little delay. The demonstrated signal took 2.4 seconds to cover a 450,000-mi. round trip to the moon.

If, however, a second earth-based control station is added to the circuit and the situation is such that "advice" is needed from both points, things become more difficult. Multiple delay factors can garble messages so badly that communication would be impossible—especially if a three-way link is required. But the distance-delay relationship poses still another potential problem.

Assuming a space vehicle at X-million mi. from the earth, and assuming an emergency exists where advice from an earth base is required, it is possible that the time delay may create a serious psychological obstacle. Crew reaction might easily be one of panic and fear wondering "Why don't they answer?" Both the long delay and multiple station factors were clearly demonstrated at Goldstone by Walter Victor, chief of JPL's communications systems research section. The five-second delay between Goldstone-moon-Holmdel-moon-Goldstone seemed forever. Yet the distance was only about 900,000 mi.

• **Expansion plans**—But these are the things Goldstone is discovering and studying. As an arm of JPL and NASA charged with deep space exploration projects such an *Ranger* tracking, Goldstone is setting up also the first of a three-station Deep Space Instrumentation Facility.

The initial site is Goldstone. It will also serve as a R&D facility to determine the exact configuration of the other two sites.

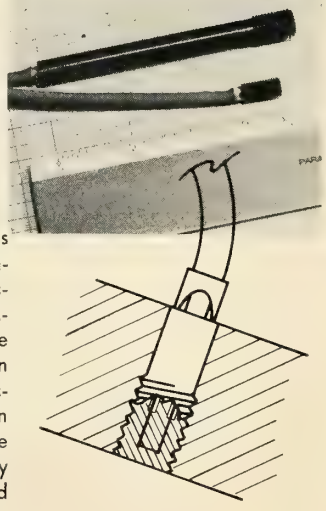
Second DSIF site will be at Woomera, Australia. A JPL crew has been in Woomera since spring directing construction of an 85-ft. receiving antenna duplicating present equipment at Goldstone. Former Goldstone chief Walter Larkin is directing the "Down Under" work. It will later be headed by RAdm E. H. Conklin, USN (Ret.), and will go into operation by the year's end. A transmitting system, also similar to Goldstone's is planned for a later date.

A third station is planned for South Africa, probably near Johannesburg, and negotiations for the site are under way.

The stations are approximately 120° of longitude apart to provide continuous contact with space probes and eventually, space vehicles.

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SD-5 Drone Can Spy 200 Miles Away

Army's new system by Fairchild supplies field commander with five types of instantaneous data

The Army's newest drone surveillance system can provide commanders in the field with "real time" information from behind enemy lines—up to 200 miles away.

Designated *AN/USD-5,* the Fairchild drone flies at Mach 0.7 and is capable of sustained flights in excess of 200 miles.

Five sensory packages permit radar, infrared, photographic, photogrammetric and radiological detection and measurement. Television electromagnetic and nuclear sensory subsystems are being considered for future integration.

Two guidance systems allow the field commander to monitor enemy movements as they occur, or set the drone on a preprogramed flight. Information is relayed instantaneously to him in pictorial form through data processing equipment in one of two control huts.

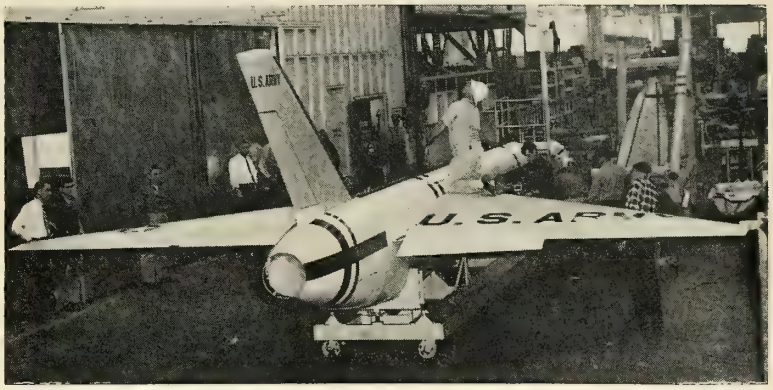
Capable of target acquisition services for missiles in the *Pershing* class, the system also can provide information on the effects of local missile impact—either friend or foe.

The system can operate day or night in any weather and will not be fooled by camouflage. Its high speeds make it relatively safe from enemy interference.

• **Turbo-jet-powered**—*SD-5* is powered by a J60 Pratt & Whitney 3000-lb.-thrust jet engine. A 4000-lb.-thrust solid-propellant booster is used to launch the 4.5-ton drone from a zero-length launcher.

The delta-winged bird is about 36 ft. long and 24 ft. in wing span. Its design differs from a conventional target drone in that its surveillance missions require a highly stable platform, even under conditions of air turbulence.

• **Recoverable**—After accomplishment of mission, the drone can be recovered and reused. It is parachuted to a selected open area by twin parachutes deployed from a compartment above the fuselage. Pneumatic bags are released from under each wing and the nose, cushioning the landing. After cleaning, checking and repacking of the chutes and bags, the drone is ready for another mission.



ARMY'S NEWEST DRONE—Developmental model of AN/USD-5 gets finishing touches at Fairchild Engine and Airplane Corp. High-performance surveillance drone will be operational in mid '63.

Scheduled for deployment with troops in mid-'63, the *AN/USD-5* will cost $350,000 to $400,000 per unit, including ground support equipment. Launch facilities, including control and checkout huts and launcher, have been estimated at $2 million per site. RDT&E funds budgeted through Fiscal 1961 total $48.6 million.

Fairchild Engine and Airplane Corp. is prime contractor for the Army Signal Corps, under supervision of Army Combat Surveillance Agency, with technical direction by the U.S. Army Signal Research and Development Laboratory at Fort Monmouth, N.J.



SUPERSONIC TARGET MISSILE, Radioplane's RP-76-X4 drone is capable of operating at altitudes in excess of 60,000 ft. at speed of Mach. 1.4.

soviet affairs

By DR. ALBERT PARRY

High praise of the rocket gunners

who allegedly hit the U-2 continues in the Soviet press. In the process, bits of data on the missile branch of the Red armed forces are revealed. Good examples of this are in a series of articles by Victor Ushakov in *Izvestia* for July 14, 15, 16, and 20, and an article by Lt. Colonel S. Yelistratov in the July 16 *Krasnaya Zvezda,* the daily organ of the Soviet ministry of defense.

Introduction of rocketry

"has permitted a manifold cut in the personnel of the antiaircraft troops" of the U.S.S.R., according to a quote attributed by Ushakov to Marshal Sergei S. Biryuzov, head of Russia's antiaircraft defenses since 1954. The *Izvestia* writer then quotes Major Michael R. Voronov, commander of the rocket unit credited with shooting down the U-2, as claiming that "by its firing capacity, one rocket can now replace a whole artillery battalion of large-caliber guns serviced by nearly 600 men," whereas in the battery which ostensibly shot down the U-2 "one rocket is managed by only 3 men."

Most of these rocket gunners

are young technicians specially trained for missiles. But their commander, Major Voronov, is a World War II veteran who rolled with his antiaircraft guns all the way to the siege and capture of Berlin. "He is an old ack-ack man," Ushakov goes on. "All of his army life has been tied with our antiaircraft service." He praises the major's adaption to the Space Age: "In a short time, along with his subordinates, he mastered the new technology, which asks of the commander not only a knowledge of its tactical features and actual battle points, but also an ability to understand deeply the complex schemes of radar installations and computers."

The rocket said to have hit

the U-2 was reportedly fired by Senior Lieutenant Eduard Emilievich Feldblum. All three of his names denote his German (possibly Baltic) origin. "This was his *first* war-rocket, shot at the *first* battle target! This fact speaks volumes about the infallibility of our war technology and the high-grade training of our rocket-men." Regarding Feldblum's personality, Ushakov continues: "He is a young, cultured officer. He is known as 'our ace in aiming.' " To refute Western suggestions that the U-2 may have been hit by a fighter-interceptor rather than a rocket, Ushakov quotes Feldblum as saying that his rocket hit the tail of the U-2; that this "saved the pilot from an imminent death" and presumably was the reason so much of the plane itself came down intact.

Radar policing of Soviet skies

Is done by zones, each consisting of "several hundred kilometers of air space" and under a separate tracking command, Ushakov writes. The aggregate of the zones is called "the unified radar field." The separate commands are in constant touch with one another, "handing over" to their neighbors any flying subject as it leaves the confines of each given zone. Soviet radar men boast (according to Ushakov): "Our screens will spot even a metallic flea, even if such a flea appears in the stratosphere itself."

Training of Red rocket gunners

is described at some detail in the *Krasnaya Zvezda* article by Lt. Col. Yelistratov. Among other things, he says that he watched a "very clever" problem being given to a detachment of Soviet rocket gunners. The problem's author, "knowing well the capabilities of this detachment, also its most vulnerable spots, had tried in all possible ways to complicate the work" of the officers and men. "But the rocket-men's collective responded in harmony and with efficiency and knowledge," and solved the problem quickly.

COMOPDEVFOR

(Continued from page 37)

ASW and certain other specialties such as communications.

At Key West, OpDev Forces' major effort in ASW is concentrated. A Test and Evaluation Detachment has six ships of destroyer and smaller size. When it becomes necessary, other fleet ships are assigned on a temporary basis for the prosecution of a particular project. The Key West Detachment covers the field in ASW—from detection thru localization and classification to kill. Since mine warfare is directly related to ASW, they specialize in all phases of this as well.

Air Development Squadron One is located six miles north of Key West at Boca Chica Naval Air Station. This unit, made up of land planes, seaplanes, carrier based and rotary wing aircraft, specializes in all phases of ASW.

• **Handling assignments**—OpDevFor looks to the CNO for top management coordination of the RDT&E program. The developing agencies, which are the bureaus, report the readiness of their products for test and evaluation processing and request that CNO set up projects for prosecution of these tests. The CNO makes a formal project assignment to OpDevFor; this is equivalent to a work order.

OpDevFor then translates the project assignment into a detailed test or evaluation plan, which when fully developed will provide a pattern of tests and operations. Then the results obtained are analyzed, evaluation conclusions are reported, and there are recommendations on the product and a concurrent development of basic doctrine, tactics and training procedures needed for its utilization by the operating forces. The entire procedure is designed to make the CNO capable of rendering prudent decisions on programs implementation.

A little over half of OpDevFor's active projects are for fleet assistance to developing agencies, i.e., to bring the development along. They are called Fleet Assists. Today, in ASW alone, it is engaged in 51 of these; at the same time, it is prosecuting 42 operational evaluations—for a total of 93 active and current ASW projects.

ComOpDevFor feels that much more can be done quickly if industry cooperates in giving the various cognizant bureaus realistic schedule dates for test and evaluation. For it takes nine months to put a system of moderate complexity through the OpDevFor process. And if the command gets the requirements far enough in advance the waiting cycle can largely be eliminated.

Capsule to Closely Simulate Space

The test space capsule which AiResearch will build for the Air Force may come closer to matching conditions of space travel than anything else constructed to date.

Under a Wright Air Development Division contract, totalling $235,000, AiResearch will develop a cabin, life support system and monitoring equipment by spring, 1961.

What makes this capsule unique is that it is both lightweight and mobile and can be placed on a centrifuge, in altitude chambers and other environmental simulators. Several factors can be simulated at one time, such as isolation and g forces, or radiation and altitude. Stresses of launch, orbit and re-entry for long or short flights can be tested in succession.

The Los Angeles subsidiary of The Garrett Corp. says the cabin will be fabricated from aluminum alloy in an all-welded construction. Ground-based and fully-sealed, the structure will be a cylinder 6 ft. in diameter and 8 ft. long.

The cabin will be capable of sustaining a limit load factor of 20 g's along the longitudinal axis and three g's along the other two axes. These combined with an external pressure differential of 13.3 psi at 250°F.

Entry and exit will be made through a removable airlock, which can be occupied by an observer for periods up to four hours. Two closed TV systems will monitor tests.

Components of the life support system will consist of pressurization, atmospheric control and temperature control for pressure suit and the compartment environment.

One of AiResearch's recent projects has been a survey of the extent of knowledge the U.S. possesses in the life science field.

As the chart shows, the biggest problem facing space flight researchers is lack of knowledge about combined stresses. Some of these will be studied with the AiResearch capsule.

Area of Interest	Stressors	Inadequate for Manned Space Flight		Adequate for Manned Space Flight of: Hours				Days						Years	
				1	3	10		1	3	10	30	100		1	3
Biophysics	Temperature Limitations	X	X	X	X	X	X	X	X	X	X	X			
	Pressure and Partial Pressures	X	X	X	X	X	X	X	X						
	Relative Humidity	X	X	X	X	X	X	X	X	X	X				
	Accelerations														
	Linear	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Angular	X	X	X	X	X									
	Radial	X	X	X	X	X	X	X							
	Accelerations As Above After Weightlessness	X	X	X	X	X									
	Weightlessness	X	X	X											
	Radiation														
	Gonadal Dosage Effects	X	X	X	X	X	X	X	X						
	Total Body Effects	X	X	X	X	X	X	X	X	X	X	X			
	Air Ionization in Space Vehicle	X	X	X	X	X	X	X	X	X	X				
	Noise	X	X	X	X	X	X	X	X	X	X	X			
	Vibration	X	X	X	X	X	X	X	X	X	X				
	Effects of Combined Biophysical Stressors	X													
Biochemistry	Metabolism	X	X	X	X	X	X	X	X	X	X				
	Energy Requirements	X	X	X	X	X	X	X	X	X	X	X			
	Water Cycle	X	X	X	X	X	X	X	X	X	X				
	Food-Waste Cycle	X	X	X	X	X	X	X	X	X					
	Air Cycle	X	X	X	X	X	X	X	X	X	X				
	Atmosphere	X	X	X	X	X	X	X	X						
	Toxicology														
	Materials, Finishes and Processes	X	X	X	X	X	X	X	X	X	X				
	Drugs	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Odors	X	X	X	X	X	X	X	X						
	Chemicals and Fuels	X	X	X	X	X	X	X	X	X	X				
	Effects of Combined Biochemical Stressors	X													
Psycho-Physiology	Maintenance of Muscle Tone	X	X	X	X	X	X	X	X						
	Physical Effort Required for Tasks	X	X	X	X	X	X	X	X	X					
	Work-Sleep-Recreation Cycle	X	X	X	X	X	X	X	X	X					
	Fatigue														
	Physical	X	X	X	X	X	X	X	X	X	X	X			
	Emotional	X	X	X	X	X	X	X							
	Disorientation	X	X	X	X	X	X	X							
	Effects of Combined Psycho-physiological Stressors	X													
Space Vehicle Operation	Cabin Space Requirements	X	X	X	X	X	X	X	X	X	X				
	Man-Machine Relationship	X	X	X	X	X	X	X							
	Emergencies														
	Fire and Explosion	X	X	X	X	X	X	X	X	X	X	X			
	Decompression	X	X	X	X	X	X	X	X	X	X	X	X	X	
	Illness and Injury	X	X	X	X	X	X	X	X	X	X	X			
	Major Environmental Control System Failure	X													
	Attitude Control Failure	X													
	Integration of Environmental Control Systems With Other Vehicle Systems	X													

contracts

NASA

Collins Radio Co., Dallas, or investigation of communication problems involved in landing an unmanned space craft on the moon. Subcontract from **McDonnell Aircraft**, St. Louis. Amount not disclosed.

$65,000,000—Douglas Aircraft Co., Inc., Santa Monica, for development of the S-IV stage of the *Saturn* space vehicle. Includes design, research, development and manufacturing phases.

$7,609,987—The Chrysler Corp., Detroit, for engineering services for *Saturn, Mercury* and *Juno II* programs.

$5,719,534—Brown Engineering Co., Huntsville, for engineering, fabrication and related services on the *Saturn, Juno II, Mercury* and *Pershing* programs.

$4,251,400—Hayes Aircraft Corp., Birmingham, Ala., for engineering, fabrication and associated services in connection with *Saturn, Juno II* and *Mercury* programs.

$1,382,540—Lockheed Aircraft Corp., Marietta, Ga., for engineering, fabrication and related services on the *Saturn* project.

$607,928—Redstone Machine & Tool Corp., Huntsville, for fabrication services in connection with *Saturn* and *Mercury* projects.

$601,580—Spaco Manufacturing Co., Huntsville, for manufacturing and assembly work on *Saturn*.

$213,500—Watland, Inc., Chicago, for microfilming and the operation of a technical documentation facility.

$154,000—Reynolds Electric & Engineering Co., Inc., Freeport, Texas, for maintenance, modification and checkout of electrical equipment at the Marshall Center.

AIR FORCE

$7,155,222—Philco Corp., Philadelphia ($3,138,848) for engineering, installation of equipment in modernization of air communications technical control facilities ($4,016,374) for modernization of worldwide communications stations.

$3,314,675—General Electric Co., Heavy Military Electronics Dept., Syracuse, for production of advanced high-power search radars.

$3,291,300—Eitel-McCullough, Inc., San Carlos, Calif., for klystron-type electron tubes.

$950,000—Northrop Corp., Norair Div., Hawthorne, Calif., for research in boundary layer control, low drag.

$583,413—American Hydrotherm Corp., L.I., N.Y., for non-personal services for on-site operation, maintenance and supply support of the SAGE utilities system.

$302,521—The M & T Co., Philadelphia, for non-personal services for on-site operation, maintenance and supply support of the SAGE utilities system.

$283,000—General Precision, GPL Division, Pleasantville, N.Y., for modification kits for radar navigational sets.

$250,000—Ruska Instrument Corp., Houston, for manufacture of dead weight gauges to be used on missile sites.

NAVY

$3,500,000—Chance Vought, Aeronautics Division, Dallas, for installation of an electronic guidance system in *Regulus I*.

$587,321—Telerad Manufacturing Corp., Flemington, N.J., for work on the URM 64-A.

$500,000—Universal-Cyclops Steel Corp., Bridgeville, Pa., for process development in the production of molybdenum alloy sheet.

$130,000—The Siegler Corp., Hallamore Electronics Div., for installation of telemetry equipment on Pacific Missile Range's new instrumentation ship, the yet unmanned AG-161.

ARMY

$1,508,622—Sperry Utah Engineering Laboratory, Salt Lake City, for *Sergeant* training material and publications.

$759,398—Nortronics Div., Northrop Corp., Anaheim, Calif., for *Hawk* missile repair parts.

$680,889—Eidal Manufacturing Co., Inc., Albuquerque, N.M., for trailer chassis.

$646,000—Convair Div., General Dynamics Corp., San Diego, for research on re-entry radar.

$456,474—Greenhut Construction Co., Inc., Pensacola, Fla., for construction of *GAM* facilities at Columbus AFB.

$443,971—Aerojet-General Corp., Downey, Calif., for research and development of rotor assembly machines.

$298,699—Nortronics Div., Northrop Corp., for engineering services.

$285,031—Aerojet-General Corp., Downey, for classified work.

$249,521—Aerojet-General Corp., Azusa, Calif., for R&D of airborne instrumentation.

$204,953—Cubic Corp., San Diego, for R&D on fabrication, installation and checkout of electronic trajectory measuring system.

$200,000—Hughes Tool Co., Aircraft Div., Culver City, Calif., for development of refractory composite material systems.

$199,805—Hughes Research Laboratories, Div. of Hughes Aircraft Co., Malibu, Calif., for R&D of rocket liner material.

$172,698—Rocket Power/Talco, Div. of Gabriel Co., Pasadena, for catapults.

$164,307—Raytheon Co., Andover, Mass., for replenishment spare parts for *Hawk* system.

$159,582—Consolidated Western Steel, U.S. Steel Corp., Los Angeles, for motor case assemblies.

$158,933—Douglas Aircraft Co., Inc., Santa Monica, for *Nike-Hercules* launching area items and adaption kits.

$146,755—Ling Electronics, Div. of Ling-Altec Electronics, Inc., Anaheim, for vibration testing system.

$124,837—Thompson Ramo Wooldridge, Inc., Canoga Park, Calif., for telemetering systems.

$113,408—Aerojet-General Corp., Azusa, for study of stress-corrosion cracking of high-strength alloys.

$95,369—Sperry Utah Engineering Laboratory, *Sergeant* equipment and repair parts.

$92,900—M. W. Hills Construction, Salina, Kan., for construction of re-entry vehicle, Schilling AFB.

$90,193—Associated Aero Science Labs, Hawthorne, Calif., for civilian technical assistance at Redstone Arsenal, Ala.

$80,241—Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif., for classified work.

$71,805—Information Systems, Inc., Los Angeles, for R&D of a magnetic-optic converter.

$70,771—Preshaw & Thompson, Inc., Van Nuys, Calif., for baroswitch test sets.

$61,000—University of Southern California, Los Angeles, for basic research in radiation.

$57,830—Autonetics Div., North American Aviation, Inc., Downey, Calif., for R&D of a digital computer.

MISCELLANEOUS

$92,695—Thompson Ramo Wooldridge, Inc., Cleveland, for SNAP-1 endurance testing program.

$55,244—Aeronautics Div., Chance Vought Aircraft, Inc., Dallas, for study of possible consequences of accidental loss into the ocean of power source devices (*Pluto, Rover,* SNAP) designed for use in space.

reviews

THEORY OF THERMAL STRESSES, Bruno A. Boley and Jerome H. Weiner, John Wiley & Sons, New York, 586 pp., $15.50.

This text is probably one of the most complete treatises yet written in English on the subject of structural stresses under elevated temperature conditions. The authors are both teachers and consequently the book leans heavily on the theoretical side. But this is good for students and practicing engineers who have learned to eschew the handbook approach when a problem must first be understood before it is solved.

The book is divided into four parts. In the first the fundamentals of thermoelasticity are developed. In part two, the authors give an account of heat transfer theory, and with methods of solving heat conduction boundary-layer problems.

The interesting part for engineers is the third. This one deals with the more practical aspects of thermal stress analysis, mainly from the strength-of-materials viewpoint. Part four deals with the newest science of inelasticity theory; temperature is a parameter.

THE EXPLORATION OF THE SOLAR SYSTEM, Felix Godwin, Plenum Press, New York, 200 pp., $6.50.

The book discusses the development of exploratory colonies on the Moon, Venus and Mars, as well as aspects of interplanetary travel and the setting up of space stations.

PHYSICS OF THE UPPER ATMOSPHERE, Edited by J. A. Ratcliffe, Academic Press, New York, 586 pp., $14.50.

There is little doubt that this book will be a standard reference for geophysicists and for workers concerned with flight through the upper atmosphere.

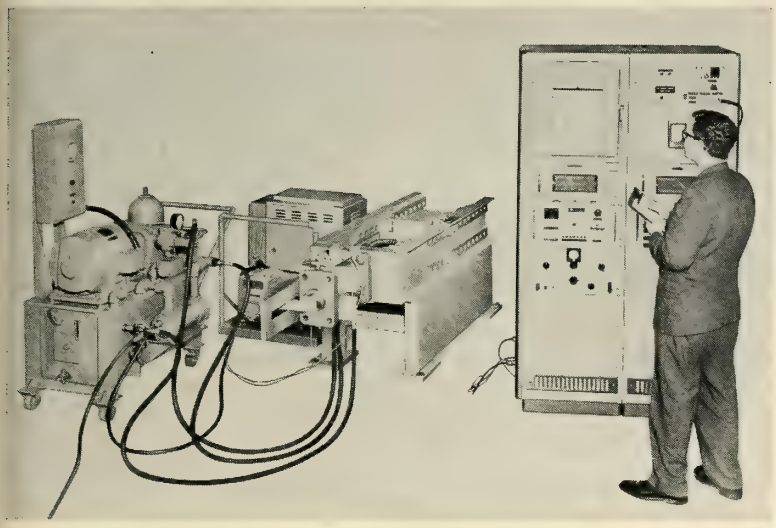
Each of the contributors to the volume has written a monograph about his speciality. And each contributor is a highly regarded authority in his field.

Sidney Chapman wrote about the thermosphere; M. Nicolet, properties and constitution of the upper atmosphere; Homer E. Newell, Jr., the upper atmosphere studied by rockets and satellites; Herbert Friedman, the sun's ionizing radiations.

D. R. Bates contributed theses about the airglow, general character of auroras, and the auroral spectrum and its interpretation.

Henry G. Booker contributed radar studies of the aurora; J. A. Ratcliffe and K. Weekes, the ionosphere; E. H. Vestine, the upper atmosphere and geomagnetism; J. S. Greenhow and A. C. B. Lovell, the upper atmosphere and meteors.

To make the book as modern as possible, and to take advantage of the work done during the IGY, the authors joined together at a late date to write the final chapter, "Advances during the IGY 1957/58." Thus the volume includes information available up to December, 1959.



Advanced Metal Testing Machine

A materials-test machine for advanced cycling or fatigue testing of specimens or structures under compression-tension and elevated-temperature conditions has been introduced by the CompuDyne Corp.

Called the Dynatest, it is capable of cycling up to 20 cps, and of following a typical program heating rate of 200°F. per second. The maximum heating rate is dependent upon the configuration of the specimen.

The Dynatest is an electrohydraulic unit with individual closed-loop systems for force and heat loading. It employs a high-speed ram that delivers up to an 8 in. stroke at a velocity of 1 in. per second at rated load.

The standard force-loading channel has multiple ranges from 200 to 50,000 lbs. full scale, and a selector switch that permits ranges to be changed without mechanical adjustment. Steady-state accuracy of the force-loading system is ± 0.5% of the selected range. Dynamic accuracy is within ± 1% of selected range.

Circle No. 225 on Subscriber Service Card.

Test Indicators

A line of test indicators are available in 0.001 and (subdivided in 0.0005 by a dot), also in 0.0001 graduation from Mueller Laboratory.

The movement of the indicator is always clockwise when changing direction of pressure on the contact point. The contact point will not slip and operates in a 186° arc. 1/32 contact points are available in carbide and hardened tool steel. Contact points are threaded for interchangeability.

Circle No. 226 on Subscriber Service Card.

Turbine Fuel Flow Control

A turbine fuel control weighing only 1.875 lbs., complete with shut-off solenoid, has been added to the extensive family of similar controls built by The Garrett Corp.'s AiResearch Manufacturing division.

Capacity of the unit's gear type pump is 200 lbs/hour of JP-4 at 200 psig and 4250 rpm. The control will also handle gasoline or diesel fuel.

Fuel flow scheduling and limiting is pneumatically regulated from the compressor during acceleration. For a metered flow variation of 10 to 60 lbs/hour a 4% speed drop is typical.

Circle No. 227 on Subscriber Service Card.

Subminiature Housing

Mitronics, Inc., manufacturers of custom metallized products have developed an extremely subminiature metallized housing with an O.D. of 0.030 in. and an I.D. of 0.012 in.

This ceramic part is 0.008 in. thick including the metallized portion. The part is metallized with molybdenum manganese and nickel plated on both flat surfaces. The part can be hermetically sealed by brazing or soft solder.

Circle No. 228 on Subscriber Service Card.

Airborne Tape Programer

An Airborne-type tape programer is available from the EECo. Anaheim Electronics Division.

The TP-813 Tape Programer is mechanically and electrically interchangeable with similar units. It has a tape capacity of 75 ft. of 35 mm mylar film or equivalent to a 20-minute program at standard speed of 0.748 in. per second. Contacts of the TP-813 are rated at 0.4 amperes.

Circle No. 229 on Subscriber Service Card.

Motorized Grinding Unit

A compact, precision, motorized fixture that enables through-feed or form grinding operations to be efficiently performed on cylindrical parts with conventional surface grinders is available from Products Supply Co. It can be used for either production or tool-room operations.

Called the Mini-Grind fixture, the device utilizes a unique outside diameter driving and adjustable roller clamping arrangement that provides absolute concentricity and avoids the use of centers, chucking devices or indicators.

Circle No. 230 on Subscriber Service Card.

Liquid Level Controller

Consolidated Vacuum Corp. is marketing a completely automatic Liquid Nitrogen Level Controller, Type BC-003, for electronically regulating the flow of liquid nitrogen and other coolants. Designed primarily for use with the new CVC multi-coolant-type vacuum baffles, the controller can also be used in any similar application where low temperature cooling is required.

Circle No. 231 on Subscriber Service Card.

Ratemeter-Spectrometer

A ratemeter-spectrometer featuring high versatility, moderate cost and compact size is now available from Tracerlab. The single channel Model SC-80 incorporates a super stable high voltage power supply, linear amplifier, pulse height analyzer and precision ratemeter, and as an optional feature, can be provided with a four-speed threshold drive for automatic spectrum scanning.

Circle No. 232 on Subscriber Service Card.

Superalloy Available

A WI-52 cobalt-base high-tungsten superalloy that possesses greatly improved high temperature strength in the



1800°F range with good ductility and corrosion resistance is now commercially available in both shot and ingot form from WaiMet Alloys Co.

Refining techniques and precise control of the important alloying elements have increased 1800°F stress rupture life by 18% and rupture elongation by 160% over previous alloy variations.

Circle No. 233 on Subscriber Service Card.

Rupture Disc Line

A wide selection of rupture discs designed to give peak performance under a variety and combination of stresses is offered by Fike Metal Products.

One of the developments is the H-O and H-O-V rupture disc. This disc is designed to withstand operating pressures closer to rupture pressure than has been considered acceptable for conventional prebulged rupture discs.

Constructed from various thicknesses of ductile metals, Fike rupture discs range in size from 1/8 in. through 30 in., for pressures up to 50,000 lbs.

Circle No. 234 on Subscriber Service Card.

Removable Contacts

The Electronics Division of DeJur-Amsco Corp. has introduced a series of miniature rectangular continental connectors with crimp termination removable contacts.

The removable contact features an extra-wide, three-tine spring clutch on pin and socket to provide maximum holding area between contact and molded block. All sharp-edged, "molded-in" metal inserts have been eliminated. Socket and pin contact material is phosphor-bronze, gold plate over silver plate.

Circle No. 235 on Subscriber Service Card.

Temperature Test Chamber

Associated Testing Laboratories has begun marketing its new Econ-O-Line low-high temperature test chamber.

The chamber, with internal working dimensions of 14 in. by 14 in. by 14 in., utilizes liquid carbon dioxide and spans a temperature range of −100°F to 350°F. The unit uses a United Electric Indicating Controller and guarantees accuracy to within a range of plus or minus two degrees Fahrenheit.

Circle No. 236 on Subscriber Service Card.

Free Turn Ball Valve

Dyna-Matics Corp. has introduced a "Free-Turn" ball valve designed for critical service with a wide range of both non-corrosive and corrosive liquids and gasses under extreme pressure and temperature conditions. The valve provides tight, positive sealing without seal drag during operation. The elimination of seal friction and wear makes possible a wider choice of packing materials for positive sealing in a variety of applications.

Circle No. 237 on Subscriber Service Card.

Small Accelerometer

A tiny 3-axis accelerometer with potentiometer output is being produced for missile applications by Humphrey, Inc. This single accelerometer provides information on linear acceleration along three different axes, replacing multiple instruments at savings in size, weight and cost. Total weight of the unit is about one-half pound and size is approximately 2½ in. diameter and 2 in. long.

Circle No. 238 on Subscriber Service Card.



Thermostatic Air Valve

A miniature thermostatic air valve weighing 2 oz. developed by Solrac, Inc. is now in production.

Primarily used as a power limiting device when installed in the exhaust outlet of a gas turbine engine, the unit has been successfully tested in a cryogenic application at −300°F.

With 35 psi air applied at the inlet an output variation of 1 psi per 2°F temperature change is obtainable through an adjustable range of −350°F to +1750°F.

Circle No. 239 on Subscriber Service Card.

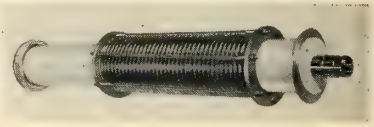
Dehydration Cartridges

Instrument type dehydrator units designed for connection directly into the system line to protect delicate sealed instruments, relays, sparking contacts and other similar components from moisture, contamination, oil vapor, fuel vapor and corrosive or explosive gases have recently been introduced by Robbins Aviation, Inc. Fiber glass pads also control downstream particle size to less than 10 microns.

Circle No. 240 on Subscriber Service Card.

Flexible Coaxial Section

Telerad Manufacturing Corp. is in full production of 3⅛ in. flexible coaxial section capable of 3 mega-watts peak



pulse power. The flexible section encompasses vibration in three planes from 5 to 500 cycles per second and meets all vibration requirements of MIL-E-5422. All units have a very low SWR. The coaxial sections utilize special flanges to reduce RF leakage.

Circle No. 241 on Subscriber Service Card.

Electronic Tapwelder

A precision electronic tapwelder manufactured by the Hanjohn Co., joins resistance alloy wires of 0.025 in. to 0.0007 in. diameters at production line speeds. The weld is stronger than the parent wire, and accurate to 1 turn.

The unit welds without pressure, hence does not flatten, stretch or distort the wire, or embed it in the core.

Circle No. 242 on Subscriber Service Card.

Wee Wire-Wound Resistor

A Type 375-P encapsulated, precision wire-wound resistor which measures 1/8 in. dia. x 1/8 in. long,

is available from Kelvin Electric Co. Units are shock, moisture and temperature proof, exceeding mil-specs. Wattage rating is 0.05, 100 K oms max., 50 volts max., temperature range, −65°C to +125°C, standard tolerances from 1% to .05%, standard temperature coefficient ±0.002%/°C. Connections are welded.

Circle No. 243 on Subscriber Service Card.

Detonator Field Tester

Explosive igniters, detonators, primers or squibs may be checked quickly and safely with a tester developed by Kinetics Corp.

A simple digital readout on the Kinetics instrument will indicate whether the device will operate properly or misfire. The tester employs a sensitive bridge circuit. Maximum test current is limited to 10 milliamperes, so there is no danger of setting off igniters during the test.

Circle No. 244 on Subscriber Service Card.

new literature

POLYALKYLENE GLYCOLS—A 52-page booklet, describing the properties and uses of Ucon polyalkylene glycol fluids and lubricants, has been published by Union Carbide Chemicals Co. The booklet contains comprehensive data on the 32 types of Ucon synthetic fluids and lubricants available from Carbide. Included are physical properties, physiological properties, physical and chemical analytical methods, storage and handling instructions, and a special section on the selection of the proper Ucon fluid or lubricant for any given application.

Circle No. 200 on Subscriber Service Card.

EPOXY ADHESIVES—An 8-page booklet issued by the Epoxylite Corp. describes five high-temperature epoxy resin formulations suitable for long-time service in the 450-500°F range. Two of the formulations are potting compounds, three are adhesives. All are variations of unique high-temperature system which combines handling ease (room temperature processing), long pot life (in excess of 16 hours), and fast cure (as short as 30 minutes at 400°F). The advantages and disadvantages inherent in the materials are described.

Circle No. 201 on Subscriber Service Card.

THERMOCOUPLE ACCESSORIES—A fully illustrated catalog which describes a complete line of thermocouple fittings, pressure sealing glands and thermocouple accessories is available from Conax Corp. Included are the Conax patented bare wire thermocouple glands that provide low mass, fast response and a simple, positive method for sealing two or more bare wires from the full vacuum to 10,000 psi. at temperatures from −300°F. to +1850°F.

Circle No. 202 on Subscriber Service Card.

SAFE/ARM INITIATORS—McCormick Selph Associates has published a four-page brochure describing their new Safe/Arm Initiator systems. The brochure describes the Safe/Arm system and its operation; shows a comparison of conventional vs. Mc/S/A Safe/Arm concepts; gives advantages of the system and, provides firing and arming characteristics as well as environmental data.

Circle No. 203 on Subscriber Service Card.

SWITCH BROCHURE — Burroughs Corporation's Electronic Tube Division has prepared a detailed twenty-four-page brochure on their new BEAM-X switch. This brochure, containing more than fifty illustrations, covers theory of operation, circuit design information, characteristic curves and the many applications of the BEAM-X switch in the fields of counting, coding, distributing, converting, multiplexing, switching and sampling.

Circle No. 204 on Subscriber Service Card.

MILITARY COMPONENTS—Ohmite Manufacturing Co. has published a new edition of its Military Components Catalog, Number 50A. This 36-page catalog is designated formally as a catalog, but more accurately, can be considered as a manual on U.S. military specifications covering those components which Ohmite manufactures. The catalog covers the latest versions of the following specifications: MIL-R-26, MIL-R-22, MIL-R-19365, MIL-R-93, MIL-R-9444, MIL-R-10509, MIL-R-19074, MIL-R-6749, MIL-R-6274, MIL-R-3965, MIL-R-5757, and MIL-R-6106.

Circle No. 205 on Subscriber Service Card.

RECORDING OSCILLOGRAPH—A Type 5-123 Recording Oscillograph is illustrated in an eight-page bulletin offered by the Electro Mechanical Instrument Division of Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co. The rack-mounting oscillograph is designed for maximum reliability, flexibility, ease of installation, operation, and maintenance. The Type 5-123 is capable of providing visible records up to 60 times faster than any other printout process.

Circle No. 206 on Subscriber Service Card.

GSE PROGRAM—The full scope of the Fruehauf Trailer Co.'s Ground Support Equipment Program, including the design, research, development and production phases, is described and illustrated in a 20-page, 3-color brochure. Participation in practically every major missile program is illustrated in the fold-out center section of the brochure showing the many and varied types of ground support equipment produced by the company's two divisions.

Circle No. 207 on Subscriber Service Card.

LEVELING DATA—Keuffel & Esser Co. has published a new brochure which describes the components and operation of its Optical Leveling Kit. The booklet contains full data on industrial alignment problems and solutions, including foundation or bed leveling, profiling, differential leveling and checking movement of equipment. It also provides product data on all component parts and available accessories such as tripods and related instrument supports.

Circle No. 208 on Subscriber Service Card.

ALLOY PROPERTIES—Detailed information on alloys for abrasion, impact, corrosion and heat resisting services is contained in a new series of data sheets issued by Coast Metals, Inc. Each sheet provides complete engineering data on a single alloy, including: the available forms, such as welding rod, automatic welding wire and cast shapes; physical properties and nominal chemical composition; typical applications and recommended finishing procedures.

Circle No. 209 on Subscriber Service Card.

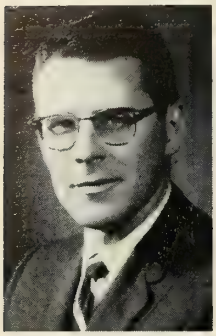
HIGH TEMP ALLOY—A four-page engineering-data folder on SUPERTHERM, new high-temperature alloy with exceptional performance capabilities in the 1800-2300°F range is available from Electro-Alloys Division of American Brake Shoe. The brochure presents specifics on physical constants, expansion coefficients, general characteristics, mechanical properties at room temperatures and high-temperature properties.

Circle No. 210 on Subscriber Service Card.

HEAT SHAPED TUBING—Expanded Teflon tubing which recovers its original dimensions when heated, giving a tight shrink fit over other parts or tubing, in electrical, chemical or mechanical applications, is described in an illustrated, how-to-do-it bulletin—Bulletin 3E—available from Pennsylvania Fluorocarbon Co. Applications and method of use are described for this expanded, shrinkable Teflon tubing which is made in eleven colors and retains its chemical inertness, thermal stability and excellent electrical properties.

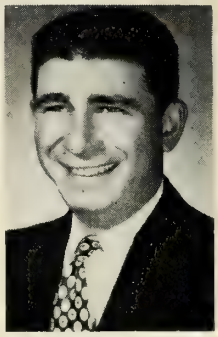
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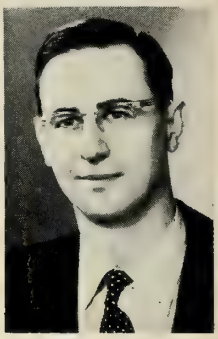
names in the news


BARNETT


ASHWORTH


BUDNIK


UNDERBERGER


SKWAREK

Ralph V. Barnett: Appointed to the newly created position of vice president by Librascope Division-General Precision, Inc. Was director of military relations in the firm's Washington, D.C. office.

Harold T. Ashworth: Named director of manufacturing for Raytheon Co. Was manager of manufacturing for the company's Missile Systems Division.

Cass A. Budnik: Former assistant manager of industrial construction with Kaiser Engineers, appointed director of field services and general manager of the *Titan* Installation and Activation Division of American Machine & Foundry Co.'s Government Products Group.

George M. Underberger: Elected project engineer at Transco Products Inc., responsible for development and expansion of the firm's microwave components and subsystems. Was formerly manager of General Precision, Inc.'s Kearfott Division Systems Engineering Laboratory.

Frank J. Skwarek: Vice president of engineering for Polarad Electronics Corp., chosen to head the firm's newly-formed Defense Products Division. **Kenneth O'Neil** will be in charge of military sales for the new division.

John W. Suurballe: Joins the Systems Research Center of Lockheed Electronics Co. as a member of the research staff. He will be engaged in studies leading toward solutions in communications and mathematics.

Howard E. Roberts: Named manager, research and product planning, for the Whittaker Controls Division of Telecomputing Corp.

C. Harold Hannan: Who joined Miniature Precision Bearings, Inc., in 1957 as assistant chief engineer, promoted to director of research.

Robert G. Wilson: Elected manager of the lunar soft landing study program at North American Aviation's Missile Division. Formerly the division's assistant chief engineer, has had 20 years experience in aircraft, missile and space vehicle design and engineering management.

Dr. Arthur Goldsmith: Former research assistant, named director of engineering for Wilcox Electric Co.

Andrew A. Dukert: Joins the recently-organized Research Products Development Dept. of Pennsalt Chemicals Corp., as a plastics application engineer. Has had 25 years' experience in the plastics field, most recently as a consultant for Acme Plastic Products Co.

F. Sutherland Macklen and **Dr. M. Shaw:** Appointed director of engineering and manager, respectively, of the solid-state laboratory of the Ovitron Corp. Macklen was formerly vice president in charge of engineering for the Fairfield Engineering Corp.; Shaw was head of the physical chemistry research laboratory of Chrysler Corp.'s missile division.

Ralph A. Russi, Jr.: Former manager of materials processing for Motorola's Semiconductor Products Division, elected vice president in charge of research and engineering at Tang Industries, Inc.

Robert A. Ferguson: Assistant to the vice president in charge of sales at Latrobe Steel Co., named manager of marketing.

R. T. McCoy: Joins the technical staff of Micromega Corp., where he will be engaged in research and development work in the field of solid state microwave. Was formerly with Hughes Aircraft, where he worked on radar guidance for the advanced *Falcon* missiles.

Harry E. Cornish: Douglas Aircraft Co.'s acting program manager on the Missileer project named program manager.

Dr. S. J. Gerathewohl and **Dr. Richard S. Young:** Elected head of operational development and chief of flight biology, respectively, for NASA's Office of Life Sciences Programs. Dr. Gerathewohl comes to NASA from the Army Surgeon General's office, assigned to ABMA. Dr. Young also comes from ABMA, where he directed space biology projects.

Lewis I. Terry: Appointed laboratory manager by Dearborn Chemical Co., responsible for all analytical services and quality control. **Richard A. Larrick,** former head of the materials testing and analytical laboratory at General Electric Co.'s Hudson Falls plant, succeeds Terry as director of analytical services.

Michael L. Mandeville: Former executive vice president, appointed president of the International Division, U.S. Industries, Inc., succeeding **R. S. Wright,** now vice president-International Trade of the parent company.

Brig. Gen. Harley S. Jones (ret.): Executive vice president of Republic Aviation Corp. elected to the board of directors.

John J. Morrissey: Named manager of Dana Corp.'s Marion (Ind.) Division. Was formerly vice president and general manager of General Drop Forge Corp., wholly-owned Dana subsidiary.

Malcolm A. Pleton: Filtors, Inc. applications engineer, promoted to assistant chief engineer.

Phillip H. Goodwin: Appointed executive vice president and general manager of National Electronics Facilities Organization, Inc. Was formerly marketing manager, weapons systems, of the Government and Industrial Group, Philco Corp.

Harold R. Fosnot: Former manager of operations for Graver Water Conditioning Co., appointed general manager of American Machine & Foundry Co.'s Maxim Evaporator division.

R. C. Chapman: Elected executive vice president and member of the Board of Directors of Crescent Engineering & Research Co. Formerly headed his own management consulting firm.

An Opportunity to Use Your Scientific Knowledge

CHALLENGING! TIMELY! IMPORTANT!

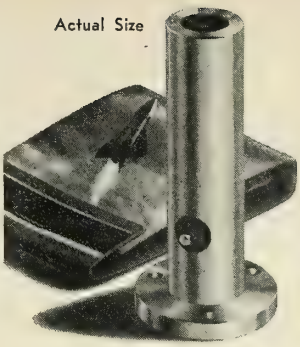
If you are at home with the terminology of physics, mathematics, chemistry, electronics, astronomy, mechanical engineering, metallurgy as related to aerospace technology, missiles, rocketry, etc., an intriguing and unusual job is waiting for you. The work will involve you with eminent U.S. scientists. You will identify and categorize abstracts from high level scientific articles. We will orient you for the screening of foreign scientific and technical literature in such areas of knowledge as missiles, aerospace technology, air defense, rocket propulsion and aircraft.

Starting salary is excellent. The work is with one of the country's leading publishers, in New York City or Dayton, Ohio, depending on your qualifications.

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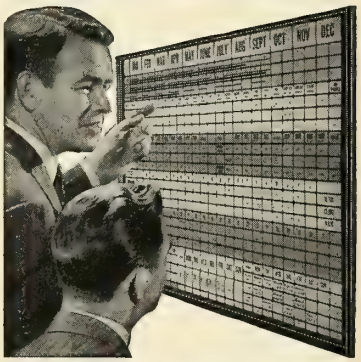
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editorial . . .

The Leaden Feet of NASA's Mercury

THIS WEEK M/R points out (page 12) the slippage, the high costs and the dubious judgment used in the NASA *Mercury* program, designed to put man in space for the first time—if the Russians don't beat us to it.

Mercury was the first major operation undertaken by the new space agency after its creation in 1958, when public pressure due to Soviet successes forced the Administration to take some action in space exploration.

It now appears that the entire Astronaut program was developed because it looked like a cheap and quick method of getting man into space; that it was approved on the very highest level because of promises the program could be accomplished at a minimum cost and within a short time—one year.

It has been neither cheap nor quick. To date $250 million has been appropriated for *Mercury*. The original year is stretching out into two—and probably will be actually more like two and a half.

Further, it appears evident that Project *Mercury* may reach a glorious climax and then expire quietly. *Mercury* is a dead-end project.

George M. Low, chief of NASA's Manned Flight Program, says in a written statement to the Senate Space Committee that lunar landings are included in NASA's manned flight program. But he adds:

"The *Mercury* capsule is not suitable as a return vehicle for a lunar mission."

He added that such a capsule must be capable of entering the atmosphere at higher speeds and that some aerodynamic guidance would be necessary, presumably guidance of a *Dyna-Soar* type.

Mercury will, of course, accomplish some things. It will, hopefully, prove what we now feel to be a certainty—that man can survive in space. It may prove that he can remain lucid, perform a few simple operations, retain his equilibrium and his lunch. And—there is no other way to prove these things except to send an actual living man into space. There will be benefits in the techniques of capsule design, in tracking, communications and recovery, in living with weightlessness.

There are many reasons for the delays in the original schedule and for the gross underestimate of the cost of *Mercury*. Most of them stem from the same basic fact—lack of experience.

When NASA undertook the *Mercury* program it was a brand new agency, converted from the old National Advisory Committee on Aeronautics. No one from the new administrator down had either factual or theoretical knowledge of a space flight program.

Some such knowledge existed in the Air Force and in the Army, both of which had quietly and secretly made studies in conjunction with three or four industrial primes. But not much of it, apparently, went into *Mercury*.

It seems to us that this is another example of the lack of judgment which has marked so much of our missile/space program.

Through either myopic inperception or vacillation we delay in doing anything.

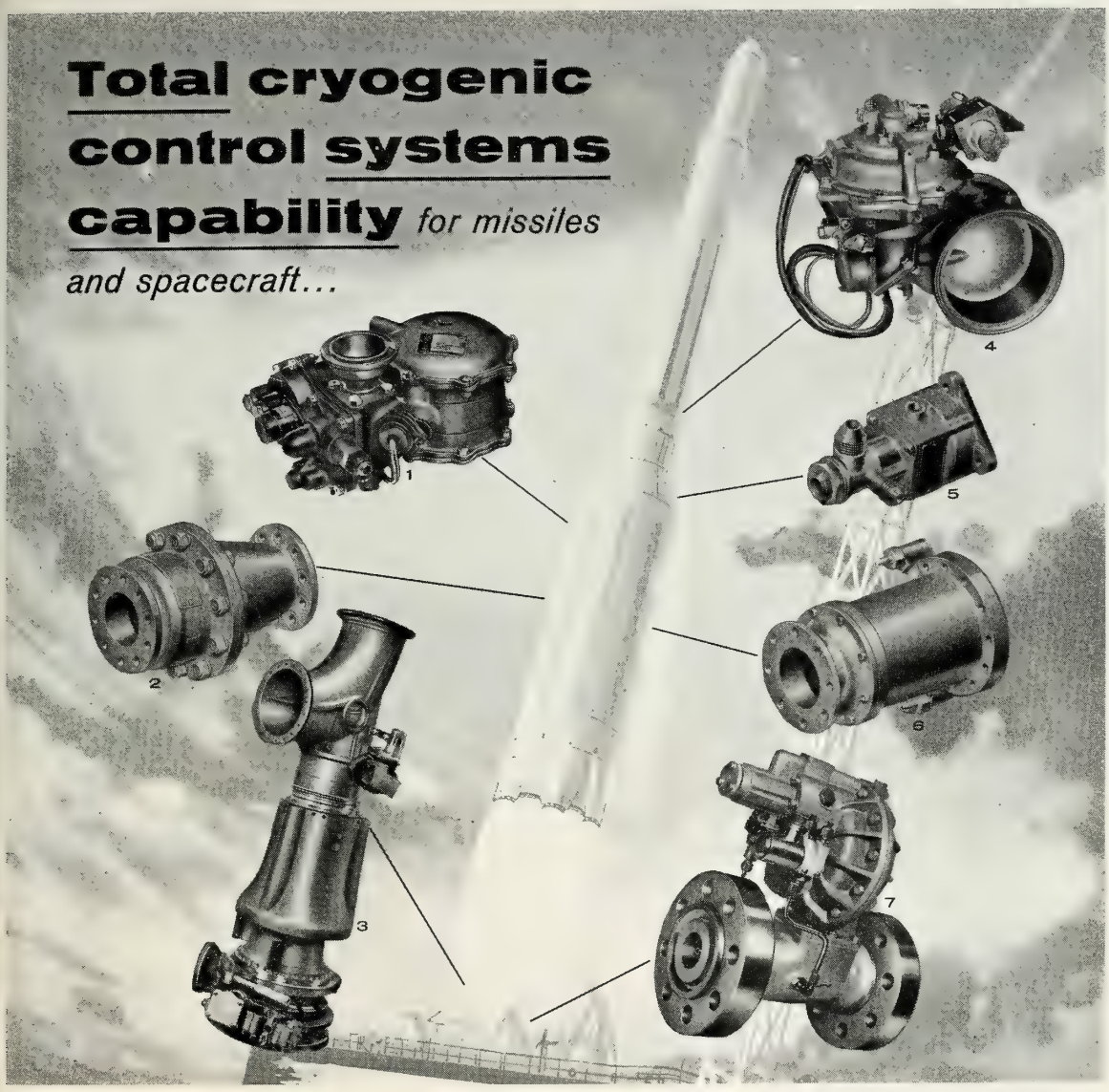
Then we frantically seize upon a program which is "quick and cheap." This was true of the "cheap and quick" *Vanguard*. It appears to be true of *Mercury*.

At least one other program was available when *Mercury* was started—*Dyna-Soar*. No one claimed *Dyna-Soar* was "quick and cheap." But it now appears that *Dyna-Soar* could have been available in about the same time period as *Mercury*. And NASA will probably turn to a *Dyna-Soar* configuration for later space flights.

Are we seriously competing to explore space —evaluating the tremendous rewards of being there first? Do we, the richest nation in the world, decide wisely and do it the best possible way? Or do we hunt out the "cheap and quick" for public appearance and political reasons?

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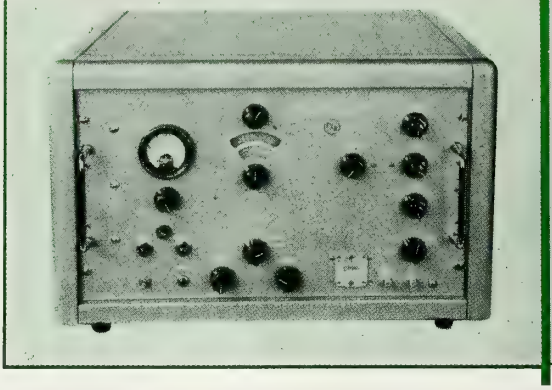
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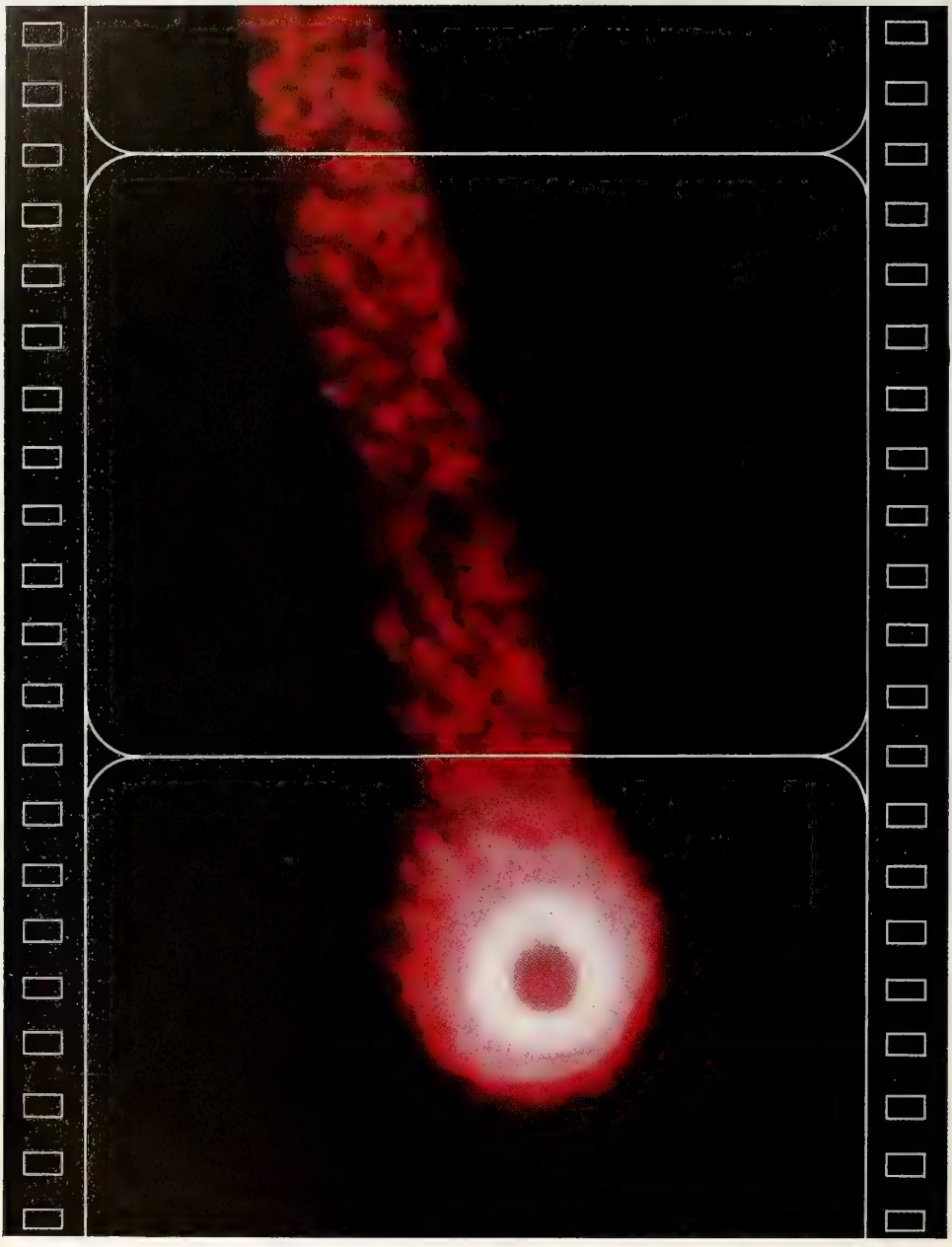
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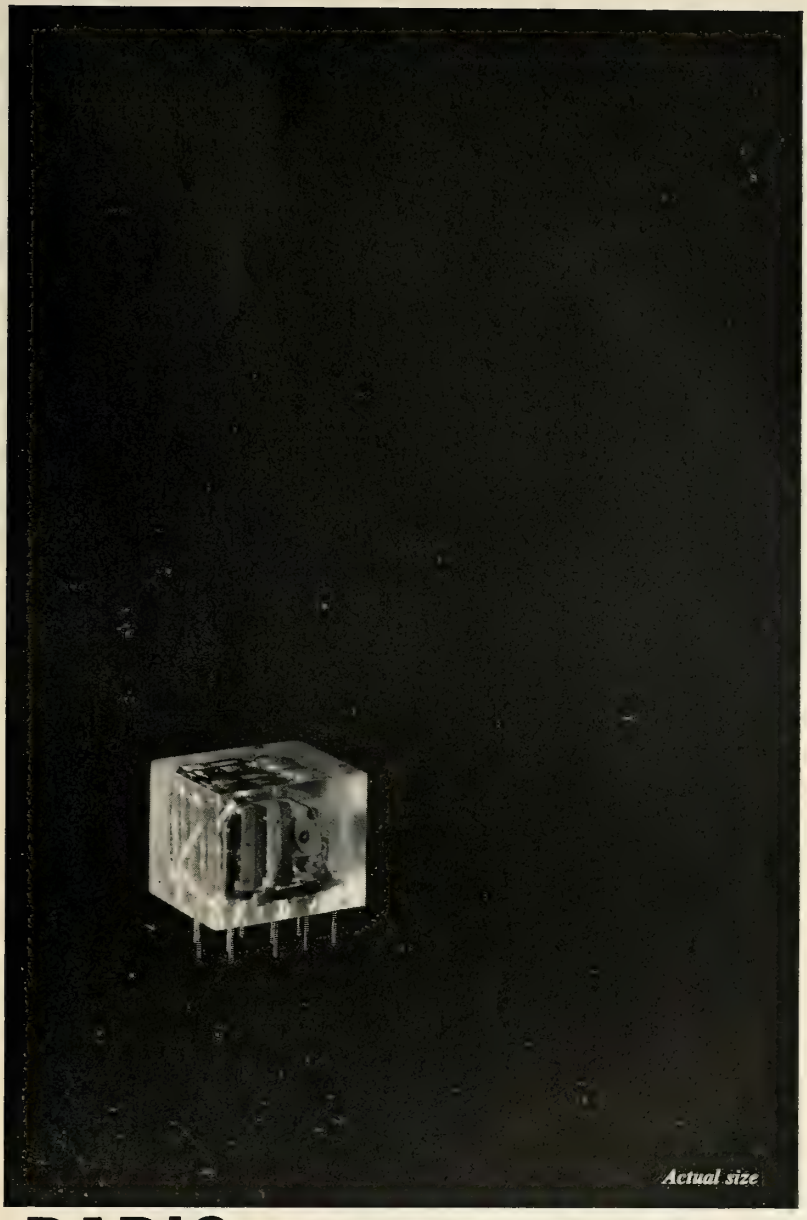


Re-entry portrait at 12,000 MPH. Critical performance data of re-entry vehicles at temperatures exceeding 12,000 degrees are obtained by a re-entry monitoring team from the Avco-Everett Research Laboratory. Portraits under these difficult conditions are obtained regularly as part of a general research program to study re-entry phenomena and related problems. Airborne equipment is used to acquire radiation data, trajectory information, and photographic documentation.

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missiles and rockets

August 22, 1960 Volume 7, No. 8

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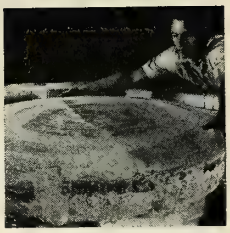
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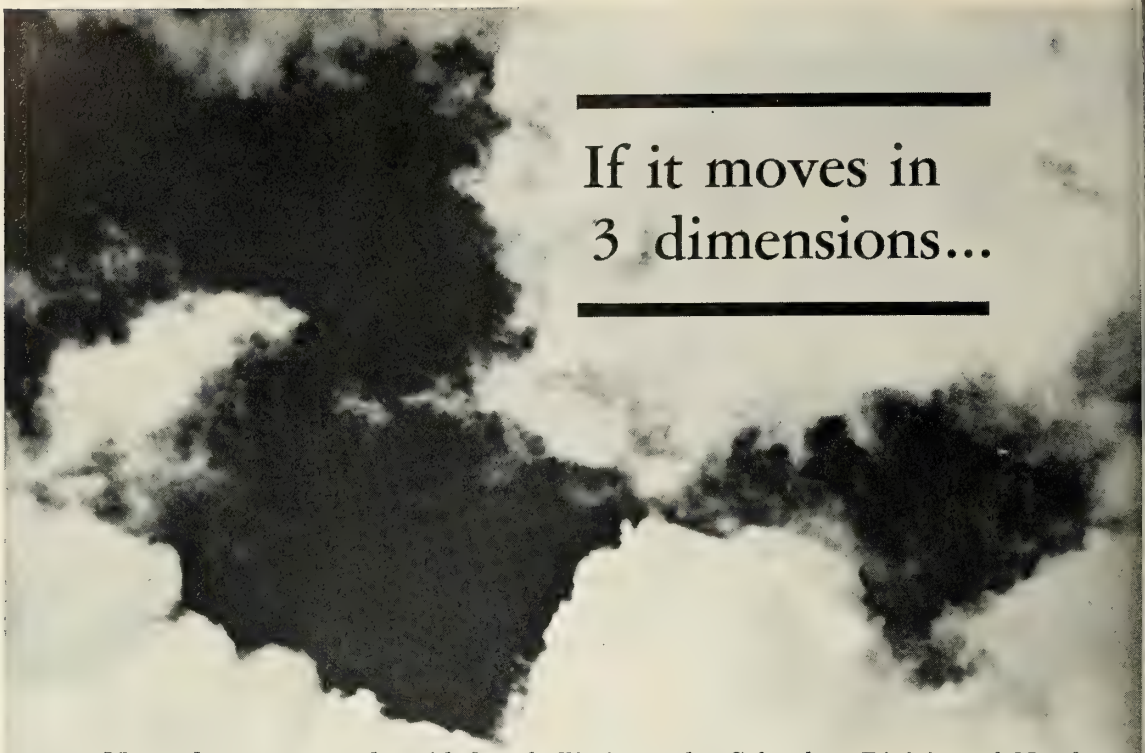
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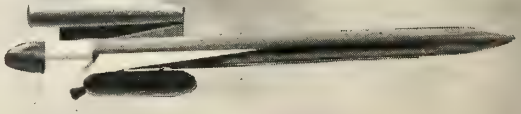
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The Countdown

WASHINGTON

First Step to Strategic Unification

Over and above his duties as SAC commander, Gen. Thomas S. Power is being made director of Strategic Target Planning for the Joint Chiefs of Staff—a new post. Defense Secretary Gates says the move does not involve any "rearrangement" of command and that *Polaris* will stay under the Navy. But it could still be a first step to a joint command over all strategic weapons.

Three More Atlas Pads Ready

The second half of the first (6 *Atlas*) squadron at Warren AFB is nearly operational. So much so, COUNTDOWN hears that with sufficient warning the ICBM's could be fired now.

SAC is the Winner

Shift in responsibility for building ICBM bases from the Ballistic Missile Division to Air Materiel Command is generally being interpreted as a victory for SAC. This has been further cemented by an AF plan to eliminate strategic missile wings as such an integrate them into strategic wings of SAC bombers and tankers. Any possibility that a separate missile force might be created around BMD now seems dead indeed.

Minuteman Rail Launching

A railroad spur will be built soon at Vandenberg AFB. It will be used for the first test shot of a *Minuteman* ICBM from a special rail launch car now under development by American Machine & Foundry and ACF Industries. Date of launch: probably early 1961.

Echo Moon Orbit

NASA is looking over a proposal to try a lunar probe with an *Echo*-type balloon. Sales point: the metallic covered balloon could be tracked visually all the way and, as an added attraction, it would make propaganda capital for the U.S.

What About Mercury?

Hilliard W. Page, general manager of General Electric's MSVD, claims the three *basic* steps in the mastery of safe return from space flight are: 1) recovery of ballistic missile re-entry vehicles (accomplished); 2) the Aug. 11 recovery of the *Discoverer XIII* capsule from orbit; 3) future recovery of a space vehicle from lunar or interplanetary flight.

INDUSTRY

From the Front Office

Navy has awarded Raytheon two additional contracts topping $2.5 million for *Polaris* advanced guidance systems. Most sub-systems will contain welded modular assemblies . . . GE-Pittsfield has just won a $1.3 million contract for prototype fabrication of more *Polaris* inertial systems . . . also from GE-Syracuse, comes word of an advanced long-range acquisition radar which reportedly "more than triples" defensive capabilities of *Nike-Hercules*. A prototype of this radar was used in the Aug. 12 kill of one *Hercules* by another at White Sands.

ARDC Electronic Report Due

Five volume report of ARDC's Winter Study Group will be available to industry in mid-September. Under the organization of the Mitre Corp., the group has completed an intensive review of all AF electronic systems. Its report contains recommendations for future requirements of the AF Command and Control Electronics complex.

New Sounding Rocket

Latest entry in the sounding rocket field is Rocketdyne's 105-in. bird which can be fired out of a 5-in. gun or from its shipping container. Ammonium nitrate motor can kick a 6-lb. payload to 230,000 ft.

ICBM Base Lag Investigation

Despite Air Force moves to counteract slippage at ICBM bases (p. 8), chances are good there will be a Congressional investigation of industry's performance as well as military management of the program. The big question seems to be when hearings can be held. The short session now in progress mitigates against immediate action. But one could still be held in the fall—before election time.

Renegotiation Battle

Fight for changes in the Renegotiation Act is now shifting to the Senate Finance Committee. A House study group is standing pat on a recommendation to extend the Act unchanged.

Off to Broadway

"White Alice"—communications network for the early warning lines up north—is moving to Broadway. A play of that name is now in production. Main action takes place, so says the script, in a concrete radar tower perched 1500 ft. above Warning Site "Jane" at Cape Anchor. Backdrop is the Arctic sky.

INTERNATIONAL

Resistance to Skybolt

There are indications a move is afoot in British industry to head off purchase of the Douglas *Skybolt* ALBM. One possible alternative apparently being offered is the *Blue Steel* powered by the new Bristol Siddeley *Stentor* ramjet. The new engine would greatly increase the *Blue Steel's* stand off capability.

Italy's Jupiters on the Line

Great secrecy surrounds the deployment of Chrysler *Jupiters* to Italy. But COUNTDOWN hears that some missiles are being put into place in fixed pads and they are expected to be operational fairly soon.

Eye on Space

Ignoring its own country's disinterest in space, Normalair Ltd. of Britian is now displaying a line of respiratory equipment for astronauts.

Ease German Rocket Plant

From under the Iron Curtain comes word that R&D of solid rocket fuels is in progress at the Gumnitz forced labor camp near Pasewalk, Pomerania. Most of the prisoners are chemists, physicists and electronic specialists convicted of political crimes.

SAC snaps the whip . . .

AF Cracks Down on ICBM Bas

by James Baar and William E. Howard

Tough new management policies—aimed largely at industry—are being jammed into action this week by the Air Force to end slippage in the mushrooming ICBM base-building program before the nation's deterrent power is compromised.

Behind the scenes could be heard the whiplash of the Strategic Air Command—the bases' impatient customer.

The new policies follow a major Air Force and Corps of Engineers shakeup which was precipitated by delays of up to six months in readying combat *Atlas* pads at Warren AFB, Cheyenne, Wyo., and at SAC's doorstep around Offutt AFB, Neb. Essentially, the AF action is intended to:

–Apply a hammer-lock hold on the awarding and policing of all base construction contracts.

–Replace R&D "improvementism" with get-it-done production line techniques.

–Expose any further "opportunism" on the part of industry and labor.

–Head off any further slippage.

However, one dubious area remains—bickering and irresponsibility among labor unions and workers at the various sites. Strikes and jurisdictional battles have cost the program more than 30,000 man-days that can be pinpointed by the AF, and thousands more indirectly.

Goading the "catch-up" effort along is the possibility of an investigation by the House Military Operations Subcommittee headed by Rep. Chet Holifield (D-Calif.) into alleged deception and profiteering in connection with the sub-contracts being let to unqualified companies and bid-brokering or "shopping" by construction primes.

Even more important, they are looking into the Air Force-Corps of Engineers management setup and procurement practices with industry.

The subcommittee may trigger a full-scale hearing into the program.

• **Catchup a question**—Under its new organizational setup, the AF has taken responsibility for virtually all base-building away from its Ballistic Missile Division and handed it to the Air Materiel Command. Maj. Gen. Thomas P. Gerrity, a 46-year-old top procurement and production man, has initiated "Operation Catchup"—as chief of AMC's Ballistic Missile Center and



GERRITY
Starts "Operation Catchup"

newly made czar of ICBM base construction.

He has given orders to a site activation "task force" of 12 senior colonels, several of them from SAC, to make sure the "pads come in on schedule." The task force commanders are being put in charge of seven *Atlas* and five *Titan* bases under construction. (BMD retains responsibility for nearly finished pads at Offutt, Warren and Vandenberg AFB.)

Precisely how much catchup will be possible under the re-aligned management structure remains a grim question. Where delays have occurred in the construction of facilities and in the delivery of equipment, the making up of time is difficult. The Engineers also contend that there have been changes ordered in the configuration of the pads—*After* completion dates—making on-time delivery virtually impossible.

In addition, there is a serious question whether it will be possible to prevent further slippage through continuing labor difficulties.

Local labor unions have fought among themselves since the beginning of construction at Warren and Offutt over who should do what. Chief source of the work-stopping jurisdictional disputes is a varying question as to what constitutes construction and what constitutes maintenance at the sites.

The local workers have repeatedly walked off the job over such picayune matters as, for example, who should install ceiling light fixtures at Offutt's Site A, and whether Convair workers could uncrate Convair-made launch control consoles at the site.

The Air Force and Convair have been powerless to halt such walkouts. They say they are still powerless. However, some critics of the program say that better management could reduce these stoppages. An effort is under way to get the international unions to make their locals change their business-as-usual policy.

• **What's the hurry?**—The men responsible for bringing the pads in at Warren and Offutt say the craftsmen at the site generally are indifferent as to what is at stake.

"These unions don't even want to hear about the urgency of this program," snorted one disgusted supervisor. "Their only interest is how much they can get out of the sugar bowl in the time it is here."

But labor alone cannot be blamed for all the slippage.

Both the Air Force and the Corps of Engineers candidly admit their management has failed in part. The admission is implicit in the switchover from BMD to AMC and in the Army's decision to establish a centralized Ballistic Missile Consrtuction Office under Brig. Gen. Alvin C. Welling in the same building with Gerrity at Englewood, Calif. The AF also concedes that there have been too many engineering changes.

As one top AF official puts it: "The engineers have had it long enough. Now it's time for production men to build it."

Under the new system, site activation commanders have full authority not only to oversee construction and installation, but to police the contracts. Formerly they had only indirect authority over contract supervision. These commanders will report to the youthful-looking Gerrity who for years has been overseeing AF bomber production and procurement.

• **Offutt story**—Most of the flare-up over the building lag is presently concentrated on the nine coffin-type *Atlas* pads at Offutt. This three-by-three complex for the 566th Strategic Missile Squadron was started in April, 1959. It

Delays

was to have been operational by this October. But the pads now are not expected to be ready until March or April.

It is here, in the Nebraska cornfields, that the Army Engineers are being accused of permitting "bid brokering" by the facility construction prime contractor, Malan Construction Corp. of New York City. The Corps has disclosed that Malan subbed out more than 90% of its contracts to "46 to 50" other companies. Nor is this all.

Malan, in the original bidding for the $13-million Offutt contract, was rejected by the Army as unqualified for the job, despite its low bid. Malan appealed and, by making a management-financial arrangement with Grove, Shepherd, Wilson and Kruge, Inc., a long-established firm which had done jobs previously for the Corps, was given the contract.

Philip Grove, vice president of GSWK, told M/R his firm performed 45% of the work at the sites and subbed out 55% to 26 "specialty" companies. He said his firm was in a "joint venture" with Malan and reports of bid brokering were "grossly exaggerated." But the Corps said "technically" GSWK was a sub to Malan and that Malan had other subs, bringing the total close to 50.

One of these subs, Superior Electric of New Jersey, was finally fired for "inactivity." Another sub which had only $150,000 in assets won a $2-million contract from Malan.

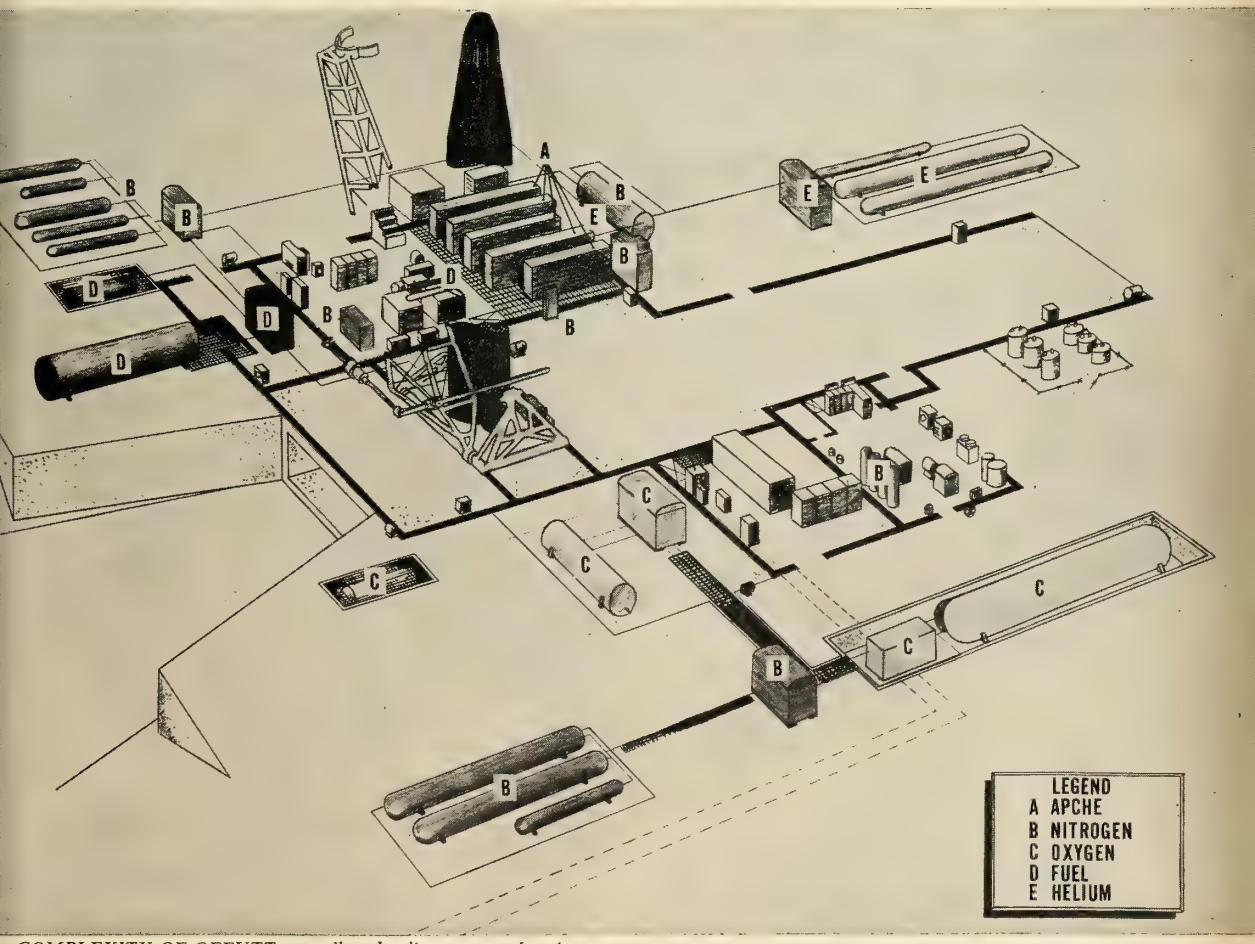
To prohibit a repetition of Malan's contracting arrangement, the Army—at AF insistence—has instituted a new requirement for the prime builder to accomplish at least 15% of the work himself; identify all of his subs in his original bid and make no changes without Army approval. The Army also is setting up a qualified bidders list to prevent "fly by nighters" from venturing into the program.

• **Pressure on Convair**—The AF said Convair also had contributed to slippage at Offutt. The prime for the program, Convair was reported to be six weeks late in delivery of ground support equipment. The company, the AF said, also brought mechanical contractors on board late and "underestimated the task," accounting for a two-month setback.

Convair has been required to expedite GSE deliveries and speed its advance planning.

Delays at Offutt are partly attributable to bad weather and some 37 engineering change orders. Authorities concede that these have hurt, but not to the extent of six months. What's the real reason?

One thing stands out clearly at Offutt's *Atlas* sites: hardly anyone seems to be in a real hurry. Somewhere between Washington and the warm green cornfields, the sense of urgency has run out.



COMPLEXITY OF OFFUTT propellant loading systems for Atlas has created a major problem: how to get skilled local labor to install it. Slippage has been caused by sub-standard values, failure to anchor pressure lines, grease applied to LOX joints.

The Missile/Space Week

Lemnitzer Picked to Replace Ailing Twining

Gen. Lyman Louis Lemnitzer, 61-year-old Army Chief of Staff, has been nominated by Pres. Eisenhower to succeed retiring Gen. Nathan E. Twining, 62, as Chairman of the Joint Chiefs of Staff. Gen. George H. Decker, now Army Vice Chief of Staff and Lt. Gen. Arthur G. Trudeau, Army R&D chief, have been mentioned for Lemnitzer's present position.

U.S. Scores Missile Successes

Still batting 1.000 in recent launchings, the United States added these missile successes to its list: An Air Force *Bomarc B* bagged a *Regulus* target drone traveling more than 1000 mph over the Gulf of Mexico Aug. 11. The next day, an Army *Nike-Hercules* blasted another *Hercules* 11 miles above the White Sands, N.M., missile range, both traveling at speeds in excess of Mach 7.

Also on Aug. 12: The Air Force sent an inertially-guided *Atlas* ICBM 5000 miles down the Atlantic Missile Range. Navy's *Polaris* zoomed 1100 miles from a land-pad launching to a target near Puerto Rico. Only flaw in the record: A 1.5-ton instrumented nose cone carried by the *Atlas* was not recovered from its watery target. But recovery was a secondary objective in the test to develop the new guidance system.

Martin Co. Saves $10 Million on Missile Master

The Martin Co. is returning $10 million on a $95-million contract it received in 1955 from the Army for the Missile Master system. Some 400,000 man-hours were trimmed from the originally estimated one million man-hours development time. Spare parts estimate of 15% was cut in half, because of "the excellent basic design of the system." Missile Masters are operating in six strategic areas, and four more will be added by the end of the year.

Rocketplane X-15 Sets Second World Record

After careful checking of *X-15* instrumentation readings and data from ground stations, the altitude record set by the North American rocketplane August 12 was revised to read 136,500 ft. instead of the 131,000 ft. first reported. Air Force Maj. Robert White flew the plane to the near-26 miles high mark.

Re-entry from 19½ Miles Up

While Maj. White made news by flying up, Capt. Joseph Kittinger hit the headlines when he came down. The 31-year-old Air Force Captain stepped out of his open gondola balloon at an altitude of 103,300 ft. and plummeted toward the New Mexico desert below. Free-falling the first 17 miles, Kittinger reached speeds of 450 mph, gradually slowing as the air became denser. At about 2½ miles above the earth his parachute opened and brought him to a safe landing. His 13 min., 8 sec. trip chalked up at least four records for the space survival program.

Attitude Arc Jet Engine Contract Awarded

A 1-kw electric arc jet rocket engine will be built by Plasmadyne Corp., Santa Ana, Calif., under a $200,000, 12-month NASA contract.

Flood Would Force Unfreezing

Legislation that would require the Administration to spend all funds appropriated by Congress for defense in FY 1961 has been proposed by Rep. Daniel Flood (D-Pa.), a member of the House Defense Appropriations Subcommittee.

Air Force to Reorganize Its Top Research Command

The USAF Research and Development Command will announce shortly the top command reorganization of its Research Division and the Office of Scientific Research.

The changes resulting from this mild shakeup are:

–Maj. Gen. William M. Canterbury will either be replaced or retired as commander of the Research Division for reasons of health.

–Brig. Gen. Ben Holzman, deputy and acting commander, will go to the Cambridge Research Laboratories as Commander.

–Dr. Knox Milsaps, former chief scientist at Holloman AFB, will replace Col. A. P. Gagge as director of AFOSR. Dr. Milsaps will also wear a second hat as chief scientist of AFRD, assuming both duties on Oct. 1. Col. Gagge has held the post since 1956.

Col. Gagge is expected to be reassigned to the Pentagon.

Maj. Gen. Daniel Hooks, presently commanding the Air Force Missile Development Center at Holloman AFB, probably will assume command of the Research Division.

Col. Nathan L. Krisberg, now commander of ARDC's European Office, is believed likely to become the Division's vice commander.

ARDC officials said there was no particular significance to the shuffle except the continuing effort to strengthen the basic research efforts of the Air Force. Gen. Canterbury, even then in bad health, was assigned when the division was formed a few months ago. It encompassed the OSR and was intended to beef up the basic research center to the same level as ARDC's other commands.

Gen. Holzman, basically a meterologist and one of the six weather experts to pick D-Day in the European Theater, World War II, commanded OSR for two years before moving up to the deputy slot of the division. There was some possibility, officials said, that he might remain in command after Gen. Canterbury's departure but it was unlikely. The Air Force wants the two-star spot filled with a major general and General Holzman has insufficient time in grade for a promotion at this time.

Dr. Milsaps holds a bachelor of science degree from Alabama Polytechnic with a Phd in physics and mathematics from Caltech. During his years at Holloman he developed the sled technique for testing gravity forces. He is a past president of the Holloman Section of the American Rocket Society.

Some companies protest . . .

Minuteman Enviroment Bidders Pressed

by Richard van Osten

LOS ANGELES—In an apparent attempt to push up the operational date of *Minuteman,* the Air Force is giving bidders only two weeks to submit proposals on the ICBM's environmental control system.

The proposals are due Aug. 26.

This early deadline, set at an Aug. 12 meeting here, is being protested by several of the 30-odd bidders. Companies with offices on the East Coast are complaining that 14 days is much too short a time to transmit data, study the system's configuration and determine where their capabilities and products can be used.

There are indications the AF would like to get at least some *Minutemen* in combat silos by late next year—followed by a fully operational 150-missile site on the previously announced date of July 31, 1962.

Proposals for subsystems and components of the overall environmental system are scheduled to be evaluated by Oct. 1. On or about the same date, a straight fixed-price engineering and development contract will be awarded to cover a four-month period in which a complete prototype system is to be developed and tested. Initial testing of the system and components is scheduled for completion no later than Jan. 31, 1961.

Next step will be the award, about March 1, of a new and separate contract for initial supply and installation of environmental systems at the first operational deployment area, Malmstrom AFB, Great Falls, Mont. The latter contract will call for 15 launch control facility (LCF) and 150 launch facility (LF) environmental systems.

Schedule for the full-scale contract calls for deliveries to begin in May, 1961, with delivery and installation of at least 30 launch facility and three launch control facility systems be completed by July 31, 1961. The remainder of the systems are to be delivered and installed by July, 1962.

• **Tight timing**—This planning will require close coordination with silo construction. A large portion of the environmental systems for both silo (LF) and LCF installations must be in place during actual concrete pouring. Invitations to bid on contracts for silo and other facility construction are expected to go out about Oct. 1—at the same time the contract for engineering and development of the system is awarded.

Time is of the essence, Lt. Col. Ira J. Blanco, Director of *Minuteman* facilities program for the USAF's Ballistic Missiles Center, told the Los Angeles briefing.

Pointing out that schedule dates requested are "not targets," he said the dates must be met.

"We are dead serious about schedule deliveries. If one section of the contracting falls behind the whole weapon system can go off schedule."

Most sensitive area of all in the timetable is the end point in the development program, the Air Force office added.

Hercules Wins 3rd Stage

Minuteman third-stage engines will be produced by Hercules Powder Co., ending a hotly contested race with Aerojet-General.

According to the Air Force, Hercules won the contract because of successful completion of its research and development work.

The R&D effort included a solid propellant with the highest I_{sp} of any measured to date, pivot nozzles for thrust vectoring, thrust termination which enables the range to be controlled and accurately programed, lightweight nozzles of non-eroding materials and a glass-reinforced plastic case from the Young Development Division of Hercules.

Negotiations between the firm and the Air Force's Ballistic Missile Center are due to start in the near future.

• **Complexities**—The rush into the *Minuteman's* environmental system was not based on quick judgment. Analysis, says Blanco, showed that the weapon system's requirement could be met in most areas with commercial equipment. Some prospective suppliers are a little less confident.

The *Minuteman* environment control system is complex—in order to maintain temperatures and humidity with tolerances of the present propellant. The missiles will probably be recycled on a schedule yet to be determined, but the USAF plans no scheduled maintenance at *Minuteman* sites for a three-year period. It would like to boost this to five years. This presents a reliability problem.

The environmental system's meantime between failures (MTBF) is not pegged at three years. For the overall system, MTBF is set at 14,000 hours—something less than two years. Components of the environmental system will have to better this timetable. This is what worries some possible suppliers.

The Air Force will not accept redundancy in the environmental system. This bothers engineers accustomed to three-way back systems.

• **No deviations**—The Air Force is adamant about space requirements, also. Components and systems must fit the prescribed envelope. There is little enough room for support equipment and the AF simply will not "buy" hardware that deviates from the plans they are trying to freeze now.

Another environmental system requirement is that the systems design and arrangement must provide the capability of restoring functional operations within three hours actual working time at the site in event of any operational failures in the system.

• **Separate systems**—The overall *Minuteman* environmental control system is divided into two complete, functioning systems. One will handle requirements at the LCF. The other will take care of the LF.

The LCF system provides normal functions of temperature, humidity and air purity within the underground control center. It consists of two brine chiller modular packages, two modular unit air conditioners, electric heating components, an activated carbon unit for odor control and an exhaust fan to remove fumes from the storage battery compartment.

The LF system is simpler—the silo being normally unmanned. It consists of a single brine chiller modular package in the support building and a single modular unit air conditioner in the silo's equipment room.

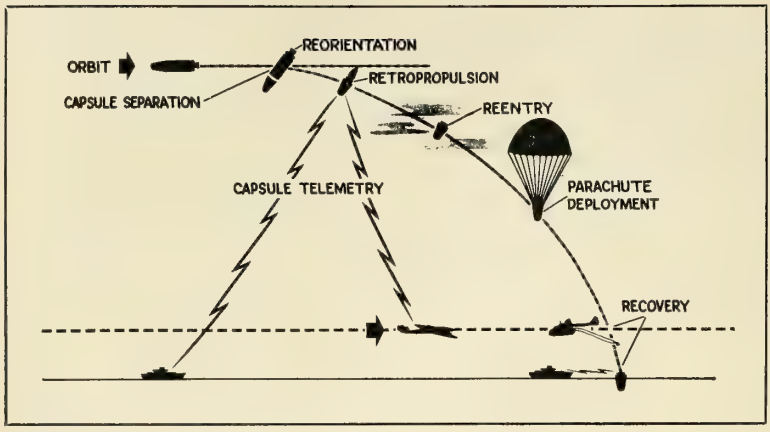
• **High pressure**—There is no doubt the AF, sensitive to criticism on ICBM site construction delays, will keep high pressure on all phases of *Minuteman.* Disliking the words "schedule dates," the AF prefers to call steps in its timetable "milestones." But as one firm's representative said at the bidder's conference:

"It's going to take a lot of 100-yard dashes to put this mile together."

Monkey retrieval planned . . .

Discoverer Success Speeds AF Plans

Recovery results will be given to Mercury program; development of Samos and Midas will also be expedited



FIRST ORBITAL recovery came with an assist from Navy frogmen.

SUCCESSFUL RECOVERY of *Discoverer XIII's* capsule from orbit has moved the Air Force into competition with the early phase of NASA's *Mercury* man-in-space project.

The Air Force is planning to recover a monkey from orbit before NASA fires a primate downrange on a ballistic trajectory.

An attempt to return a primate from orbit will be made with *Discoverer XV*—scheduled for launching in the middle of September. NASA's *Mercury* program lists a downrange shot with a monkey aboard a *Redstone* in October. (NASA won't try to boost a monkey into orbit until March or April of next year, barring further slippage in the program.)

However, the Air Force does not plan to go beyond a monkey, although more than one may be launched in life capsules.

After the historic recovery of the *Discoverer XIII* capsule Aug. 11, Lt. Gen. Bernard A. Schriever, said all of the AF results will be made available to the *Mercury* project. He added that he hopes the combined effort will lead the way to *Dyna-Soar.*

Development of the *Midas* infrared early warning satellite and the *Samos* reconnaissance satellite are also being speeded by the first *Discoverer* success. The Air Research and Development Command chief notes that stabilization and recovery techniques are similar and both use Lockheed *Agena* upper stages. *Atlas* boosters will replace the *Discoverer Thor* boosters to put up the heavier *Midas* and *Samos* payloads.

Schriever also revealed these plans:

–About 35 *Discoverers* in all (22 after the Aug. 11 shot) will be fired through 1961 at the rate of about two per month.

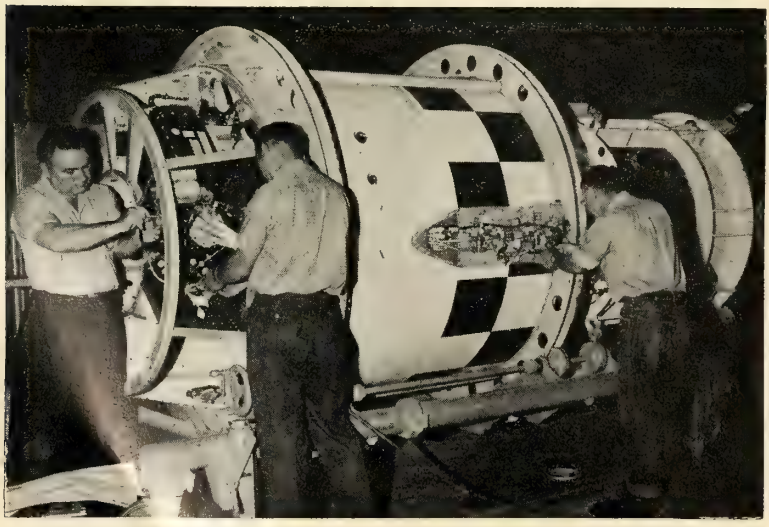
–First shot of a restartable Lockheed-Bell *Agena B* second stage will come in September.

–A series of *Discoverers* will carry infrared sensors to test equipment for *Midas.* However, there won't be any cameras, because the ones needed for *Samos* would be too bulky for the capsule.

• **It worked**—Successful recovery of the *Discoverer XIII* satellite capsule was not due to any major design changes in the system, but can be credited to the fact that "this time everything worked," according to a spokesman for Lockheed Missiles and Space Division.

Discoverer XIII contained a diagnostic instrument package designed to pinpoint problems which previously balked successful recovery of the 85-lb. capsules after ejection from orbit. Principal function of this package was to provide minute time breakdowns via telemetry of all phases of orbital operation during the re-entry sequence.

Together with its predecessor, *Discoverer XII,* which failed to orbit, the capsule was one of the most heavily instrumented in the entire program. It



CONFIDENT LOCKHEED engineer inserted a note in the Agena capsule predicting that this time—for the first time in the series—the capsule would be recovered.

was recovered very close to the planned splash area 300 miles northwest of Hawaii on Aug. 11.

Air Force C-119S of the 6593rd test squadron, patrolling the area in hope of making an air snatch with trapeze-type recovery gear, were thwarted by broken clouds in the recovery area which delayed sighting. The parachute-borne capsule was sighted by the crew of a C-119, however, and it was pulled from the water by a Navy frogman from a H04-S helicopter. The capsule arrived aboard ship, the Haiti victory, just 3 hrs. 54 mins. after its ejection from orbit over Alaska at 7:11 PM. When recovered, the capsule was still transmitting radio signals.

Lockheed said only minor changes had been made in the system and that additional instrumentation was almost entirely of a sampling type designed to monitor the re-entry and recovery phases with extreme detail. Air Force Ballistic Missile Division declined to discuss changes on the grounds that such information was classified.

• **High heat**—Telemetry data transmitted from the capsule indicated that drag and heating effects became severe at about 350,000 ft. temperatures on the surface of the protective shield rose to about 4000° F.

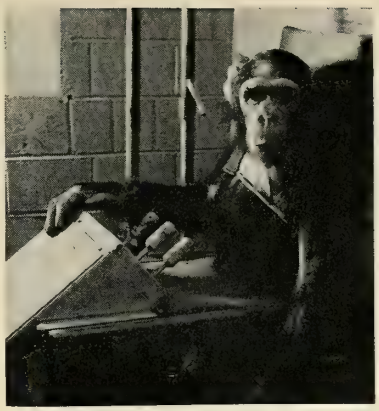
A thin gold plating on the inside surfaces of the heat shield helped to protect the payload from the relatively long exposure to aerodynamic heating. Unlike the nose cone of a ballistic missile, whose ablation period can be measured in seconds, the *Discoverer* capsule faced an exposure to intense heat for periods which could be measured in minutes, due to its more gradual re-entry path.

Bowl-shaped ablative heat shield of the capsule was 33 in. in diameter and 27 in. long. with its cone-shaped afterbody, the entire vehicle was about 40 in. in length.

During re-entry, a two-minute telemetry blackout was caused by the fact that high temperatures broke the air down into a plasma which blocked radio signals. At about 135,000 feet, the speed and surface temperature of the vehicle dropped to a point where radio signals could once again be transmitted.

During the blackout period, a tape recorder inside the capsule received and stored data on re-entry phenomena, transmitting this information after the blackout period ended. Maximum deceleration force on the capsule was between 10 and 15G's.

First stage of the *Discoverer* vehicle was a modified Douglas *Thor* propelled by a 165,000 lb. thrust Rocketdyne liquid propellant engine. Height of the first stage with its adapter



CHIMP named Pale Face, now training at Holloman AFB, may be first astrosimian.

was 66.7 ft. guidance and control was provided by a tape-fed programer for pitch and roll control and an autopilot for attitude stabilization.

Second stage was a Lockheed *Agena* vehicle, 19.2 ft. in height and 5 ft. in diameter, weighing approximately 8400 lbs. at launch. Orbital weight after fuel exhaustion was approximately 1600 lbs. after burnout of the booster, the first stage and second



MODIFIED THOR boosted Discoverer XIII into orbit. Program will total 35 shots.

stage separated.

Satellite guidance and control system included an inertial reference package, an infrared scanning device, a pneumatic jet control system and a hydraulic control system. The inertial reference package and the pneumatic jets, aided by the infra-red horizon scanner, combined to place the second stage in a horizontal attitude prior to ignition of the *Agena's* bell liquid fuel rocket engine.

Following the coast period, the engine, developing more than 15,000 lbs. thrust, propelled the second stage into orbit. Command for second stage ignition originated at Point Mugu, Calif.

After ignition, the pneumatic jet control system was succeeded by the hydraulic control system which gimballed the Bell engine to hold the satellite horizontal during orbital injection. The infrared horizon scanner continued to operate, relaying corrections to the second stage guidance system.

After cutoff of the *Agena* engine, the pneumatic jet control system resumed operation. Compressed gas under high pressure was metered to a series of external jets which swung the vehicle horizontally 180 degrees.

• **On 17th pass**—*Discoverer XIII* made 17 earth orbits during a period of 27 hours before ejecting the capsule. During the 17th pass, a timing device triggered gas jets which pitched the vehicle into a position 60 degrees down from horizontal. Separation of the re-entry vehicle was accomplished by a series of explosive bolts and springs. The retro-rocket was fired immediately after separation.

After retro-rocket burnout, the vehicle was travelling at only slightly less than orbital speed and following a path of less than five degrees from horizontal. After re-entering the earth's atmosphere, the trajectory became progressively more vertical as the vehicle slowed. Release of the parachute was accomplished by a switch operated by deceleration forces.

The entry and recovery vehicle was built by General Electric's Missile and Space Vehicle Department in Philadelphia.

Ejection capsule of *Discoverer XIII* weighed 300 lbs. at the time it left orbit. During descent, it shed its retro-rocket, parachute cover, and heat shield to reduce the weight to 85 lbs.

Launch of *Discoverer I* was on Feb. 28, 1959. The capsule from *Discoverer II* re-entered successfully on April 14, 1959 but due to the incorrect setting of a timer, was ejected prematurely. The capsule and its parachute were visually sighted in the Spitzbergen area at the computed time and position of re-entry and telemetry also gave positive indication of ejection.

The shadow test . . .

Echo Tests Practicality of Passiv

by Jay Holmes

ECONOMIC PRACTICALITY of a passive communications satellite system will be tested this week when NASA's *Echo I* balloon enters the earth's shadow for the first time.

Preliminary calculations give the 100-ft. aluminized plastic sphere, which was lofted into a nearly circular 1000-mile orbit on a second try Aug. 12, a life of about one year. However, there is no assurance that its useful life as a reflector will last beyond the first time it is hidden from the sun and plunges into supercold space. This will occur about Aug. 22.

To be acceptable, a satellite system must be at least potentially cheaper than conventional methods of building new transcontinental and intercontinental channels—such as submarine cables or microwave repeaters in hovering aircraft. Furthermore, the rebound type system is in competition with the active repeater communications satellite embodied in the Army's Project *Courier*.

Echo I's plunge into darkness will help answer the key question of how long such a satellite can live—and the frequency of launchings needed to provide enough such balloons to maintain relays between any two stations at any time.

• **Reversion to solid?**—Early experimentation had established that passive reflection of microwave signals from a satellite is a feasible way of adding to the earth's limited supply of radio channels. Successful reflections from the moon and the relatively small *Tiros I* weather satellite had proven the concept (M/R Aug. 15, p. 38).

However, *Echo I* is kept inflated in the near vacuum of space by only the incredibly low pressure of 4×10^{-5} psi (about three millionths of sea level atmosphere). Even this little amount, NASA calculates, is 25,000 times the external pressure of solar radiation and air drag at 1000 miles.

As soon as the balloon spends any length of time in darkness, the gaseous benzoic acid, anthraquinone and a trace of air inside it may contract and revert to a solid state—allowing the balloon to deflate.

When it returns to sunlight, there is a question whether it will re-inflate to the perfect spherical shape required for useful radio reflection.

Another problem is the effect of micrometeorites. There is no question that at least some punctures will be caused when the thin surface is struck by these particles of cosmic dust. Further, the launching took place at the height of the annual Perseid meteor shower, somewhat increasing the possibility that the *Echo* balloon might be struck by a larger meteor.

NASA scientists planned for some micrometeorite leakage in *Echo's* internal design. The sublimation of 10 lbs. of benzoic acid, which has a relatively high vapor pressure, provided initial inflation. In reserve was 20 lbs. of anthraquinone, with a much lower vapor pressure. The anthraquinone sublimated much more slowly, so that some remained as a solid reserve to replace the benzoic acid gas as it leaked out the micrometeorite holes.

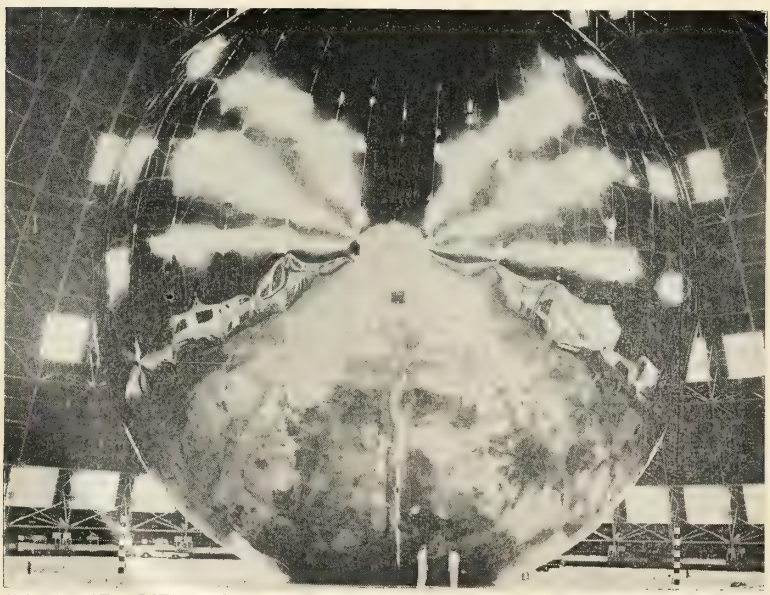
When most of the gas leaks out, the balloon will begin to distort and the quality of the reflected signals will degrade. Research is already under way at NASA's Langley Research Center to produce rigid satellites, which will not collapse after loss of internal pressures.

Since very little information on micrometeorite density is available, scientists are unable to predict how long the puncture and deflation process will take.

A third question with bearing on *Echo's* usefulness is the life of the solar cells powering the radio beacons. At 1000 miles, the balloon is passing through an intense portion of the lower Van Allen radiation belt. The Van Allen particles are bound to damage the solar cells. The only question is

Echo I Vital Statistics

Time of launch	5:39 a.m. (EDT) Aug. 12
Time of inflation	6:02
Vehicle	Thor-Delta
Perigee	943.0 stat. mi.
Apogee	1050.9 stat. mi.
Orbital inclination	47.243°
Velocity at perigee	15,980 mph
Velocity at apogee	15,636
Period	118.299 min.
Expected lifetime	1 year



ECHO SATELLITE is shown during ground inflation tests. Forty thousand lbs. of air is required to inflate the sphere on the ground, only a few lbs. in orbit.

ɔmmunication

when the damage will be incurred.

• **Communication experiments**—The first message relayed, a recorded statement by President Eisenhower, was transmitted from the Jet Propulsion Laboratory at Goldstone Lake, Calif., to the Bell Telephone Laboratory station at Holmdel, N.J., as the balloon was over the central United States near the close of its first orbit. The recording, played at an Aug. 12 press conference, was loud and clear with just a trace of whistling noise.

The first two-way exchange took place the following morning between engineers of Collins Radio at Cedar Rapids, Iowa, and the Alpha Corp. in Dallas, Tex. Later that day, JPL and Bell Labs accomplished a two-way exchange.

JPL and Bell Labs also accomplished simultaneous transmission and reception of recorded messages. Bell Labs played back Eisenhower's message while JPL sent a recording by Sen. Lyndon B. Johnson, chairman of the Senate Space Committee.

Many other organizations, both government and private, conducted similar experiments. NASA provided orbital data to help scientists around the world in similar experiments. NASA's Abe Silverstein said he knew of no Soviet interest, however.

The American Telephone and Telegraph Co., parent company of Bell Labs, has an interest much greater than that of a government contractor in the success of satellite communications experiments. Only last month, company officials appeared before the Federal Communications Commission with a plea for the assignment of a broad section of the radio spectrum above 1000 megacycles for satellite and space communications.

AT&T wants to establish a network of 50 satellites to create additional telephone and television circuits throughout the world—both for commercial and military use.

John R. Pierce, director of research and communications principles at Bell Labs, credited with originating the idea of communications satellites in 1955, told the FCC active satellites like *Courier* appear superior to passive satellites for commercial communication. Major objections to *Echo*-type relay, he said, are the lifetime of the balloons and the requirement of very powerful ground transmitters, which would have to be separated by very large distances to avoid interference.

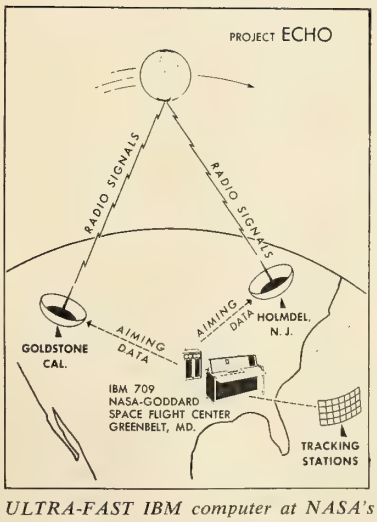
In the *Echo* experiments, JPL used an 85-ft. parabolic antenna to transmit 10 kilowatts at 2390 megacycles. Bell Labs used a 60 ft. transmitting antenna to transmit 10 kilowatts at 960 megacycles.

NASA's Newell D. Sanders, assistant director for applications and manned flight programs, has said studies indicate that at least 12 passive communications satellites spaced around the world are required to provide essentially continuous communication. Several satellites would have to be put in orbit by a single vehicle for the plan to be economically feasible, he said.

Pierce's figure on the number of satellites needed is higher. About 30 satellites in somewhat random 2500-mile polar orbits would provide a commercial grade of service between the eastern United States and Europe, he estimated. But he declared that individual satellites will have to have lifetimes in terms of years to be economically feasible.

NASA plans two more *Echo* experiments, in 1961 and 1962, and experiments with multiple satellites, under the code name Project *Rebound*, in the time period 1963-65.

• **Delta succeeds**—The Aug. 12 launching was the first success—on its second try—for the Douglas *Delta* second stage, a more sophisticated version of the workhorse *Able*. *Delta* has a second-stage guidance that makes possible an extremely precise orbital injection after a coast period up to 15 minutes, which brings the vehicle up to two-stage apogee.



ULTRA-FAST IBM computer at NASA's Goddard Center aims antennas at Echo.



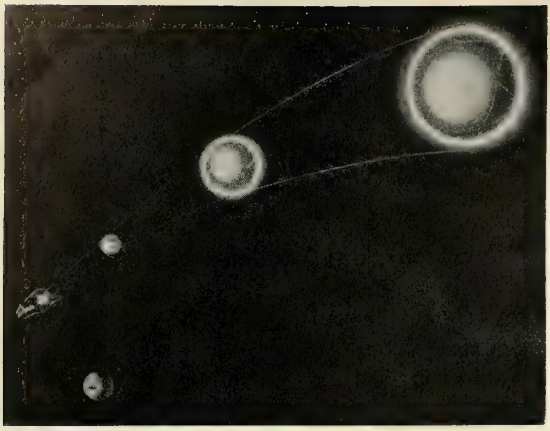
SEPARATION mechanism for Echo sphere shown in Douglas hangar at Cape. Spring throws in away from vehicle's 3rd stage.

Delta has an Aerojet-General storable liquid engine, Bell Telephone radio command guidance for 90 to 275 seconds and a specially developed Douglas flight controller during the coast period. The cause of the first *Echo* launch failure, in the May 13 launching, appeared on telemetry to have been the attitude jets designed to keep the vehicle on course during the long coast.

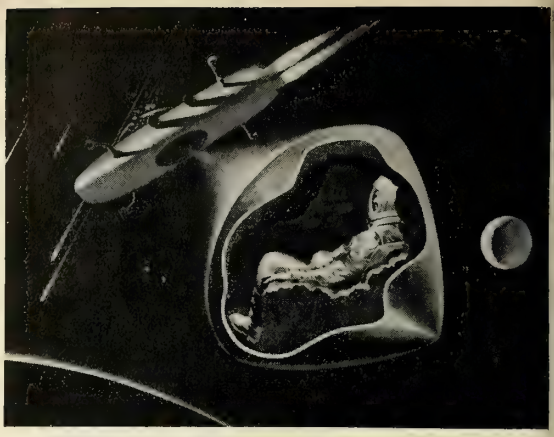
Just as in the *Thor-Able*, the booster was a modified *Thor* and the third stage was an Allegany Ballistics Lab-Hercules Powder Co. *Altair* 248 double-base solid rocket.

The balloon, made of Du Pont Mylar with a vacuum-deposited layer of Aluminum 2200 angstroms thick, was manufactured by the G. T. Schjeldahl Co. of Northfield, Minn. National Metallizing Division, Standard Packaging, Trenton, N.J., deposited the aluminum, which gave the sphere a reflectivity of 98%. The globe has 82 orange-slice shaped panels, each about 48 in. wide at the equator. The total plastic weight is 135 lbs. The aluminum weighs 4 lbs.

Other major contractors included: Kaiser-Fleetwings, Bristol, Pa., 26½-in. magnesium container that carried the package into orbit; Astro-Electronic Products Division, RCA, two 11-oz. tracking beacons transmitting 10 mw at 107.9 mc; General Mills, Minneapolis, initial development of inflatable sphere; Varian Associates, 10 kw power amplifier for the Goldstone transmitter; Remington Rand, computer in the Delta guidance, and tracking by Lincoln Laboratory, Atlantic Missile Range and Naval Research Laboratory.



JUPITER TRIP might be possible with ship powered by string of small nuclear reactors, suggested by Lockheed scientist.



PROTECTIVE COCOON of plastic could be spun by astronaut for emergency re-entry in system proposed in GE paper.

U.S. Delegates Paint Bright Picture

IAF meeting hears predictions of electric propulsion by 1963, two-stage trips to the moon

STOCKHOLM, SWEDEN—U.S. space exploration schedules will be revised upwards considerably if predictions made by U.S. delegates before the International Astronautical Federation come true.

One of these predictions, by Dr. Ernest Stuhlinger, chief of the Research Projects Laboratory of NASA's George C. Marshall Space Flight Center, is that electric propulsion systems may be flight-tested in 1962—and used for space missions the next year.

Stuhlinger and his Huntsville colleagues, led by the Marshall Center Director Wernher von Braun, were prominent among the U.S. speakers before the Federation.

Other papers by U.S. delegates discussed varied proposals from two-stage trips to the moon to a device that would allow an astronaut to spin a "space cocoon," allowing him to return safely to earth in emergencies.

Stuhlinger predicted that arc-heated and ion electric propulsion systems are being developed rapidly enough to be flight-tested in 1962.

He also said that space missions "may be flown from arc-heated systems from about 1963 on, and with ion systems from 1964 or 1965 on."

"Electric systems," according to Stuhlinger, "will be competitive with chemical systems on heavy freight missions in near space; on unmanned and manned missions to Venus and Mars; and very particularly on missions to more distant planets, and into deep space."

The present NASA space schedule for the 1960s is based on the use of chemical propulsion systems only. The advent of the type of efficient electric propulsion systems of the magnitude that Stuhlinger is talking about would drastically accelerate this schedule.

Reds Shun World Groups

STOCKHOLM, SWEDEN—*Russian delegates to the International Astronautical Federation meeting here have refused to go along with the proposal to establish an International Academy of Astronautics.*

They also refused to join a second international organization established here—an Institute of Space Law.

The Russian objection to the IAA is that there are already too many international bodies concerned with outer space. Their objection to the Space Law Institute is that this matter should be handled through the United Nations.

The new IAF is to have its headquarters in Paris, and will be headed by Dr. Theodor von Karman.

Also refusing membership in the new academy was Dr. Harrie S. W. Massey of Britain, who complained that research was suffering because scientists were trotting from one international conference to another.

• **Two to the moon**—Before man can go directly to the moon and return, a vehicle will have to be developed which has 12 million pounds of thrust at lift-off, but the U.S. hopes to perform manned lunar landings much earlier by refueling a *Saturn*-launched vehicle in flight.

Von Braun told the assembled space experts that the two-stage trip to the moon would be more reliable than the non-stop trip.

Other vehicles described by Von Braun were *Saturn*-launched space cargo stations and manned laboratories in earth orbits, and manned capsules that will be used to orbit the moon and to return man from the moon's surface.

The first phase of the two-stage trip to the moon, as Von Braun describes it, will be the launching by *Saturn* of a two-man capsule into earth orbit.

• **Tankers first**—Previously launched into the same orbit by *Saturn* boosters will be orbital tankers.

"Orbiting working crews, trained to perform certain functions under zero-gravity conditions," according to Von Braun, "connect the moonship and tanker and transfer the propellants from the latter to the former."

"The limited time period for the whole operation may demand a substantial number of *Saturn* pads on earth," Von Braun predicts, and if "limitations on time caused by the storage of hydrogen over extended

periods . . . prove decisive, lower energy storable propellants may have to be used . . . increasing the number of tanker flights by 50 percent."

Von Braun believes that the orbital tankers will prove to be more than a stop-gap measure. "A large vehicle could be assembled from a number of smaller ones," and by the time a large enough booster is developed for a direct trip to the moon, "the smaller, orbital-refueled vehicles would be of a more mature vintage and, therefore, more reliable."

Von Braun also envisages space stations where "high-acceleration space carrier vehicles could rendezvous and the transfer could be made to low-acceleration (ion or plasma) orbit-to-orbit spaceships."

Besides orbital tankers, Von Braun foresees orbital cargo carriers which would supply orbital space stations.

The orbital space station, Von Braun states, would have three individually sealed compartments: "(1) the crew capsule for powered flight, emergencies and re-entry; (2) the instrumentation and working area; and (3) the supply storage room.

Variations and modifications of the space station would be used for manned circumlunar space ships, and for the lunar manned-return capsule.

• **How big is big?**—If the U.S. desires to place 1 million pounds of cargo a year into orbit around the earth, the most desirable chemically propelled carrier would have a take-off weight of about 1 million pounds.

This is one of the conclusions reached by H. H. Koelle of NASA's Marshall Center in a paper based on his initial research into the problem: How large should rocket carriers be?

The parameters that must be used in determining the rocket carrier's size are according to Koelle, cost per pound of payload, mission reliability, annual transport volume, pad time, and the results in certain firing rates and the number of launch pads required.

And the ideal vehicle Koelle comes up with for low-orbit missions (for a 96-minute, 307-nautical-mile orbit) has characteristics identical with those of the rocket cargo carrier presently being developed by Koelle and his associates at Huntsville: *Saturn*.

In general, economic considerations tend to favor use of smaller vehicles, and operational consideration tend to favor use of larger vehicles. The resulting vehicle will be a compromise, Koelle believes.

His preliminary data indicates that operational requirements (payload size, real estate, etc.) rather than economy will be the determining factor; he doubts that the cost of putting cargo into low orbits will be much under $100 per lb. in the next decade.

How large the vehicle should be depends a great deal on how many years it will be used, and how many pounds per year the U.S. wants to put into earth orbits, Koelle believes.

"The size of the most desirable vehicle tends to increase with increased operational lifetime," Koelle states, and "tends to become more efficient . . . as reliability increases and production cost decreases.

Koelle warns that the numerical results given in his paper are correct only for orbital carrier vehicles using chemical propellents, and that a more refined study of this problem should be made.

• **To Jupiter**—Dr. R. H. Olds of Lockheed Missiles and Space Division described in his paper a nuclear-thermionic-ionic propulsion system which could operate under full thrust for the two years necessary to carry it to the planet Jupiter with enough residual power to operate its instruments for several years after.

The key to the whole system, Olds stated, is a series of small nuclear reactors about two feet in diameter producing 1200°C to banks of thermionic generators which convert the heat directly into electrical energy for the ion beam motors.

The fuel, according to Olds, would be 110 pounds of cesium vapor, which would be capable of delivering an equal amount of payload to Jupiter.

Before such a system becomes a reality, Olds stressed, more reliable generators, motors, pumps and similar items containing moving parts will have to be developed.

• **Cocoon safety**—How a man in space could "spin his own cocoon" for a fast return to earth in an emergency was described by Harold L. Bloom of General Electric's Missile and Space Vehicle Department.

Reading a paper which he co-authored with GE's John H. Quillinan, Bloom described a space suit over with an oxygen supply, recovery aids, and survival gear. Over the space suit is a plastic covering with attached tanks of foaming plastic and mixer, and a retro-rocket.

First, the escaping astronaut would fire his retro to head back toward earth. He would then inflate the plastic covering which would have proper shape for re-entry and impact. Next, the space between the man and the plastic covering would be filled with foam plastic. A hardened dense plastic foam would serve as the ablation heat shield, and a less dense, spongelike foam would act as a cushion.

NASA Adds Education Staff

The National Aeronautics and Space Administration is building a staff to conduct broad educational work about its activities on a long-term basis.

Heretofore, the NASA Office of Public Information has been so preoccupied with meeting the day-to-day demands of the current press—newspapers, magazines and radio-television—that it has not been able to give what officials felt was sufficient attention to long-term activities.

Last May 27, a new Office of Technical Information and Educational Programs was established, reporting directly to the office of the associate administrator. Shelby Thompson, deputy director of the Division of Information Services, Atomic Energy Commission, was named as director of the new NASA office.

Thompson's division took over the old NASA Technical Information Division, which had been in the Office of Business Administration. In addition, the new division assumed the function of preparing documentary films, exhibits, leaflets, reports and booklets of a general information nature, which had been part of the job of the Office of Public Information, headed by Walter T. Bonney. The OPI reports directly to the NASA administrator.

As a result, the OPI, with a staff the same size as before, is able to give more attention to current news. Bonney said that at last count telephone queries to the OPI were averaging about 400 a day.

Meanwhile, OPI has set up a nine-desk newsroom that brings all OPI information officers together in one room.

Herbert H. Rosen, former deputy director of OPI, has transferred to the new OTIEP. Joseph A. Stein, former chief of the OPI News Division, has been promoted to deputy director. Paul P. Haney replaces Stein.

Thompson said his division eventually will have a staff of 10 to 15 in addition to the 30 persons in the old Technical Information Division, headed by Bertram A. Mulcahy. Thompson said he has not yet chosen his chief deputy.

The former AEC official said he will welcome the cooperation of industry in his efforts to gain broad public support for America's space program. He said he hopes to be on all industry mailing lists, so that he will know of everything being done and will be able to suggest areas of possible activity when asked.

mergers and expansions

ARDC—renamed three of its Research Division's directorates. Geophysics Research Directorate and the Electronics Research Directorate located at Hanscom Field, Bedford, Mass. Both will be identified as the Air Force Cambridge Research Laboratories. AFRD's Detachment No. 3 at Thule, AFB, Greenland is redesignated Detachment No. 1 of AFCRL.

RADIO CORP. of AMERICA has broken ground near Palm Beach, Fla., for a new $4-million plant for its Series 301 electronic computer system. The 180,000-sq.-ft. facility will be in operation next January and employ several hundred persons.

IT&T has acquired the electromagnetic vibration equipment interest —including manufacturing rights, tooling, equipment, inventory and key personnel—from the L. C. Miller Co. of Los Angeles. IT&T will market an accelerometer calibration system and develop and expand other products into a complete line of vibration testing equipment.

TAYLOR FIBRE CO. is acquiring Dytronics Inc., Rochester, Mich. The manufacturer of die-stamped circuits for electrical and electronic applications will be operated as a subsidiary at its present location, retaining present officers and employees.

financial

Lear, Inc.—First-half earnings increased 10% over the corresponding period in 1959, reaching $1.2 million this year. Sales amounted to $45.6 million, compared with $38.6 million the initial half of 1959.

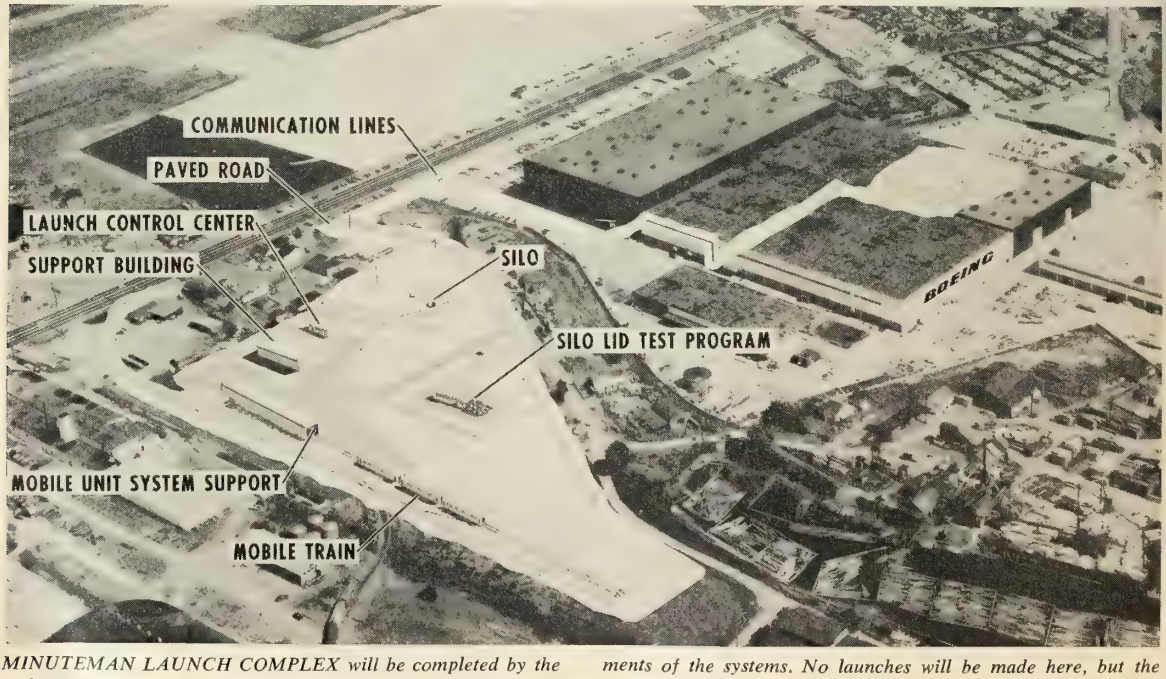
Texas Instruments—Both quarter and six-months totals reached new highs for TI, but the company forecasts a slight downward trend for the remainder of the year. For the three months ending June 30, net income rose to nearly $4 million on sales of $59.9 million, from $3.3 million income on gross of $51.5 million a year earlier. Third-quarter figures are expected to run somewhat lower than the first two quarters, with year totals expected to be between $16.5 million and $17,250,000, on sales of between $235 million and $240 million.

Ryan Aeronautical—During the nine months ending July 31, Ryan sustained a drop in profits to $1.6 million from the $1.8 million earned the same period last year. Sales during this time were $84 million compared to $53.7 million last year. Although not yet final, anticipated third-quarter figures are expected to reach $750,000 profits on sales of $33 million. Sales for the third quarter in 1959 were $16.4 million.

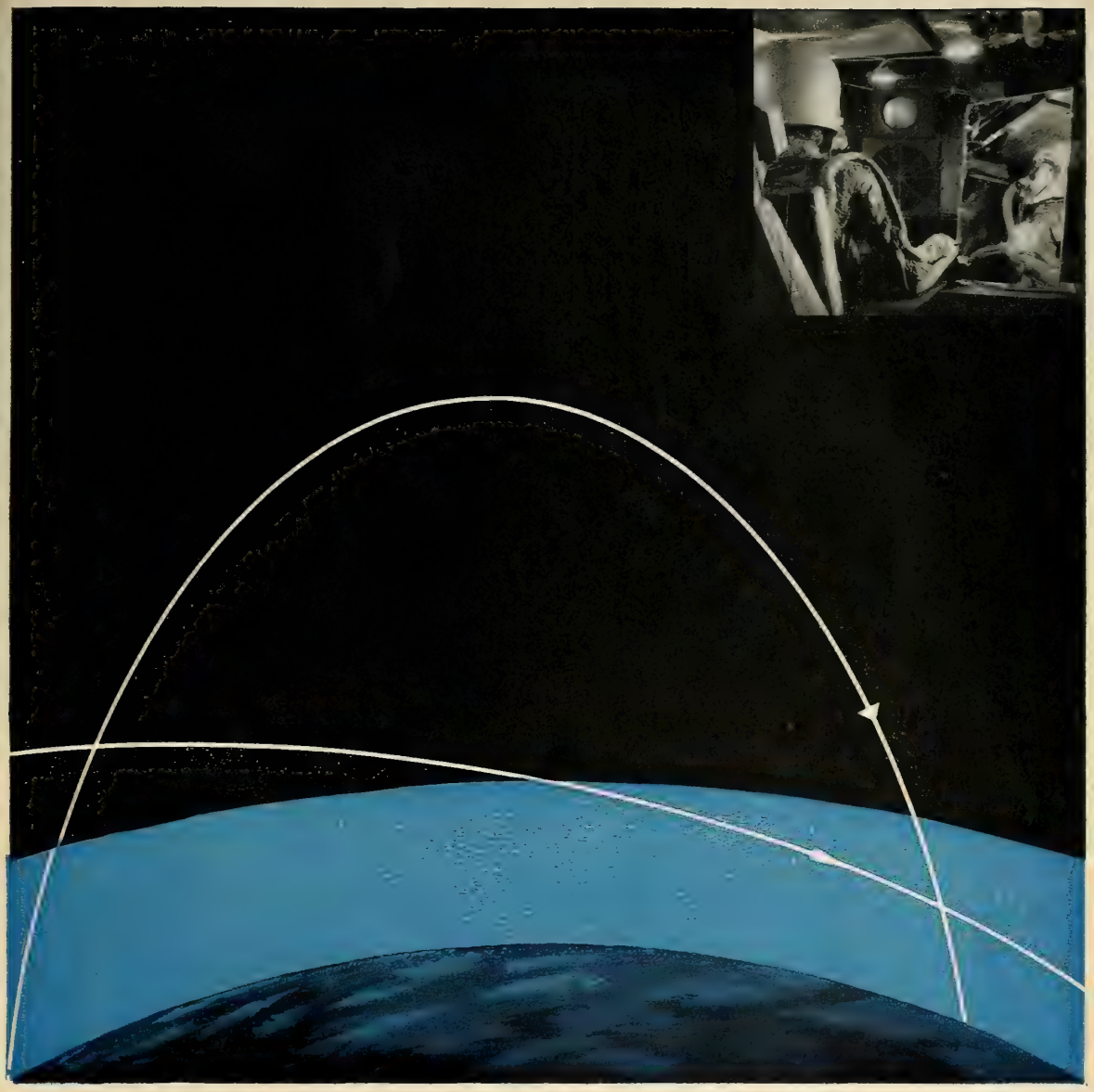
Vitro Corp.—Net income for the first six months of 1960 doubled the same period in 1959, while gross increased 10%. Income totaled $546,398 on sales of $30.5 million.

Lockheed Aircraft Co.—The company plunged $55.4 million into the red for the first six months of this year, while writing off $67.6 million in costs, partly on the Electra. Chairman Gross said the company has been operating profitably since June 26 and will earn between $9 and $10 million in the second half. This would put Lockheed's 1960 loss near $45 million. In 1959 the company earned $8.7 million on sales of $1.3 billion.

General Dynamics—Second quarter earnings dropped 26% from the like 1959 period despite a 12% increase in sales. Indicated earnings were $5.9 million on sales of $506.4 million. Second quarter in 1959 showed indicated earnings of $8 million on sales of $452.6 million. First six months income this year is $12 million on sales of $979.8 million. Same period in 1959 brought income of $15.1 million on sales of $804.3 million.



MINUTEMAN LAUNCH COMPLEX will be completed by the end of the year next to Boeing Airplane Co.'s Seattle Facility. Called the Seattle Test Program, the complex will enable the concurrent development of ground support equipment and elements of the systems. No launches will be made here, but the Air Force hopes that tests conducted on the site will make it possible to speed development timetables and save money in the construction of operational launch sites.



Ballistic and boost-glide flight paths

These flight paths, arcing through space and re-entering the atmosphere, are characteristic of the paths of a ballistic missile and a boost-glide vehicle. In both areas, Boeing holds major contract responsibilities. Boeing is weapon system integrator for the solid-fuel ICBM, Minuteman, and as part of a USAF-NASA research program, is developing Dyna-Soar to study the problems of manned space flight. The Dyna-Soar vehicle will be capable of re-entering the atmosphere and making a normal controlled landing.

Boeing scientists and engineers, in addition, are advancing the state of the art in many areas: advanced military and commercial aircraft, hypersonic flight, space crew environments, vertical and short take-off and landing aircraft, gas turbine engines, anti-submarine warfare systems, among others.

Professional-Level Openings

These and other future-oriented programs at Boeing offer outstanding career openings to professional specialists in the scientific and engineering disciplines, as well as in a broad spectrum of company activities in other-than-engineering areas. You'll find at Boeing a professional environment conducive to deeply rewarding achievement. Drop a note, now, to Mr. John C. Sanders, Professional Personnel Administrator, Dept. MII, Boeing Airplane Company, P. O. Box 3822, Seattle 24, Wash.

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THRUST TERMINATION

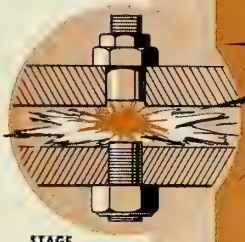


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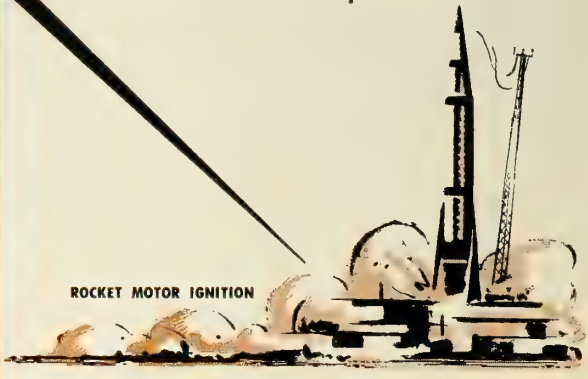
Complete XB Systems Capability For Missiles and Space Vehicles



STAGE SEPARATION BOLT



MISSILE DESTRUCT

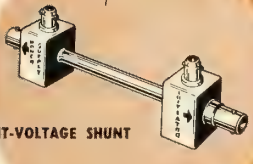


ROCKET MOTOR IGNITION

McCormick Selph Associates, after two years intensive study and development of high voltage power supplies, now offers a complete exploding bridgewire systems capability: available as complete missile and space vehicle XB ordnance systems (power supplies, transmission line and XB ordnance) or as separate components and devices. The Mc/S/A power supply uses no spark gap or thyratron high-voltage switches, charges condensers below minimum breakdown potential of air (< 327 volts), uses light and compact electrolytic condensers and has a controllable discharge rate.

Mc/S/A's approach provides wide versatility of application.

- POWER SUPPLIES
- EXPLOSIVE BOLTS
- XB CURRENT-VOLTAGE SHUNT
- INITIATORS
- IGNITERS
- PRESSURE CARTRIDGES



XB CURRENT-VOLTAGE SHUNT

To separate the characteristics of the XB initiator from the power supply, Mc/S/A has developed a current and voltage measuring shunt to be used in conjunction with dual-channel recording oscilloscopes. This dynamic test instrument provides voltage and amperes vs. time oscillograms at the XB initiator and permits accurate analysis of initiation characteristics separately from power supply and transmission line.

Contact Mc/S/A Applications Engineering Department with your specific XB systems or components requirements.

EXPLOSIVE ORDNANCE

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Technical Countdown

ELECTRONICS

Courier Will Have High Capacity

The Army-ARPA *Courier*—first active satellite communications system—will be able to handle almost 3.5 million words per day, roughly equivalent to twice the daily output of a major news wire service. Almost 100% redundant electronic circuitry and equipment will give the satellite an estimated 90% probability of remaining active for one year.

Army Reduces R&D Lead Time

The Army Signal Corps has, in some cases, reduced normal R&D lead time by as much as 50% through a "limited procurement" technique. Authority is given to buy promising items after successful engineering tests, but prior to complete user tests and standardization.

Thermionic Converter Operates

Conversion of nuclear fission heat directly to electric power by means of a cesium-cell thermionic converter has been reported by General Atomics Division of General Dynamics. The converter produced 90 watts from a nuclear fuel element of uranium carbide and zirconium carbide, with an overall efficiency of 10% at 3500°F.

Communications-Electronics Dictionary Published

A 25,000-item dictionary covering military communications and electronics is being published by the Air Force. Compiled at Maxwell AFB, "AF Manual 100-39" will be distributed late this month.

GROUND SUPPORT EQUIPMENT

Minuteman Test Area Completed at Cape

A $7-million launch area for the Boeing *Minuteman* has been completed at Cape Canaveral. The installation includes two complete launch sites, each with blockhouse, flat pad, service towers, 90-ft. underground silo, and assembly, storage, inspection and industrial area facilities.

FM-AM For Telemetry?

A considerable improvement in telemetry would be realized by changing the standard frequency-division system from FM-FM to FM-AM, according to one top expert in the field. Writing in the June *Transactions* of the IRE PGSET, Dr. L. L. Rauch says that such a change would result in better r-f spectrum utilization and better use of near-optimum demodulation and data reduction methods.

Plastic Bags for Space Repair Stations

"Drydocks" for space vehicles have been proposed by a General Electric engineer. Speaking at the recent AAS meeting, he said the space repair station could be a plastic skin drawn over the vehicle to be worked on, then inflated to provide a comfortable working atmosphere for the astromechanics.

PROPULSION

Hi-Fi Retro-rockets for Discoverer

Success of *Discoverer XIII* depended heavily on critical retro-rocket burning time and thrust to achieve precise re-entry. Rockets used were Thiokol TE-236A, similar to those slated for *Mercury*. The 50-lb. engines burned for about ten seconds.

Agena-B to Get Operational Test

An *Agena-B* will be used next month to put a *Discoverer* satellite in orbit. This first operational use of the bigger, restartable *Agena* is considerably ahead of announced schedule.

Satellite Stabilization Works Well

Accuracy of the attitude stabilization system on last week's successful *Discoverer XIII* reportedly was within one degree. A combination gas-jet control system and IR horizon scanner operate to stabilize the vehicle in different sequenced attitudes for injection, orbiting and—finally—for separation and re-entry.

ADVANCED MATERIALS

Heat Treater Looks Ahead

Second-generation solid-engine cases will find heat-treating facilities ready and waiting at the J. W. Rex Co. The firm is constructing a furnace with a working area 40 ft. high and 12 ft. across designed to handle chambers for million-pound solid rockets.

Hydrogen from Diesel Fuel

Army Engineers have developed a mobile unit capable of delivering 1000 ft.^{3} per hour of 98% pure hydrogen from ordinary diesel fuel oil. The unit was built by Girdler Construction Corp.

Silicon Prices Slashed

Prices of electronic-grade silicon were cut 6 to 28% by Merck & Co. The reduction was attributed to lower production costs resulting from new and expanded facilities.

Teflon Antenna on Discoverer

A mixture of Teflon and ceramic fibers was used in the *Discoverer XIII* second-stage beacon antenna. The uniformly ablating composite is a development of Rogers Corp.



SPECIAL ASPHERIC optical elements such as these will afford Mercury astronaut 190° field of view vision through his periscope while in orbit.

OPTICS

SPECIAL REPORT

Market Is Likely to Double

Although technology has suffered from relative shortage of R&D support, a bright future seems assured

by Charles D. LaFond

DESPITE AN ACUTE manpower deficiency, the optics market in the missile/space industry is expected to double in from three to five years. Its volume for Fiscal 1961 is estimated to be from $75-85 million.

Ninety percent of this market today is military, but with growing support from the National Aeronautics and Space Administration non-military sales for both R&D and products are expected to increase steadily for some time to come. This should broaden the diversity of technological advancement, but it is not expected to reduce the dependence of the optical industry on government sales.

For several decades half its revenue and most of its advanced research impetus have been derived from the military. Its future growth, however, appears tied directly to missile/space advancement.

• **Will optics need continue?**—This is a question frequently asked—usually by those in competitive fields. It is invariably followed with a whole string of reasons why optics is obsolescent.

This bias is well grounded in ignorance.

Land-Air is an engineering service company doing a great deal of contract work for the military at various missile ranges. Its personnel have lived with, operated, maintained and modified all types of electronic and electro-optical missile support systems. One of its senior engineers summed up the situation this way:

No one system, optical or electronic, can become the one and only system for missile/space use. The task is to fully develop each system to perform the functions for which it is best adapted, to use each system cognizant of its specialized role, and to use secondary benefits derived without compromising its primary purpose.

• **Is there an optics lag?**—This is a more difficult question. Technological advancement has been slower relatively than in other areas such as electronics. The reason is quite apparent—the military services have not allotted the funds for R&D so necessary for stretching state of the art.

Regardless of this lack of support, the industry has advanced. American optics has reached a point where it no longer is dependent on European supply of precision components.

The future looks even better. Dr. Konstantin Pestrecov, chief of Nortronics optical systems group, says: "The challenges for improvement in all areas of optics are likely to be solved in the U.S. because of growing importance of optics in missile/space systems. European nations are not devoting the same emphasis to these areas and therefore are not in a position to pursue development of capability to the same extent as the U.S."

• **Why is growth assured?**—The resurgent growth of optics in the Missile Age is a result of two things: the unique abilities of advanced optical components and systems; and the need to achieve high accuracy and resolution during the development of missiles, their flight operation phase, and their application.

This requirement for accuracy and resolution is a direct result of the enormous altitudes and ranges characteristic of missiles. Missile requirements have led to accuracy requirements in the seconds and fractions of seconds-of-arc range. In fact, seconds of arc are now becoming gross units. The micro-radian, approximately 0.2 second of arc, has now become a more convenient unit of angular measurement in missile optics.

• **Optical developments**—In the development of electro-optical systems for missiles, the crucial area is still the basic optical system. Development here has been directed to the design and fabrication of lenses capable of essentially perfect imagery when used in severe temperature and vibration environments. The design of "perfect," or diffraction-limited, lenses (those whose accuracy and resolution are limited only by physical laws) was almost impossible for the optical designer until the advent of high-speed computers.

The second development which the optical designer required was the freedom to use lens surfaces which were not spherical. In the past, he was forced to restrict his design to combinations of spherical surfaces which in many cases failed to give him complete corrections.

During the fabrication of the 20-in.-diameter f/1 satellite tracking optics, the optician developed techniques for fabricating surfaces which departed from spherical. Since then, aspheric lenses have played a major role in increasing optical system performance

A Special Report

This 16-page section, compiled under the direction of M/R Associate Editor Charles D. LaFond, surveys the market outlook and recent technological advances in a field seldom covered as a unit. Some highlights:

- Optics share of missile/space business likely to double in 3-5 years.
- U.S. optics industry is no longer dependent on European components.
- Astronomers remain vital to data collection, can now get 'clean' data.
- New firms may move into expanding area of missile tracking.
- Competition grows in production of tooling and alignment devices.
- Reconnaissance and research breed sophisticated new photo devices.
- Interest increases in light transmission through fiber optics.
- Optics finding application in guidance, navigation and communications.

while at the same item reducing "package" size and weight.

• **Optics in missile R&D**—The effect of missiles in accelerating progress in optics has been broad. The use of optics as a tool during the development of missiles, its use as a critical subsystem during the launch phase, and its prime role in missile and satellite payloads assure continued use.

One of the earliest development applications of optics was in Perkin-Elmer's Baker Super-Schmidt Meteor Camera. This f/0.67 system secured photographs of meteors entering the atmosphere, which permitted astronomers to determine their precise deceleration. This then allowed them to predict the upper atmosphere densities to be encountered later.

When missiles reach the flight test phase, tracking telescopes provide trajectory measurement and allow close monitoring of the engineering performance of the missile. Long-focal-length tracking telescopes have proved themselves invaluable during the critical first firings in the missile program.

• **Optical missile alignment**—Optics is now used as the link between the inertial guidance system and the earth coordinate system on which the target will be found.

In a normal launch from a fixed pad, the azimuth alignment of the stable platform is monitored by an autocollimator. The autocollimator, with a sensitivity of 0.1 second of arc and an accuracy of 1 sec. of arc, senses platform deviations in azimuth.

The correcting signal from the autocollimator restores the desired azimuth heading which will direct the missile to its target. In this fixed launch-pad application, the optical problem is one of maintaining the stable platform and the autocollimated axis constant with respect to either the celestial pole or an artificial reflector.

In addition to this prime reference system, a bi-axial autocollimating monitor must be used to continuously monitor the optical and radio sextants which are periodically used to calibrate the inertial navigation system. This heavy use of optical reference systems to tie the missile guidance system to the inertial and astronomical navigation systems has led to development of extremely precise, stable periscopes.

• **Geodetic applications** — During both the test and possible use of the guided missile, one of the present problems arises from the ambiguity in the relative surveyed locations of geographical points.

Conventional surveying techniques have established precise mapping of continental or regional land masses. Present techniques for linking these regional surveys or continental surveys to each other across large spans of water, however, are less precise than the inertial guidance systems.

Conventional astronomical techniques are incapable of achieving the desired accuracy because of gravitational anomalies.

The most precise means of linking the maps of separate land masses is based on use of ballistic cameras and flares or strobe lights on missiles or satellites. The pyrotechnic flare or strobe light at missile or satellite altitude is photographed by two fixed, open-shutter ballistic plate cameras located at known points on one land mass and by a third camera located over the unknown point requiring calibration.

Stellar background is used as the basis of measurement. The first two cameras, with their known base line, determine an angle with the flare. The location of the unknown station is determined, using the known base line and the fact that the lines of sight from all three stations intersect at the flare.

• **Surveillance and reconnaissance**—The full potential of optics for resolution and accuracy and for maximum information content is available in missile and satellite payload applications.

One of the major reasons is that the optical system is essentially above the degrading influence of the turbulent atmosphere. Hence it is limited only by the laws of diffraction, which allow resolution increases in direct proportion to increases in the aperture.

The resolution and maximum information content advantages of optics are shown by the panoramic camera. The information contained in its roll of film would require hours of telemetry transmission. Major current problem in systems of this sort is in stabilizing the camera and image compensation to prevent the motion of the missile or satellite from degrading the photograph.

The materials and structural problems involved have been solved adequately for apertures up to 5 or 6 inches. It is believed that the problems of large aperture instruments—36 in. diameter and greater—will be solved more readily for astronomical applications than for surveillance and reconnaissance applications.

Current development of high sensitivity, 1/30th second-of-arc star trackers and stabilizing techniques for balloon-borne telescopes will greatly ease the guiding problem.

Unfortunately, surveillance and reconnaissance from satellite and missile altitudes are extremely complex. Their informational effectiveness will be limited by the difficulty of achieving image and motion compensation better than 1/30th or 1/50th of a second of arc, and by the limited band-width available for the transmittal of information.

• **Problems galore**—The greatest problem today, a Ball Bros. official told M/R, is the lack of trained optical engineers. Optics, he said, has been shamefully neglected by engineering schools. The few good physicists in the field are just not interested in everyday optical engineering.

Others complain there are too few optical and photographic scientists. Even skilled optical specialists are hard to find. But, worst of all, none of the many companies which have felt this shortage sees any signs of improvement.

Many manufacturers believe that optical progress is being delayed to a large extent by simple economics—the very high cost of tooling up for radical experimental optical systems.

Most in the industry have felt the duress of having to produce precision optics within 1-second-of-arc tolerance. They recognize the need for such accuracies, but somehow, they feel, the in-



MARK I ROTI (Recording Optical Tracking Instrument) is an automatic tracking system developed by Perkin-Elmer and recently delivered to Air Force Missile Development Center, White Sands. It provides detailed missile performance data at distances up to several hundred miles.

dustry must improve production techniques and make the technology more of a science than an art.

Part of this problem may be the result of another common feeling now being voiced by younger engineers. They say there is an ever present strong resistance to any change in the industry, especially in production techniques.

Much of this resistance stems from the highly skilled craftsmen in the trade.

The broad use of photography in missile work has generated another problem. Many feel that now is the time for the government and industry to sit down and carefully review requirements.

Many times the limitations of photography are not recognized. For example, many missiles have been launched during heavy overcast. Under such conditions most of the footage will be useless.

• **New products needed**—Typical of any field experiencing accelerated growth, the optics industry has a multitude of new material, product, and process requirements. The rate of growth to a large extent depends on how fast these requirements can be met. Here are a few more urgent needs:

• **New materials** to solve environmental conditions not conducive to high-quality optics (vibration, sudden temperature change, rapid acceleration, etc.)—materials offering real stability during missile flight. Also, improvements in glass and crystalline substances of special characteristics—so that large-diameter optical blanks of high quality can be obtained readily.

• **Production capability** for cast optics. It should be possible to reproduce in quantity with image quality comparable to astronomical telescope elements. Another must is automated production of high-quality aspheric surfaces to any given prescriptions.

• **New lens elements** capable of ultra-high resolution—in the magnitude of 6 million image elements/sq. in. Lightweight optical elements must be produced also without loss of quality, precision, or reproducibility.

• **Shutters** of large diameter must have greatly increased reliability.

• **Equipment** refinements in many areas are needed: automatic tracking with automatic focus and real-time readout; vastly increased photographic frame rates and automatic exposure control; adequate attitude and stability control of directional optics; more sensitive, less noisy detectors for all spectral regions; low-power, high-temperature optical communications modulators; long-range inertial guidance by optical means.

1961 Military Market Estimates for Optical Industry

(Figures represent reasonable summary of estimates resulting from M/R poll of 115 manufacturers, directly or indirectly associated with military optics. Totals include electro-optics but exclude these instruments primarily designed for infrared. Also excluded from this roundup are ophthalmic, medical, metallographic, spectrographic, spectrometric, and photomicographic instruments and microscopes.)

	(millions of dollars)
Specialized instruments	150-175
Photographic lenses	45- 55
Projection equipment	45- 55
Binoculars & telescopes	7- 11
Optical process & quality-control instruments	3- 4
Total (Military)	250-300
Total (Missile/Space)	75- 85

• **Data assessment** from film is too slow. A rapid means in both processing and data reduction must be developed.

• **Who controls components market?**—The so-called U.S. "optical industry" is unlike almost any other segment of our whole industrial world. It is an industry of specialized producers. True, there are many large manufacturers who control large pieces, but none dominate in all areas.

A brief rundown of the kings in the optical components domain must include the following:

–Optical glass—About seven manufacturers produce the bulk of the high-grade optical glass, with four companies in the lead. The biggest are Eastman Kodak (Hawk Eye Works), Bausch & Lomb, Pittsburgh Plate, and Corning Glass Works. The others are American Bifocal Co., Hayward Scientific Glass Corp., and Southwest Optical Co.

–Lenses, prisms, mirrors—Chief figure without question is the American Optical Company—over 35% of its sales are in the precision lens field. Next are Eastman Kodak, Bausch & Lomb, Elgeet Optical Co., C. P. Goerz American Optical Co., and Wollensak Optical Co. Not quite so big but still important producers are Bell & Howell, Argus Cameras, Kalart Co., Meyer Opticraft Co., Atlantic Research Corp., Nortronics, Aerojet-General, Simpson Optical Co.

–*Filters*—High-quality precision optics are of little benefit to many instruments without equally perfect filters. In this area, the U.S. has obtained international control and five companies are leading the field: Kodak, Harrison & Harrison, Ednalite, Tiffen, and Enteco.

• **Who are systems leaders?**—Leading producers of instruments and systems change almost every few years. The reason is just a reflection of our leap-frogging technology. (More details are provided on manufacturers and equipment in succeeding sections.)

–Tracking—J. W. Fecker Div. of American Optical Co. looks like the current leader in missile optical tracking instrumentation. Besides its own systems it handles the Contraves Ag Zurich cinetheodolites and has installed, maintained, and modified the system at every major range in the U.S. Askania-Werke, Wild Heerbrugg (Swiss), and Perkin-Elmer rank next in that order. P-E handles the Bodenseewerk systems. Others include Electro-Optical Systems, Bausch & Lomb, Nortronics, Mitchell, Bowen and Cook Electric.

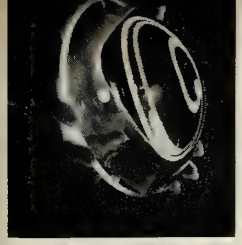
–Telescopes—Perkin-Elmer is currently developing some of the bigger telescopes (a 36-in. reflector for Stratoscope II and a 48-in. reflector for M.I.T.) but for the smaller and higher volume instruments Bausch & Lomb, Fecker, Kollmorgen and Air Cargo Equipment Div. of ElectroVision Corp. are ahead, B&L leading.

–Tooling & alignment instruments—Keuffel & Esser has about the widest line of industrial tooling and missile alignment devices in the Free World. It controls 40% of the market. K&E also handles Askania theodolites under the K&E brand name. Nearest and biggest competitors are Hilger-Watts, England, and Brunson Instrument Co. Next in line are Perkin-Elmer, Davidson Optronics, Bausch & Lomb, Kollmorgen, Air Cargo Equip., Nortronics, Texas Instruments, Kern Instruments, Farrant Optical, and Optron.

–Special photographic equip.—For precision still and motion photographic equipment (excluding tracking and surveillance), these are the leaders: Perkin-Elmer, Chicago Aerial, Cook Electric, Bausch & Lomb, Consolidated Electrodynamics Corp., Milliken, Mitchell, Bell & Howell, Eastman Kodak, Wollensak, Argus Cameras, Cameraflex, Federal Mfg. & Engineering Corp., Avco, Electro-Optical, and Fairchild Camera.

–Guidance & navigation—A relatively small field at the present time, optical guidance and navigation is in its infancy. These are the current leaders: Chicago Aerial, Ball Brothers, Kollsman, Cook Electric, Nortronics, Texas Instruments, Kollmorgen.

–Surveillance—This is an area of growing importance. More and more manufacturers are moving into the field with new advanced systems: CBS Laboratories, Chicago Aerial, Texas Instruments, Milliken, Cook Electric, Bausch & Lomb, Nortronics, Westinghouse, Aerojet-General, Hughes, Kodak.



OPTICS

Visual Sighting Still Vital

Astronomers now can hoist instruments high enough to get 'clean' data; some high spots in new instrumentation

DESPITE ADVANCES in telemetry and radiotelescopy, visual observation of space phenomena and space vehicles remains indispensable to the collection and interpretation of data.

And the astronomers can at last get through the atmospheric veil that has for centuries restricted their observations. With our progress in space technology, we can now lift instruments through the fog and obtain "clean" information. Eventually man, too, will follow.

Dr. John Strong of Johns Hopkins University and Cmdr. Malcolm Ross, U.S. Navy, have achieved much with their celestial observations from aboard an astronomical balloon.

Dr. Martin Schwarzschild's Stratoscope I, an unmanned balloon, successfully carried a 12-in. telescope up seven times. The clearest solar pictures ever made were photographed on these missions. His Stratoscope II, carrying a larger telescope, will go aloft sometime in 1961 to observe the atmospheres of Jupiter and Venus and to make other studies of Saturn, Pluto, and the Great Nebula in Orion, according to the Princeton University professor.

Prof. Leo Goldberg, of the University of Michigan, predicted recently that either a satellite or moon observatory probably can be established within 20 years. (He further believes that man would be a liability on such a platform, because he would make accurate aiming impossible.)

The first true astronomical research satellite is now being built by Ball Brothers Corp. NASA plans to launch the 300-lb. satellite on a *Thor-Delta* rocket next year.

• **High spots**—None of this would be possible, of course, without a vast number of improvements in instrumentation. A brief glimpse at recent developments for astronomy should include the following:

Perkin-Elmer, long a leader in optics and well known to astronomers for its Baker-Schmidt telescope, continues to supply better instruments. Its six Super Schmidt meteor cameras are being used in pairs to study height, speed, and direction of passing meteors.

The Stratoscope I telescope was built by P-E and the 36-in. Stratoscope II is now being built by the company. The fused-silica blank for the 36-in. mirror was cast by Corning Glass Works.

Definition with this system is expected to greatly exceed that offered by the 12-in. instrument.

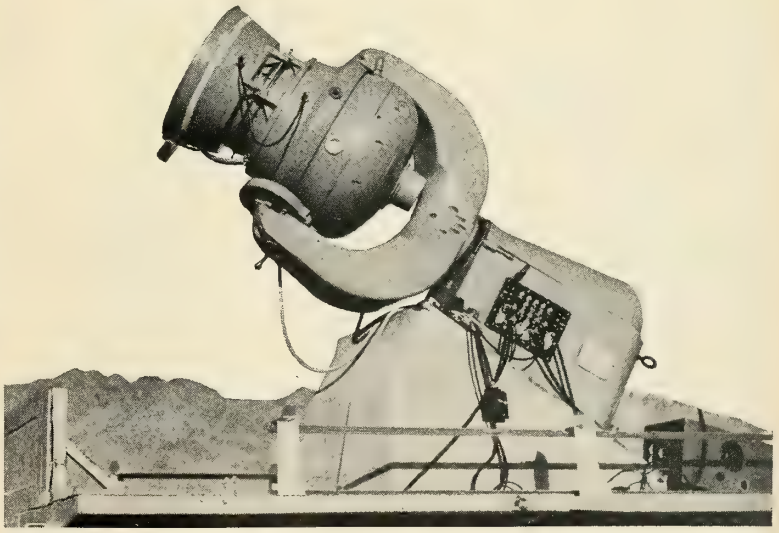
By employing closed-circuit television techniques with powerful telescopes, the Air Force says it can now capture photographs of stars heretofore unobtainable. Key to the system is an image reproducer developed by ITT laboratories of Ft. Wayne.

An electronic transducer receives light through the telescope and transforms it to electrical impulses. These are amplified and converted to a visual image on a storage cathode-ray tube. The object being scanned then may be observed visually or photographed.

So sensitive is the equipment, says the Air Force, that photographic exposure time can be sufficiently brief to eliminate the quality degradation so often caused by atmospheric tremors. Exposure time can be reduced over 10,000 times with the system.

Another recently developed aid to stellar studies is a wavefront-inverting interferometer, conceived and built by the National Bureau of Standards in Washington. Simple and accurate, it can be used to measure the diameter, separation, and time of meridional transit of stars. (It may also be used to check aberrations in reflector- or refractor-type astronomical objectives.)

The system consists essentially of a special prism assembly, eyepiece, and a camera attached to a telescope. The desired wavefront inversion is introduced by the nature of the prism used, a modified Koesters prism made up of two identical prisms cemented together with a partially reflecting film on the inner face. Fringes can be viewed from either side.



BAKER SUPER SCHMIDT Meteor Cameras built by Perkin-Elmer. Early meteor photographs taken with this camera yielded data on upper-atmosphere densities which would be encountered by missiles and satellites. The camera, which has a 52° field of view, also took the first photo of Vanguard I.



OPTICS

Missile Tracking Field Due

Three makers now lead technology established during World War II; a survey of advances in telescopes and came

OPTICAL TRACKING has been, remains, and will continue indefinitely to be a primary method of obtaining and recording missile performance information.

Its value is long-established; while its progress has undoubtedly been accelerated since missile manufacturing became big business, it is well to remember that the cinetheodolite was a standard field item in the German Army during the Second World War.

Today, two general classes of instruments are used by all missile ranges: the cinetheodolite and ballistic camera, for precisely recording spatial position of a missile in flight; and the long-focal-length photo telescope, for recording events.

Three manufacturers—Fecker, Askania, and Perkin-Elmer—at present lead the field. But new products and growing in-house capabilities indicate that others may move into—and change—the picture within a few years.

• **Biggest supplier**—J. W. Fecker, Inc., a division of American Optical Co., has more major tracking systems in operational use today than any other single company. It has achieved this record with two principal instruments: the EOTS (Electro-Optical Tracking System) cinetheodolite and the IGOR (Intercept Ground Optical Recorder) long focal-length photo telescope.

Over 50 EOTS's are now in use and many more are on order for missiles ranges in and around the U.S. (They are also used by General Electric to check BMEWS antennas.)

Good from 1 km to infinity, the 35-mm instrument can track at accelerations up to 60°/sec.^{2} and with velocities for both azimuth and elevation from 0.02° to 30°/sec. Frame rate is variable from 10 to 30/sec. Contraves Ag Zurich Switzerland, manufactures the EOTS; Fecker installs, modifies and maintains them.

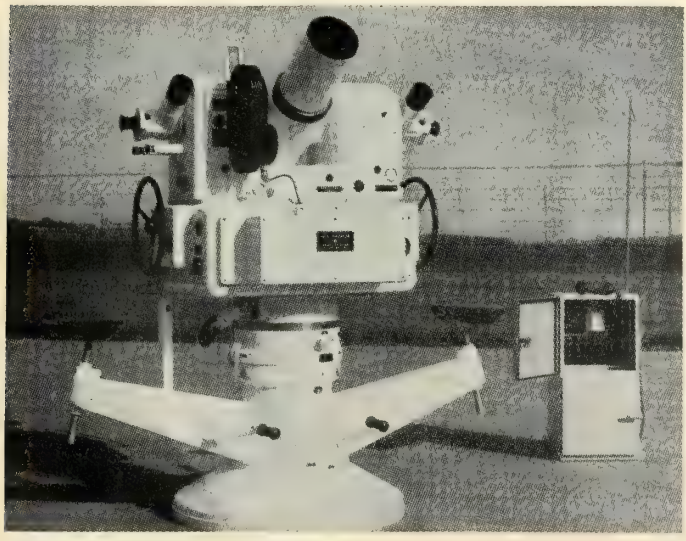
The IGOR photo-telescope is used to record events, rather than trajectory. It has an initial focal length of 90 in. and can be stepped up to 500 in. A very precise and high-quality instrument, it is also considerably less costly than competitor instruments, according to Fecker. Twelve have been placed in operation and more are on order.

• **Hundreds of miles**—Similar to the IGOR is Perkin-Elmer's Mark I ROTI (Recording Optical Tracking Instrument) recently placed in operation at the Atlantic Missile Range and White Sands Proving Ground. It can provide detailed photos at distances up to hundreds of miles of missile flight path, velocity, acceleration attitude, etc. (A modified version is being used for infrared missile plume studies at AMR.)

Perkin-Elmer has developed 12 satellite tracking cameras for Air Research and Development Command, USAF. Called SATRACK, the cameras are used to plot the orbital positions of U.S. and foreign satellites from strategic sites around the world.

Another P-E device is its panoramic tracking camera, first developed for the Air Force. Using a rotating prism to "wipe" an image on film, the airborne camera covers a 180° field perpendicular to the plane's heading with each exposure.

• **First with theodolites**—The first and still a major world producer of cinetheodolites is Askania-Werke of Germany. Its Kth58 (manual) and Kth



LEFT: *EOTS PHOTO-THEODOLITE, built by Contraves/Ag Zurich, Switzerland, is sold by J. W. Fecker, Inc., throughout U.S. It is widely regarded as among the best for missile/space tracking use. More than 50 are now in use.*



RIGHT: *NORTRONICS will develop this 60-millimeter ballistic camera—largest of its type. A recent Air Force contract calls for six of the cameras, which will make use of a new louvre-type shutter one foot in diameter.*

o Expand

58E (motor-driven) instruments are used at every major missile range. Each offers unlimited azimuthal range, 180° elevation, and 15° depression angles.

Interchangeable cameras can be used for either 5 or 10 frames/sec. operation. Lenses, too, are interchangeable for focal lengths of 30, 60, 100, or 300 cm.

The best known ballistic camera in the field is probably the BC-4, developed by Wild Heerbrugg, Ltd., of Heerbrugg, Switzerland. Used on most of the major missile ranges, it is believed by many to be the most accurate optical measuring device of its kind in use.

Nortronics Div. of Northrop Corp. is currently designing a new 60-mm ballistic camera for the Air Force. It will be used to determine exact missile trajectory by photographing its flight against a background of stars. Specifications call for a louvre-type 12-in.-dia. shutter to operate at a speed of 2 millisec. Six will be delivered.

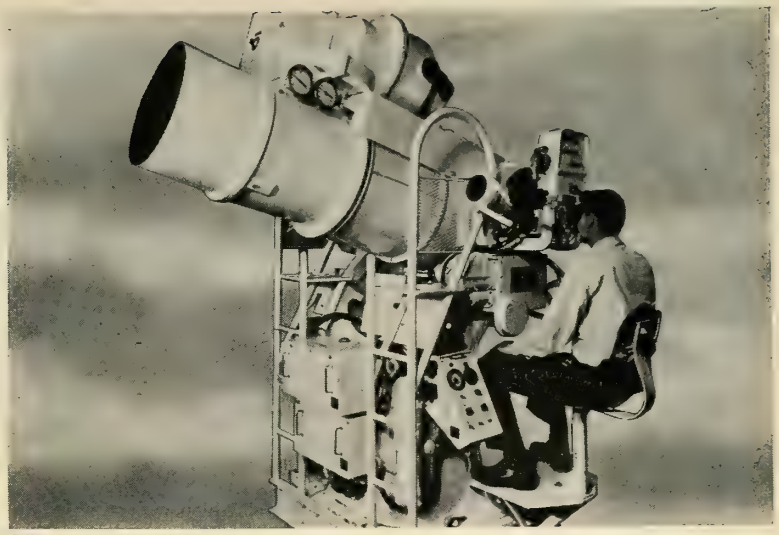
• **New system for Cape**—To provide highly accurate real-time missile trajectory information, Radiation, Inc., is reportedly developing a new system for the Air Force called SORTI. The Star Oriented Real-Time Tracking Instrument will in effect combine a ballistic camera system with electronic tracking and stellar orientation reference. The system will be built, it is believed, for the Missile Test Center at Cape Canaveral.

Designed especially for range tracking is the Model V. Multidata 70-mm Camera by Flight Research, Inc., of Richmond, Va. Frame rates from 10 to 60 ft./sec. and exposure times from 1/30 to 1/1440 sec. are standard. Start-up time for full speed operation is 3 sec.

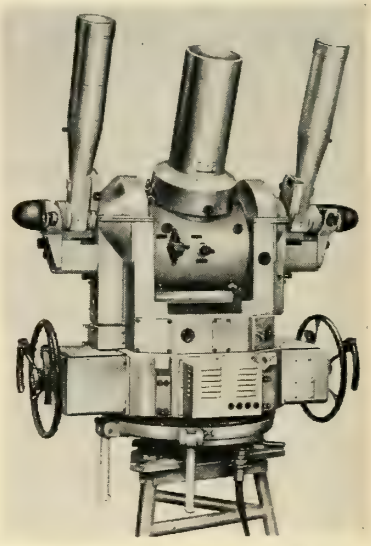
Cameraflex Corp., Garden City, N.Y., has designed and built the Model IBDM-20 for use as a radar antenna-mounted boresight camera. It will be used to collect data for calibration, tracking-error correction, etc.

Less magazine, the 35-mm camera assembly weighs 15 lbs.

Frame rate is 20/sec., but this can be raised to 48/sec. with a change of drive gears. The system has a reflex-type viewfinder with bore-sight reticle. A three-track optical data recorder handles square wave pulses up to 2 kc.

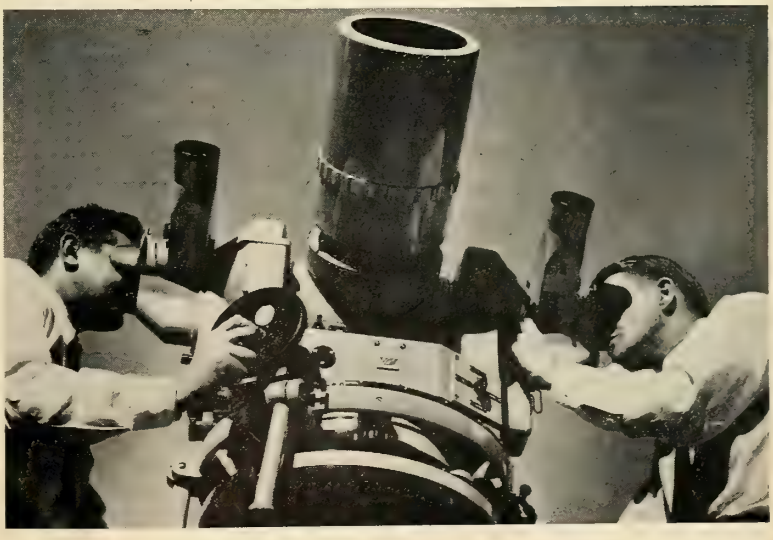


ABOVE: *IGOR MARK II 70-mm Tracking Telescope is used to document events during missile firings. Tracking rate is 10°/sec. Optical system is an 18-in. clear-aperture catadioptic telescope with variable focal lengths.*



RIGHT: *ASKANIA-WERKE'S widely used Kth 58E automatic tracking cine-theodolite. Germans used early type in 1941.*

BELOW: *CINETHEODOLITE, built by Bodenseewerk, German subsidiary of Perkin-Elmer, is one of series of intermediate-focal-length units designed primarily for tracking missiles at short and medium ranges. Electrically driven, it permits frame rate of five exposures per second.*





OPTICS

Optical Alignment Field Sees Steadily Growing Rivalry

AMERICAN BOSCH-ARMA CORP. mock-up of typical collimator pit as laid o for Atlas ICBM. In ceiling are two openings: one to align the porro prism on t inertial platform, and the Polaris (star) sighting hole. To the left and rear of t alignment group are the azimuth reference prisms for calibration of the electro-col mator. Reference-prism alignment can be cross-checked with an alignment on Polari

OPTICAL TOOLING and alignment devices have changed drastically since World War II.

When the war ended, they were mostly optical-mechanical systems. From 1945 to 1950, there was a sharp decline in interest in the field. The '50's, however, saw the beginning of a surge toward electro-optics and electro-opti-mechanical instruments and systems—an upsurge largely created by missile/space impetus.

The missile/space field is by far the biggest current user of precision angular and linear measuring instruments. Because this field demands rigid quality control, inspection, and unusually close tolerances, the establishment of separate metrological laboratories—such as GE-Pittsfield and Keuffel & Esser (K&E)—is increasing.

Competition in the auto-collimator field is steadily rising. Leaders now are Perkin-Elmer, K&E, Davidson, Farrand Optical and Texas Instruments.

Practically no U.S. firms make standard theodolites. Those sold under the name of K&E are made in West Germany by Askania-Werke. Bodenseewerk supplies P-E. Contraves, Kern Instruments and Wild Heerbrugg (all Swiss) also are important European producers for the rest of the world. It just is not economically feasible for U.S. manufacturers to compete in the standard lines. For special theodolites, however, the U.S. can compete with its manpower and production capabilities.

Here are a few of the best devices now in use—and some of the more notable recent advances:

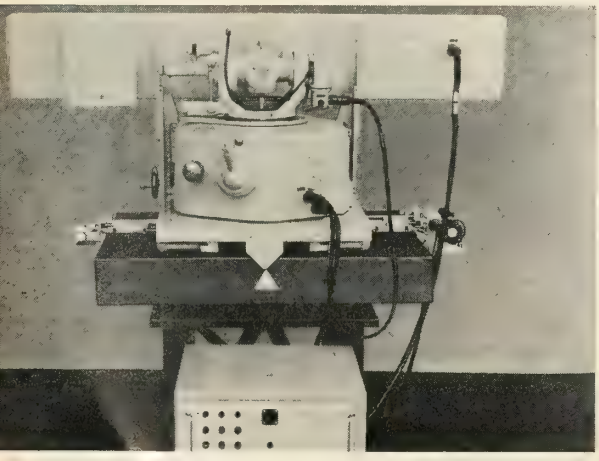
Perkin-Elmer's precision Azimuth Alignment Theodolite (actually, it combines an autocollimator with a theodolite) is used to align guidance platforms of many missiles, including *Jupiter, Mace, Thor* and *Atlas*. It can detect alignment deviations to less than 1 sec. of arc, the company says.

• **Self-correctors**—Among its hundreds of precision optical tooling and alignment devices, two of K&E's special systems are finding particularly widespread use. These are its electronic tilt-angle transducer and an electronic autocollimator. Each system uses the same type of power amplifiers and similar indicators (different scales); only sensing units are different.

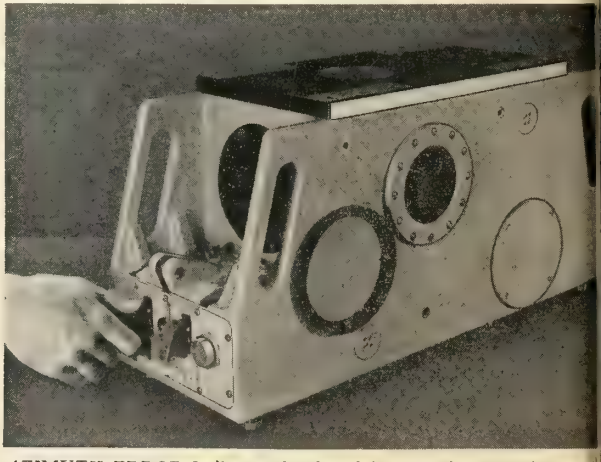
The tilt-angle transducer is a leveling unit, detecting automatically angular deviation with respect to gravity. By feeding the signal from the amplifier into a servo-mechanism, the system can be made to correct itself remotely.

The electronic auto-collimator differs from its optical cousins in its photo-electric sensing; it is much more sensitive. Used to measure angular deviations of a reflective surface with respect to the collimator axis, it too can be made self-correcting.

K&E also has produced recently a few prototype theodolites specifically



DAVIDSON THEODOLITE used to align the Thor missile prior to launching. Similar instruments are employed for different alignment phases of Atlas, Jupiter and Minuteman. Davidson has also built a highly accurate Platform Alignment Fixture.



AZIMUTH ERROR Indicator developed by Bausch & Lomb is used in Polaris submarines for missile guidance alignment before launching. It is tied in with General Electric's fire control system, together with three other B&L optical devices.



designed for missile alignment. These are direct-reading azimuth theodolites accurate to 0.5 sec. of arc. They are currently being used to align inertial guidance platforms.

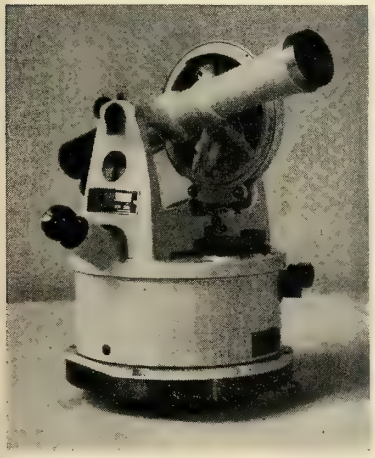
Another system was recently developed for initial missile alignment by Automation Laboratories, Inc., in New York. A prototype system, it is capable of measuring dynamically a 1-sec. deviation of line of sight to a source or target with a 3° or 4° field of view, according to the company.

• **Fixing acceleration** — Optron Corp. of Santa Barbara, Calif., has developed a line of calibration systems based on its Model 701 Displacement Follower. An electro-optical instrument, it measures vibration, motion and displacement for a myriad of applications. For example, it is used to study the three axes of motion of an accelerometer.

The instrument includes a CRT, amplifier, optical system with beam splitter and an end-on, 10-stage, multiplier phototube. When a spot of light is focused on the work, a photocell-servo system causes the spot to follow the object's motion.

The output presents an exact waveform of motion. Displacement can be read directly in inches; displayed on an oscilloscope, the waveform provides displacement and frequency readout. When both of these are known, acceleration may be calculated.

Linearity variation, absolute or terminal, over full scale from true linear line does not exceed ±0.2% full scale, according to Optron. Interchangeable lenses permit five displacement ranges with resolution of the lowest at 12 micro inches.



DIRECT READING azimuth theodolite developed by Keuffel & Esser Co. has accuracy to within less than 0.5 sec. of arc. It was designed for missile alignment.

• **Missile angles**—Among its many optical alignment devices, Davidson Optronics, Inc., built a missile elevation alignment set, D-980, recently for Minneapolis Honeywell. Used to determine the inclination angle of a missile with respect to horizontal, the system operates automatically up to launch time. It provides a warning signal when the missile position is ±0.5° of the desired angle, an uncaging signal when it is within 1 minute of the correct angle.

Davidson also built a Platform Alignment Fixture for Autonetics Div. of N.A.A. Having an accuracy to 1 sec. of arc, the rugged fixture will be used to secure alignment of inertial instruments to reference accelerometers on the stabilized platform of a missile autonavigator. Total fixture weight is 3.5 tons.

Through use of an automatic autocollimator with aperture sharing capabilities, the reading from an optical level is optically transferred by means of a front surface mirror and optical cube to the porro prism. The transferring procedure is achieved by translating the autocollimator along a precision slide until the optical axis reaches the porro prism.

• **Polaris applications** — PEAC, Photo-Electric Auto-Collimator, developed by Barnes Engineering Co. is used for prelaunch azimuth alignment of the inertial guidance system for *Polaris*. It is capable, says the company, of detecting deviation of an angular position to better than 1 sec. of arc.

A major portion of the *Polaris* optical alignment instrumentation is provided by Bausch & Lomb. Used with General Electric's fire control system are four B&L devices. The principal unit is its Azimuth Error Indicator (AEI), used to set the guidance package on the desired trajectory.

It performs a measurement function so that the inertial guidance receives constant precise settings from fire control prior to launch.



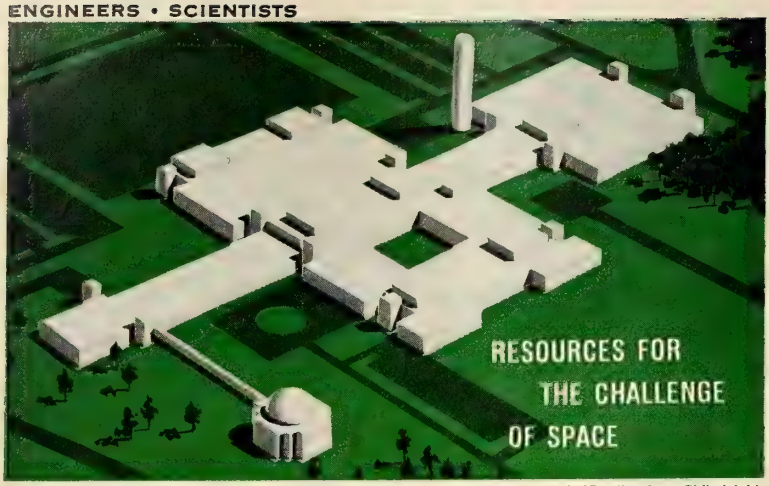
Kollmorgen Missile Tracking Binoculars are an integral part of an acquisition and photography system which records tactical air-to-air missile performance at China Lake Naval Ordnance Testing Station. These binoculars, adapted from a basic Kollmorgen design, are high magnification, wide-field instruments with unusual light-gathering power. An operator is able to spot a missile-launching aircraft and track the missile from the time it is fired until it finds its target—all at extreme ranges. Among other Kollmorgen contributions to the missiles field are the bunker periscopes at Cape Canaveral.

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Opportunities in Advanced Systems Engineering for Manned-Space Vehicles at General Electric's Missile and Space Vehicle Department

The growing emphasis on advanced studies in space systems at Missile and Space Vehicle Department—is demonstrated both by General Electric's investment of $14,000,000 for a new Space Technology Center now under construction, and by the formation of an independent Advanced Systems Engineering Section with the charter of developing systems to meet the requirements of the advancing space age.

The Advanced Systems Engineering Section has been given responsibility and freedom for anticipating operational and performance requirements, conducting advanced studies and performing preliminary systems designs on a broad variety of future space flight programs.

One major program currently under way, from preliminary design through vehicle prototype, is the study of manned-space vehicles to accomplish future missions of military reconnaissance, satellite inspection, space vehicle maintenance, space flight logistics and supply, scientific and military experimentation, and space rendezvous.

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OPTICS

SOME OF TODAY'S most advanced photographic instruments are emerging from two generally disassociated fields: reconnaissance and research.

Photography is a component of many of the optical systems associated with the missile/space field. But in most systems, modified off-the-shelf camera equipment is merged with theodolites or telescopes and an electrical or electronic control system.

In both photo-reconnaissance and basic and applied research, new configurations are being born. For reconnaissance, camera manufacturers are building equipment to satisfy stringent and unusual requirements rather than modify existing instruments to fit special applications. For research, the scientists themselves often build radically advanced devices simply because neither the know-how or instrumentation exists from manufacturers.

These are some of the newest developments in both fields:

• **Photo-Reconnaissance** — For manned and unmanned aerial reconnaissance Chicago Aerial has developed a line of compact photographic equipment and electronic accessories. One, the Sonne Continuous Strip Camera (invented by CAI's president) produces a single exposure of up to 400 feet in length. Resolution and quality are high.

Its KA-30 day or night camera is automatic and has built-in image motion compensation to eliminate blur. Coupled with the CBS Laboratories' Photoscan system, images are obtained and stored by the camera. By processing the film automatically, the negatives can then be scanned electronically and converted to video signals for immediate transmission to ground. Either way, permanent record is obtained.

The 5-second airborne processing was developed by Ansco. It uses a self-arresting liquid monobath. Emulsions are pre-hardened.

Use of a similar technique has been proposed by RCA's Astro-Electronic Products Div. with a maneuverable satellite-chasing camera. This particu-

Advanced Photographic Units Spawned

Strict and unusual requirements in both reconnaissance and research have made it necessary to depart from standard equipment

lar application technique would be especially suitable for a high-resolution space camera, currently being developed by his division, said manager Spencer Spaulding, speaking before the American Rocket Society in Los Angeles recently.

The new camera records images in the form of electrical charges on sensitive tape. Capable of storing up to 300 pictures, the equipment would transmit the data to earth, using standard television techniques, on radio command after each orbit is completed.

The camera could be launched either separately or with a satellite and ejected later. In either event, the objective would be for the camera vehicle to remain roughly 100 feet from the satellite to observe satellite performance.

By preprograming and radio assist from ground tracking stations, the camera would photograph its subject from different locations. If pulsed light were used for control, illumination also would be provided for use in the earth's shadow, said Spaulding.



BULOVA ENGINEER checks the optical system of a special camera developed by the company. It is one of several classified photographic units developed for aerial reconnaissance purposes. (The photo was made through a large "master" diaphragm-shutter used in the testing device.)

• **Research Photo-Instrumentation** —Avco's Research and Advanced Development Div. recently installed the first commercially produced 50 nanosecond (50 x 10^{-9} sec.) hypervelocity shadowgraph system. It will be used by Eglin AFB's Air Proving Ground Center as a tool to study terminal ballistics conducted under simulated high altitude conditions.

A complex light source-lens-camera system, its 0.25-μsec. light source and 0.50-μsec. Kerr Cell shutter can obtain images of projectiles travelling over 1400 ft./sec.

Similar laboratory shadowgraphs were used by Avco in studies resulting in operational ICBM nose-cone designs.

Benson-Lehner Corp. of Santa Monica has produced an ultra high speed camera having a frame rate up to 1.6 million frames/sec. Film is held stationary in a disk-like drum while the image is reflected onto the film with a wedge-shaped, air-turbine driven mirror. A Kerr Cell shutter controls light passage. A flash lamp produces 400 million lumens for 3 milliseconds.

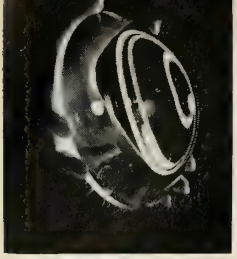
The systems should find research use in study of arc discharges, explosive reactions, shock cavitations, etc.

The Project *Mercury* space capsule will carry two D. B. Milliken Co. 16-mm observation cameras. Special purpose and very lightweight, one will photograph the astronaut while the other records instrument panel readings.

Operation of both cameras will be programed. Film speed during launch and re-entry will be 3 ft./sec., during orbit 1.2 in./sec.

A Kerr Cell camera has been developed by Electro-Optical having an exposure time of 5 millimicroseconds. By using the phenomena of electrically induced bi-refringement in liquid nitrobenzene, no mechanical shutter is required.

The company has used the device for the study of explosion phenomena and other hypervelocity research. The fast switching capability necessary for the cameras unusual exposure time also led to the development of exploding wire (see "Communications").



OPTICS

Fiber Optics Improves Sca

Huge potential for light transmission method; high resolution possible in electronic imaging with 'light pipes'

ENGINEERS WITH line-scanning problems are taking an active interest in a remarkable new method of transmitting light—fiber optics.

This infant technology represents the realization of a new application of an old principle: total internal reflection.

If a glass cylinder has an index of refraction greater than that of the surrounding medium, those light rays entering one end which are incident on the cylindrical surface at angles greater than the critical angle will undergo total internal reflection. The light will, in effect, be trapped within the cylinder.

A cone of rays, having a divergent angle determined by the critical angle, will be emitted at the other end of the cylinder. Qualitatively, this is the principle of fiber optics.

In addition, a moderate bending of the tube will result in only a slight loss of efficiency, since some of the rays close to the critical angle will escape. If the bending is gradual over the length, this effect is negligible.

Thus, if a bundle of these "light pipes" is constructed using very small-diameter fibers with the ends polished to high-grade optical plane surfaces, it is possible to transmit a complex image of light and dark areas through the bundle.

If, in the fabrication of the bundle, the order of the fibers has been maintained, a picture will be visible at the emitting end.

In practice, certain problems arise. The output resolution can be no finer than the fiber. Actual resolution turns out to be of the order of 1.5 times the fiber diameter.

• **Track jumpers**—Light rays which are not totally reflected back into a fiber may enter adjacent fibers. This results in a general reduction in contrast of the entire image.

American Optical Co., a major producer of fiber optic bundles, overcomes this difficulty in the fabrication process. The major cross-sectional area of a fiber consists of a high-refractive index glass. This is the primary medium of light transmission. This is surrounded by a thin layer of low index glass which serves as a boundary condition for total internal reflection.

DuMont Military Electronics Dept. of Fairchild Camera & Instrument Corp. goes one step further and coats the assembly with a thin metallic cover which reflects back or absorbs any rays not handled by the glass-to-glass junction.

Current individual clad fibers have an outside diameter of 0.002 in. and a maximum length of about one meter.

Bundle ends are matched in the distribution of fibers so that both ends of the fiber occupy the same geometric position. The intermediate part of the bundle can be permitted to hang loose, making it possible to lock the viewing end in position and move the input end around to "look" in various directions.

The limit of bending radius per fiber is 20 times its diameter. This amounts to a 0.04-in. radius of curvature. A smaller radius of curvature would cause serious image distortion.

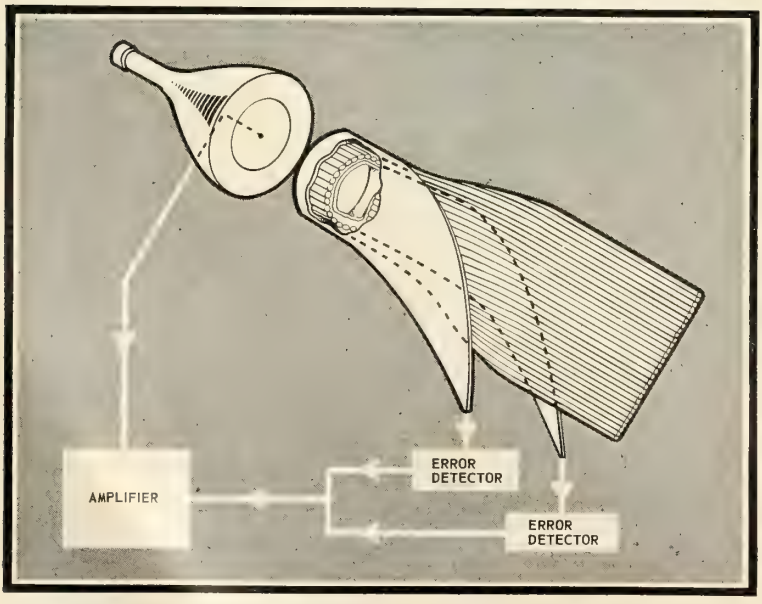
Broken fibers show up as dark spots at the emitting end of the bundle.

• **Oral inspection**—The applications of fiber optics are many and extremely varied. Although most aspects of the development are still in the research phase, the Research and Advanced Development Division of Avco Corp. has applied it to a TV optical probe.

The firm's medical research department developed the instrument which permits a dentist to view any part of a patient's mouth magnified on a TV screen. The probe is being developed for medical use to explore inside the human body.

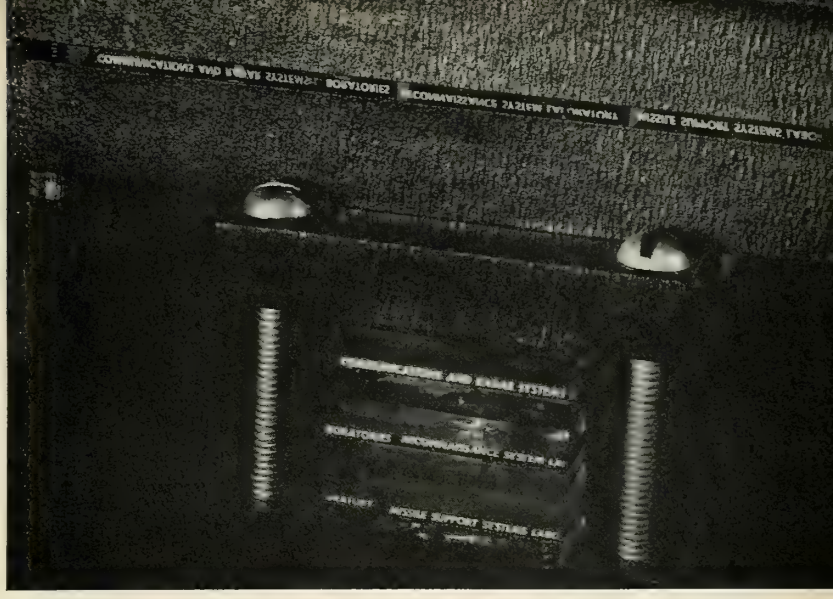
From this example it is obvious that fiber optics can handle problems which cannot be solved with a lens and mirror system. There are other areas where the use of fiber optics simplifies or improves such systems.

A short bundle can be used to transfer a curved-image surface to a flat one or to a different curve. An example of this is a fiber optics faceplate for cathode ray tubes. According to Du-



ERROR SENSING system unrolls cathode-ray tube spiral into straight line on film.

›ystems



LONG LINE on input broken into three segments by fiber optic system. Bonded only at the ends, the input can "look" in any direction.

Mont, there are several reasons for maintaining the phosphor surface approximately spherical.

A fiber faceplate can meet this condition and, by grinding the external face flat, the image field is made plane. A second advantage is in the realization of high efficiency of light transfer and the absence of scattering and parallax problems.

• **Raster-spiral uses**—The major field of application is in line scan systems. DuMont says that fiber optics are uniquely qualified for this.

Although the general problem has many facets, the reduction of side-looking radar data can be examined as a typical application.

When a 0.02 microsecond pulse is transmitted, the return is a video signal containing 50 megacycle components. It is desired to print this information as a varying density line across a film in the order of 100 microseconds.

Because of the high scanning and data rates involved, mechanical systems with modulated light sources are impractical for this and cathode-ray tubes has proven a somewhat-less-than-ideal solution.

The cathode tube is used inefficiently because of the nature of the radar data. A standard commercial tube can readily reproduce 200,000 picture elements over its surface. But it is difficult to build a tube which will reproduce the required 5000 to 20,000 elements along a straight line.

The cathode tube spot must be very small and bright. This implies small beam currents at very high ultor potentials. A certain amount of "splash" occurs at the phosphor, enlarging the spot and producing possibly dangerous X-rays. Focus modulation is required as the beam moves across the tube and this is less than perfect. Internal reflection in the faceplate results in a halo and effectively increases the spot diameter.

In practice, it has proven impossible to prevent the tube from being the resolution-limiting element in the system.

Fiber optics permits the utilization of a greater area of the cathode-ray tube. This is accomplished through an optical segmenter—the unit breaks up a single line into segments in the form of a raster.

The fibers are laid in the form of a wide sheet. DuMont achieves this by winding a few layers of fiber on a long cylinder. The fibers are bonded in a narrow strip down an element of the cylinder and then cut along the center of the strip. The sheet is opened out, and—because it is bonded only at the ends—it can be separated into a number of short segments.

The video would be used to modulate a three-or-more-line raster scan on a flying-spot scanner tube using the return from a single radar pulse. The segmenter would then assemble it into a single line for printing on film.

It is a relatively simple matter to obtain a 500 to 1000 line resolution along a single line of the scanner tube. By employing a 10 element segmenter, 5000 to 10,000 line resolution across the film can be realized.

Another application of this segmenter is in the field of line-scan television aerial reconnaissance. A single line along the earth is imaged onto the single-line input of the segmenter. The segmenter transforms this to a raster which is, in turn, imaged onto a television pickup tube. The video output can be transmitted to a ground station, presented on a cathode-ray tube in raster form, reconverted to a single line through a second segmenter and printed out on film.

An increase in resolution by a factor of 10 is achieved without any extension in television tube pickup art.

There may be a slight loss in information as the line is broken up into segments due to the finite retrace time of cathode-ray tube scan. This can be totally eliminated by using a spiral scan.

A spiral sweep on a cathode-ray tube permits a single line to be several times the diameter of the tube. The fibers can unroll this spiral into a straight line.

The most difficult aspect of these applications is that of maintaining registry between the cathode-ray tube spiral or raster and the fiber optics spiral or raster.

• **Self alignment**—DuMont says that it is presumably possible to control the cathode-ray tube voltages with sufficient accuracy so that, once aligned, registry would remain perfect throughout the recording.

Realistically, some sort of feedback arrangement is desirable. One means of accomplishing this in a spiral system would be to flank, top and bottom, the readout sheet of fibers with two similar sheets. One end, including the flank sheets, is rolled into the required spiral. The signal sheet is flattened out at the other end for line recording on film. The flank sheets are rolled at their free ends and exposed to photoelectric cells.

If the cathode-ray tube spot starts to wander off its prescribed spiral path, one of the cells is excited and the spot is pulled back onto its correct course.

The potential of fiber optics is enormous. Chicago Aerial Industries Inc. is using fiber optic configurations in the development of ice detector systems for aircraft and in the construction of a flat cathode-ray tube.

DuMont points to fiber optics utilization in satellite reconnaissance in a manner similar to the radar application. Radio Corporation of America is also working with this versatile concept.

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OPTICS

Optics Will Guide Spacecraft

Systems already in development will be exploited in guidance, navigation and communications

FOR YEARS optical systems have been used for collection and preservation of data. Now, with the imperative need arising from the surety of manned space flights, optics will not only be aimed at the stars—they will be used as an aid to steer craft toward them.

Not only are these new applications in navigation, but also in communications. With vast, almost unbelievable distances to be covered, new problems in communications are being unveiled. New answers must be found.

Finally, there is the possibility of devising visually guided missiles, only in its infancy. Who knows but what some future form of optical guidance may control spacecraft automatically from point to point?

• **Guidance**—Currently under development by Chicago Aerial is a passive optical guidance system for air-to-surface missiles. Called SOLO (Selective Optical Lock-On), it is responsive to visual and infrared emissions. Immune to jamming, SOLO is locked onto the target by visual reference when the pilot sights through his viewer. The system was developed for the Martin Co. which is currently testing it for possible use in an improved *Bullpup*.

Transistorized and gyro-stabilized, the guidance package weighs less than 10 lbs., says the company. Maximum guidance error at 2 miles range reportedly is from 13 to 26 feet max.

• **Navigation**—An Automatic Astro Compass, MD-1, has been developed by Kollsman Instrument Corp. for the Air Force for continuous and precise heading. The compass measures relative bearing of a star, angle between star and vehicle heading axis. By computing azimuth, heading of the vehicle relative to north can be determined.

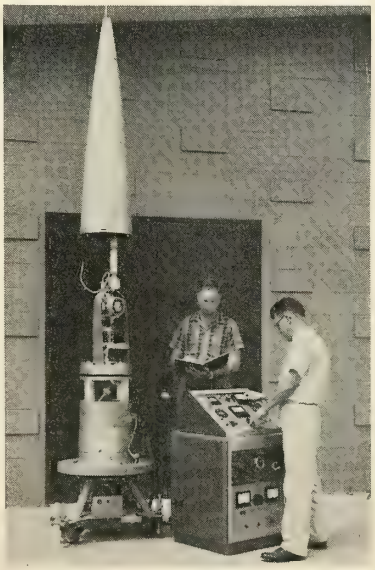
The tracker for the system is a small servo-controlled photo-electric telescope, carried on a small pitch and roll platform, horizontally stabilized by reference to a vertical gyro.

Designed initially for the B-52 long range strategic bomber, it will have almost direct application for manned spacecraft of the future. Kollsman has suggested however that instead of the present 3-star fix, a 4-body method be employed using two star trackers, one sun tracker, and one planet tracker.

For posible use in future celestial navigation is the Radiation Tracking Transducer developed by Electro-Optical. The RTT is a semiconductor sensor capable of detecting and resolving angular position of light at angles of motion less than 0.1 sec. of arc, says the company.

• **Communication**—Electro-Optical also is currently studying the feasibility of using solar radiation as a means of transmission for communications. Called SOCOM, the research is sponsored by AF Wright Air Development Div. in Dayton.

EOS engineers estimate that signal-to-noise ratio for such a system at a range of 10 million miles would be roughly 10 db. This is based on use of mirror antennas having areas of 1 sq. meter and 10 cps bandwidths. A factor of 10 increase in S/N might be possible by cooling the detector stage of the receiving systems, said EOS.



SUN-SEEKING pointing control for the Aerobee research rocket is manufactured by Ball Brothers Research Corp.

Cassegrainian optics would be used for energy collection. EOS believes that such an optical system could be satellite tested in two years.

The company for some time has been investigating the use of electrically exploded wires for communications by making use of the resulting high-intensity light. The study was a by-product of research sponsored by the Army Ordnance Corps in exploding wire for fuse initiators.

The technique involves switching tremendous amounts of current into thin wires in millimicrosecond time. Many times the material's vaporization energy is poured into the wire creating temperature over 100,000°C and pressures in the megabar range.

By using tungsten wire, researchers found that surface temperatures of 5000°C (plus the superheated interior) would give a light source excellent visibility and large output.

Optical-frequency communications took another big step toward reality with Hughes Aircraft's recent development of a laser—or optical maser (M/R, 7/18/60). The coherent-beam generator offers promise of extending the electromagnetic spectrum available for communications up to 500,000 gigacycles (kmc)—which includes infrared and approaches visible light.

Heart of the light-amplifying laser is a half-inch cube of synthetic ruby crystal. Irradiated by a powerful light source, the atoms are excited to a higher energy state and energy is reradiated in a narrow band of frequencies. The excited atoms are coupled to an atomic resonator and stimulated to emit the radiation in-phase. This is in contrast to ordinary light sources where the atoms radiate individually at random and produce "incoherent" light energy.

The laser radiates an almost perfectly parallel beam—less than one-hundredth degree of arc wide. It could have important application in space communications and radar as well as providing a new scientific tool for basic research.



OPTICS

Periscopes Now Well Wedded to Optical Display Systems

UNTIL RECENTLY, the only common denominator between periscopes and optical display systems was the characteristic of direct readout.

Now periscope systems employ multiple indices for various measurements and its viewers are assuming the characteristics of miniature display panels. New capability for inner space craft—submarines—and new requirements for outerspace craft are helping to spawn complex hybrids.

• **Display systems**—Using an advanced plastic lens developed by its Pacific Optical Div., Chicago Aerial is developing an integrated data display called V.I.P. (Visual Integrated Presentation). How close to hardware this advanced concept may be is an unknown, but its potential for space, aircraft, ground, and undersea use would be almost limitless.

A major display system is currently under development for the Army at Aeronutronic Div. of Ford Motor Co. A part of Tactical Operations Control project, the system will be an integrated tactical command intelligence center housing computers and a communications control.

Processed data will be fed into a CRT, photographed, film processed, and then projected for a blow-up display. Film processing is automatic under vacuum in 2 seconds. The process was developed by Aeronutronic's Carl Heinz-Lotze with the assistance of Ansco and Eastman-Kodak researchers.

The projection system uses a single back light source with 5 lenses to provide 4-color display. A 4-overlay screen also can be used.

Two display projectors are being developed by Nortronics for the Navy. One is a 70-mm rear-view projector for studying aerial and panoramic photos, and—in conjunction with a computer—it will be used to determine exact positions of details in the photos. The other will be a comparative view projector employing two screens for photo comparison and for projection of stereo photographs.

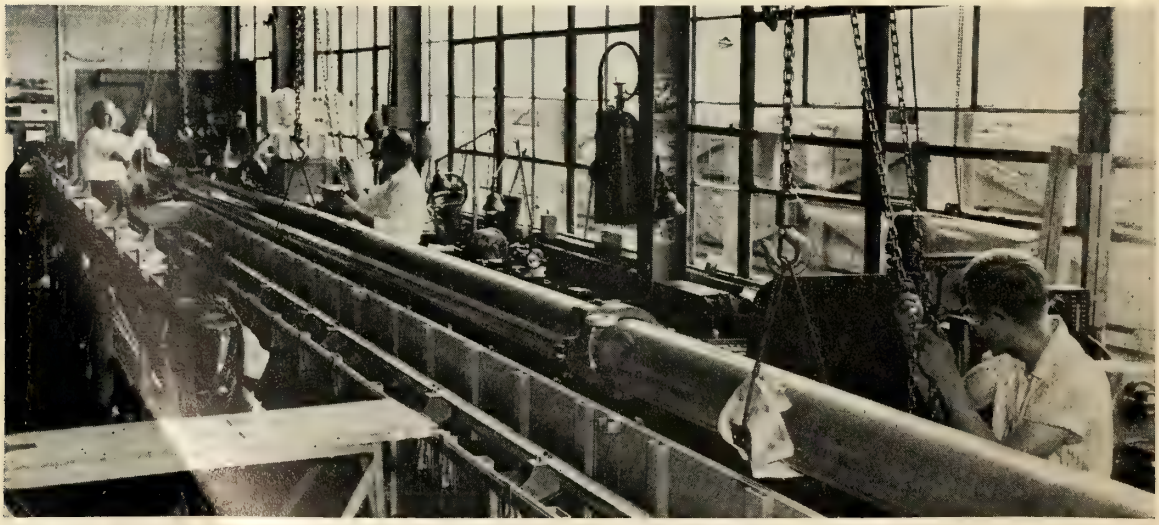
• **Periscopes**—The *Mercury* manned space capsule will use a unique periscope system designed and built by Perkin-Elmer. Used as a navigational aid as well as a viewer for the astronaut aboard, it will provide an 8-in. diameter display screen. It will cover a 190° field of view normally, but a power lens assembly can be swung into the system providing a magnified 20° view superimposed in the center of the former field.

An aspheric surface will be used for the 190° field. The periscope also will have an optical altimeter. Four indices on the screen will be used to measure apparent diameter of the earth circle displayed. For orientation, another index will permit measuring the angle of the sun with respect to the capsules longitudinal axis. Other indices will be used to derive capsule direction, location over the earth, and attitude.

The much publicized Type 11 Star Tracking Periscope used in the Navy's *Polaris* submarines is a product of Kollmorgen Corp., Northampton, Mass. It is an integral part of the Ship's Inertial Navigation System and is used to correct the Sperry or Autonetics inertial systems. It is the world's largest periscope.

The emergency periscope and alignment periscope for *Polaris* submarines are being provided by Bausch & Lomb.

Kollmorgen also manufactures the Bunkerscope, a line of missile bunker-type periscopes. Employing both high and low power ranges, the devices show images in true color.



TYPE 11 PERISCOPE, the world's largest, shown being loaded into its shipping case for delivery to the USS George Washington, nuclear-driven Polaris submarine. The periscope represents a significant achievement by its developer, Kollmorgen Optical Corp., in the application of modern precision optical techniques for advanced systems. It is a vital part of Navy's SINS.



OPTICS

Materials, Processes Keep Pace

Industry draws on vast experience to meet needs of missile/space effort; fantastic accuracy achieved by Corning Glass Works and other lens manufacturers

TWO WORLD WARS, the emergence of the motion picture industry and the insatiable demands of over 40 million camera amateurs laid the groundwork of this country's capability to meet the exacting requirements of missile optics.

The perfection of sandless optical glass and magnesium fluoride coatings are only a part of the story. New grinding and polishing materials and processes were rapidly reduced to mass production techniques without any loss of quality.

Lens curvature deviation can be checked down to one hundred thousandths of an inch. Quality control procedures are carried to impossible lengths.

To mention two highlights, Corning is extruding glass in prism shape and the Hawk-Eye Works of Eastman-Kodak is producing a lens with a speed of f/0.75—close to the theoretical maximum of f/0.5.

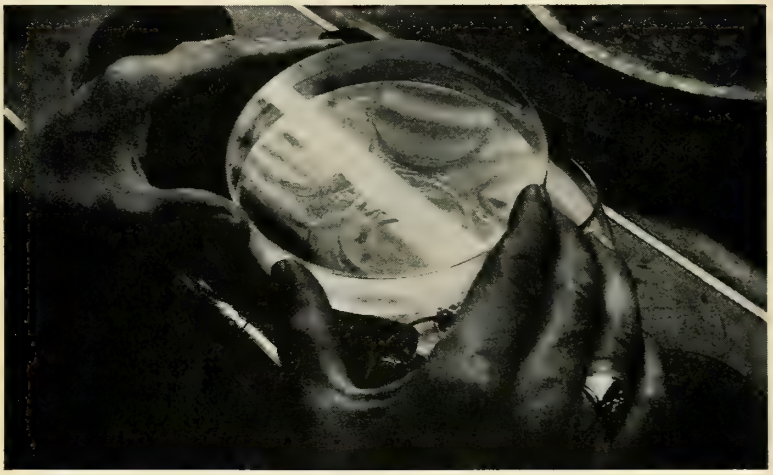
The optics industry has plunged into new areas to answer the ever increasing needs of the missile-space effort.

• **Space telescopes** — Lightweight mirrors of fused silica have been developed by Corning Glass Works for use in missile, satellite, and airborne telescope systems. The company is producing mirror blanks made by an unusual sandwich construction that reduces critical size and weight of mounting and auxiliary equipment.

The mirror blanks consist of two fused silica plates separated by walls or tubes of the same high purity glass. The ribs are permanently sealed to each plate under intense heat.

With this type of construction, Corning believes mirror weight can be reduced to half that of a solid disk with equal surface area.

The near zero thermal expansion of fused silica means the mirrors will retain their shape under sudden and extreme temperature changes. The ribs help maintain rigidity. These qualities should assure distortion-free images even in hostile environments.



FLATNESS of an optical element is shown being checked by a Newton ring test, a technique long used by specialists in optics.



SLATED FOR USE in the Stratoscope II balloon-borne telescope project, this 36-in. fused silica quartz mirror produced by Perkin-Elmer from a Corning blank weighs more than 400 lbs. It is polished to an accuracy of 1/1,000,000th in.

The surface of the blanks will accept any standard reflective coatings and can be precision ground and finished with standard optical equipment.

The fused silica reportedly is one of the purest man-made substances—impurities average less than one part per million.

The material can withstand long-term use at temperatures over 1700°F and intermittent use to 2250°F. The softening point is 2880°F. Coefficient of thermal expansion is 3 x 10^{-7} per degree F, giving the material excellent resistance to thermal shock.

Multiform fused silica is extremely viscous at high temperatures and tends to sublime before it can liquefy and flow. Tests of the material in a plasma jet show uniform removal of sample surfaces by ablation.

• **Orbiting sightseers**—Heat resistant glass viewports are being produced by Corning for McDonnell Aircraft's *Mercury* capsules.

Corning is making glass panes for a large rectangular window in each of the experimental capsules. The glass will have to maintain good visibility at searing temperatures generated when the capsule plunges back into earth's atmosphere.

The windows will include four panels of high temperature glass, two of them strengthened by a tempering process. The outside pane will be 21 inches high, the innermost, 13 inches.

Because the capsules will land in the ocean, the windows must remain completely watertight despite the intense heat of re-entry.

Photronics Corporation of Flushing, N.Y., recently received a contract from the Navy to design and fabricate a high acuity aerial reconnaissance lens which will provide particularly high resolution for low contrast targets.

The aspheric surfaces will require accuracy in excess of 2 micro-inches and the metal parts must be accurate to over 0.0001 in.

When its design has been accomplished, the company believes it will have developed a lens superior to any which now exists in its area of application. A precursor of the lens exhibits an average laboratory resolution in excess of 200 lines per mm.

• **Polymer invasion**—Low-cost optically ground and polished plastic lenses in a wide variety of sizes, shapes, and types have been developed by Fostoria Corporation. The primary advantage of the plastic lenses, according to the company, is low cost—about half that of equivalent glass lenses.

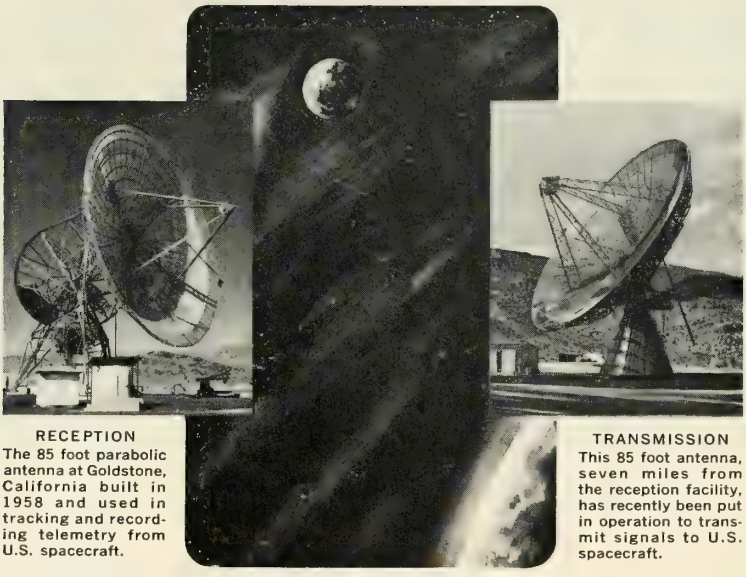
Other advantages are: Light weight; relative lack of distortion; high resistance to chipping and breakage; and ease of machining for quick, inexpensive mounting. In addition, plastic lenses are extremely clear transmitting up to 7% more light than glass lenses of the same thickness.

All types are now being manufactured including optically ground solid, molded, lenticular lenses; Fresnel, aspheric, and other specialized lenses also can be fabricated.

Kodak scientists recently announced a new method for detecting aerial film distortions as small as 0.0002 in. wide. Technique is based on moire-pattern effect, network of wavy lines of interference. Moire patterns have been used by Kodak researchers to locate minute film distortions by printing a half-tone tint on the aerial negative under study. A glass print is then made from the negative and registered with the master halftone screen. Location and size of distortions then become visible as irregularities in the resulting moire pattern.

Last fall the National Bureau of Standards announced development of a computer routine, called LENSTAR, to assist in the design of optical lenses. It provides a visual presentation of any one of several previously computed focal plane images. A rapid method has been devised for interpolating between them so that an operator may choose the most applicable image.

LUNAR and PLANETARY COMMUNICATION



RECEPTION
The 85 foot parabolic antenna at Goldstone, California built in 1958 and used in tracking and recording telemetry from U.S. spacecraft.

TRANSMISSION
This 85 foot antenna, seven miles from the reception facility, has recently been put in operation to transmit signals to U.S. spacecraft.

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New opportunities involving advanced research and development projects are now open at JPL in the Laboratory's Telecommunications Division for engineers and scientists capable of assuming a high level of technical responsibility.

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Research Scientists
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SNAP Units Well Along in Development

AEC spokesmen see 300-kw spacecraft APU available within five years, predict host of applications during '60's

by William Beller

A NUCLEAR auxiliary power unit generating 30 kilowatts of electrical power will be ready for spacecraft use within five years, according to a key Atomic Energy Commission official.

Within four years a 3-kilowatt unit will be available, says Lt. Col G. M. Anderson (USAF), AEC's Chief of Systems for Nuclear Auxiliary Power (SNAP).

Before the end of 1962, he predicts, a 300-watt unit with no moving parts will be awaiting flight test.

Spacecraft designers are being urged by AEC to learn about these units because within this decade they "will be the predominant and most reliable source of high power that will be available for application in space satellites."

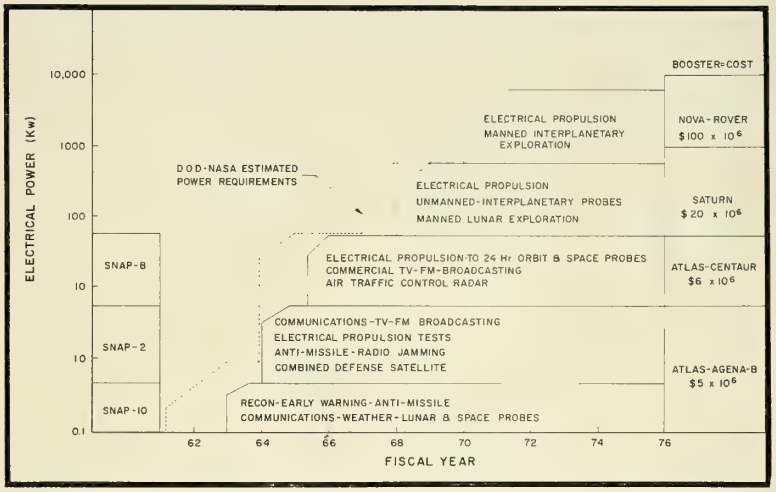
SNAP 2, 8 and 10 are the three nuclear reactor space electric power units that the AEC is currently developing for the National Aeronautics and Space Administration and the Air Force.

The SNAP 2 system is designed to generate 3 kilowatts of useful electrical power continuously for one year. A prototype of the reactor for the system, called the SNAP Experimental Reactor (SER), was built by Atomics International Div., North American Aviation, and put into full-power operation in November, 1959.

SER has already passed a 1000-hour continuous shakedown test at 50 kilowatts thermal power. Between November, 1959 and June, 1960, the system generated more than 147,000 kilowatt-hours of thermal energy.

• **No moving parts**—The SNAP 8 and 10 programs are peel-offs from the SNAP 2 program. The three systems use similar nuclear reactors, employ the same advanced materials and are operated in the 1200° to 1400°F temperature range. They differ in power output and design details.

The SNAP 8 system is a larger version of the SNAP 2. Each uses a turbogenerator to convert heat energy to electrical energy. However, the SNAP 8 unit will be generating 30 electrical kilowatts, which can be boosted to 60 kilowatts by adding a second turbogenerator to the system. Thus, SNAP 8 will be yielding 10 to 20 times as much power as SNAP 2.



TIMETABLE AND USE of three nuclear auxiliary power systems for spacecraft.

Recent advances in developing thermoelectric semiconductors have made the process of converting nuclear-generated heat into electrical energy economic in the relatively low-power region, below one kilowatt.

In the prototype SNAP 3 generator built by The Martin Company and revealed by President Eisenhower last year, the efficiency of this 5-watt radioisotope-powered device was reported to be 5 to 6%. Martin avers that "in the next year or so this efficiency can be doubled."

The merits of such a static source of power, which is now available for field use, led AEC to starting the SNAP 10 program. The unit under development, which uses a reactor as the heat source, is expected to yield 300 electrical watts for an unshielded system weight of 355 lbs., a little more than a pound a watt.

• **SNAP uses**—If SNAP 8's 60-kilowatt system were coupled to an electrical propulsion unit, the combination could send the *Atlas*-boosted *Centaur* spacecraft (9000 pounds) from a 200-mile orbit to a 22,000-mile (24-hour) orbit. This is the finding that NASA recently reported to the Joint Committee on Atomic Energy.

Because of the low thrust and acceleration the unit would be developing—4.5 x 10^{-5}g—the trip would take about two months. This contrasts badly with the speedy 5.4 hours a chemically propelled spacecraft would take.

Yet, if the time factor is not all-governing and if the spacecraft in each instance is unmanned, then for the same delivered payload the craft with the SNAP 8 would be far smaller and less expensive than the chemically powered craft.

The SNAP 8 would also be a continuing power source, available for such things as orbit corrections, communications work and scientific instruments.

Testifying before the Joint Committee, Atomics International's deputy chief of Compact Reactor Division, J. R. Wetch, anticipated the following developments on the basis of SNAP

developments during the 1960 decade:

–Earth satellites providing reliable, low-cost, all-weather, intercontinental telephone systems.

–All-weather, global FM and TV broadcasting coverage.

–Precise air-traffic control and navigational aid from near-earth satellites.

–Satellite global weather surveying and land surveying, leading to improved forecasting and more accurate maps.

• **Sun-seeking cells**—Electrical power in a spacecraft can come from any of three basic energy sources: chemical, solar or nuclear. Though the chemical systems are generally more familiar and therefore simpler than the other two, the life of a chemical system is severely limited. After about a week, the system is drained of energy.

Solar cells if shielded from radiation damage—as might occur in Van Allen belt—have a fairly long life expectancy, measured in years. The devices are highly useful for the small power requirements of a few watts to several hundred watts.

The cells fail when they lose the sun, perhaps when the spacecraft is entering the earth's shadow. This problem is somewhat overcome by the cells' feeding energy into storage batteries during the sunlit periods. Nevertheless, for high-power outputs the solar cell system becomes expensive, heavy, large and difficult to integrate into a spacecraft.

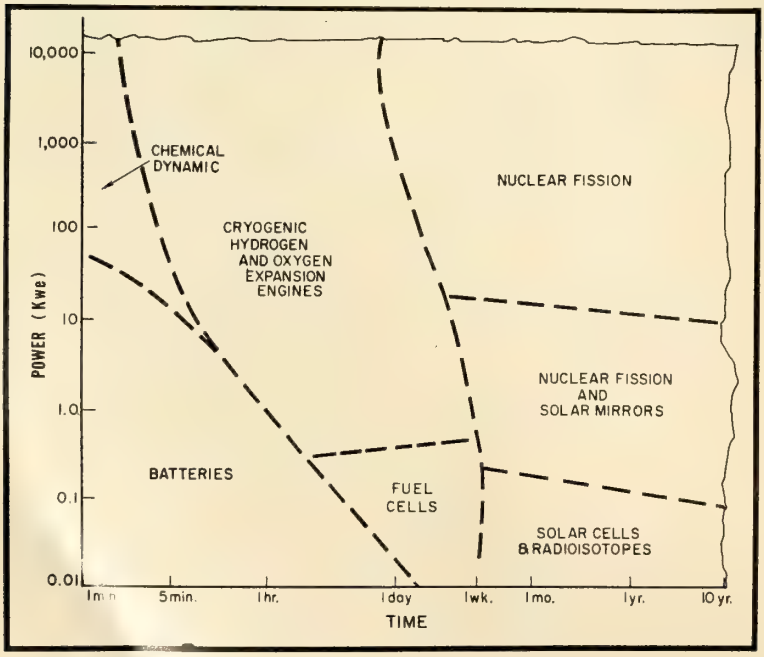
From a cost and weight viewpoint, the solar mirror ranks high as a source of electrical energy. A large parabolic reflector is folded into a spacecraft, and then unfolded at altitude. The reflector focuses the solar energy on a boiler, whose working liquid is a low boiling-point metal. The liquid, operating under a Rankine cycle, transfers its energy to a turbine coupled to an electric generator.

For deriving powers greater than 10 to 30 kilowatts, the solar mirror package becomes unwieldly for any spacecraft now contemplated. The system also suffers from having to be continuously oriented toward the sun. Some experts have even questioned the feasibility of the solar-mirror concept because of the perhaps deleterious effect of micrometeorites impinging on the reflecting optical surfaces.

• **A nuclear diode**—Three sources of nuclear energy can be considered: radioisotope, fission process and fusion process. There are no reports that fusion will be used for getting space electrical power.

For generating space power in the kilowatt and higher regimes, particularly for long time periods, nuclear fission reactors appear to be the best current way. Note that the energy content of fission nuclear-power systems is 1000 kw-hr/lb.

The nuclear power system for spacecraft embraces three major sub-systems: a nuclear heat source, a power conversion system, and a heat dump system. The heat source can be either a radioisotope or a reactor.



USEFUL REGIMES of energy sources which can generate electrical power in space.

The radioisotope energy system, dependent as it is upon the natural decay rate of its fuel, is limited in electrical energy output to about one kilowatt. On the other hand, the reactor system has no such limitation.

Three power conversion systems are being studied: turbo-electric, thermoelectric and thermionic.

The thermionic system offers the biggest potential for high power and light weight (5 lbs./kw). Its future is nearer than many experts have believed. Earlier this month, the General Atomic Div., General Dynamics, announced development of a cesium cell thermionic converter that produced 90 watts of electric power directly from the heat of nuclear fission.

The theory of operation is the same as that of the diode. The cathode is heated until electrons boil off and are picked up by the anode. In this way, an emf is generated between the two surfaces. A drawback is that the cathode must operate at very high temperatures, greater than 1500°F.

• **High temperature, low weight**—For any of the power conversion systems to work, there must be a temperature gradient—and thus a heat sink. This leads to a radiator system which in space can dispose of its energy only through thermal radiation.

Since a thermal radiator acts best when its temperature is high, then for a respectable Carnot cycle efficiency the heat source temperature must be even higher. Also, to get rid of the heat even at high temperatures, an appropriately large radiator system must be used.

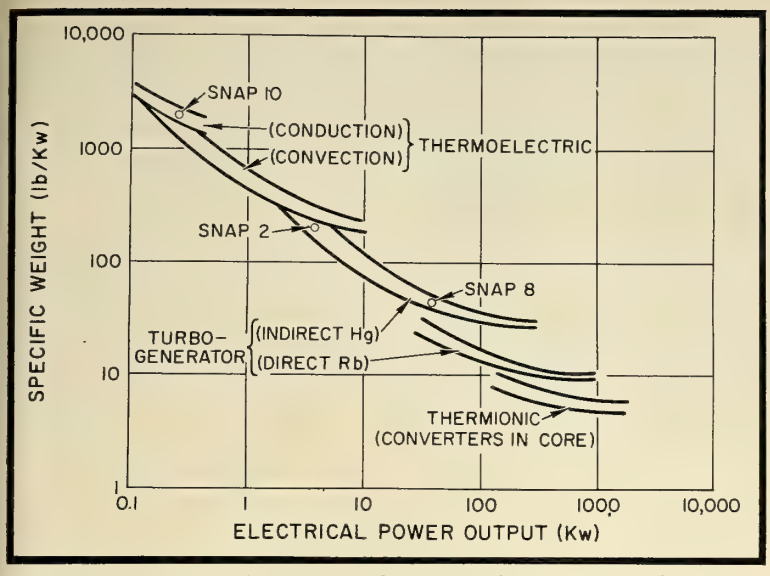
These factors and other design considerations combine to form the following observations, which were indicated at last week's International Astronautical Congress in Stockholm by Lt. Col. Anderson and Atomics International's Wetch and H. M. Dieckamp:

–To reach the lightest system weight for a space power nuclear unit, it should operate at the highest source temperature materials will allow.

–The most power per pound of system weight will come from space nuclear powerplants operating in the 300-3000-kilowatt electrical size range.

• **Elements of SNAP 2**—The SNAP 2 system has all the functional items of a conventional Rankine cycle. The energy from a heat source, a nuclear reactor, brings a working fluid (mercury) to superheat in a boiler. The gas gives up its energy by expanding in a turbine, which drives an alternator. The mercury is then cooled and condensed in a radiator and pumped back into the boiler for another cycle.

The nuclear reactor used here, which is being developed by Atomics International, produces heat energy by



SPECIFIC WEIGHTS of the systems used to turn nuclear energy into electrical.

the fissioning of U-235. A sodium-potassium eutectic liquid metal (NaK) picks up some of this energy by being pumped into the reactor's core, proceeding along the interstitial passages between the fuel elements, and then flowing out again.

At a flow rate of 61.3 lb./min, the liquid metal absorbs 50 kilowatts of thermal power. In the process, the fluid's temperature is raised from 1000° to 1200°F.

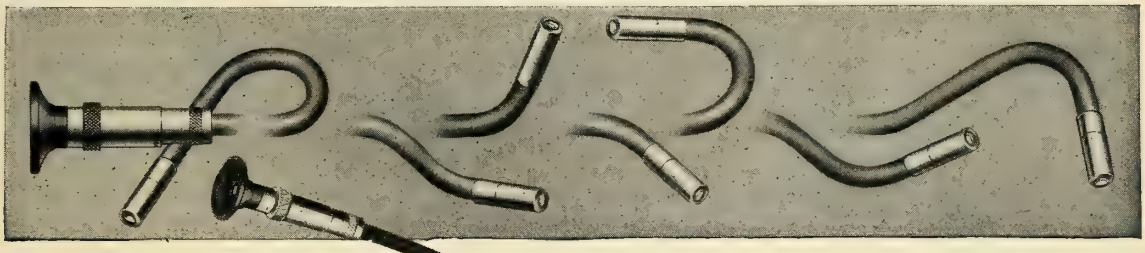
Heat exchange occurs in the boiler-superheater, where the NaK converts the mercury working fluid into a gas. The superheater is a concentric tube, counterflow, once-through boiler. NaK flows in the annulus and mercury through the central tube. The mercury is next expanded through a two-stage impulse turbine.

The turbine drives an alternator which is a permanent magnet machine with a sealed stator. The alternator delivers up to 3.5 kilowatts at 110 volts and 2000 cps.

After exiting from the turbine, the mercury vapor passes to a combination radiator-condenser which forms part of the outer skin of the spacecraft. The mercury condenses at 600°F and 6 psia within a number of small diameter parallel tubes.

These tubes are attached to an aluminum skin which dumps the heat of condensation into space. The area necessary to radiate 40 kilowatts is about 100 sq. ft. The condensate is returned to the boiler by a boiler feed pump.

• **One moving part**—All rotating components in the power conversion system are mounted on a common shaft which is called the Combined Rotating Unit (CRU). This is the only moving part in the SNAP 2 system. It is being developed by Thompson Ramo Wooldridge, Inc., under subcontract to



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Atomics International.

Rotating at 40,000 rpm, the shaft rides on mercury dynamic bearings. Principal components on the shaft are:

(1) The permanent magnet induction NaK pump, whose operation is similar to that of a conventional electromagnetic pump except that the moving magnetic field is put in by a rotating magnet.

(2) The mercury turbine.

(3) The alternator, a permanent magnet machine with a sealed stator.

(4) The mercury pump, a conventional but miniature centrifugal device that supplies pressurized mercury to the boiler and to the shaft bearings.

The entire rotating unit is enclosed in a hermetically sealed housing, thereby preventing loss of the mercury working fluid during the system's life.

• **Elements of SNAP 8**—The SNAP 8 system will use a reactor quite similar to SNAP 2's but with thinner and many more fuel elements. This change is necessary in order to get more heat power, higher heat transfer to the intermediate fluid, and at the same time keep system weight and size low.

Other changes will be dictated by the power upgrading: The flow rates of both the intermediate and working fluids will be increased tenfold in order to bring more thermal energy to the turbine. A 1% increase in Carnot efficiency will be squeezed out of the system by upping the coolant's working temperature to 1350°F. This efficiency increase would be greater if the coolant's temperature entering the reactor did not also rise.

Aerojet-General is developing SNAP 8's power conversion system for NASA. It is still too early for the system's specifications to be firm. However, this much is known: Operating temperatures and pressures higher than SNAP 2's will be used. The system will retain the Combined Rotating Unit devised for the SNAP 2 unit.

One difference is that the NaK pump will be separately motor-driven. This change is needed to produce efficiently the higher pressures required by the tenfold increase in coolant circulation.

If the reactor drives two power conversion units, SNAP 8's electrical output doubles to 60 kilowatts.

• **Elements of SNAP 10**—The SNAP 10 concept uses as its heat source a reactor derived from SNAP 2. Conductively coupled to the reactor is a combined thermoelectric converter-radiator.

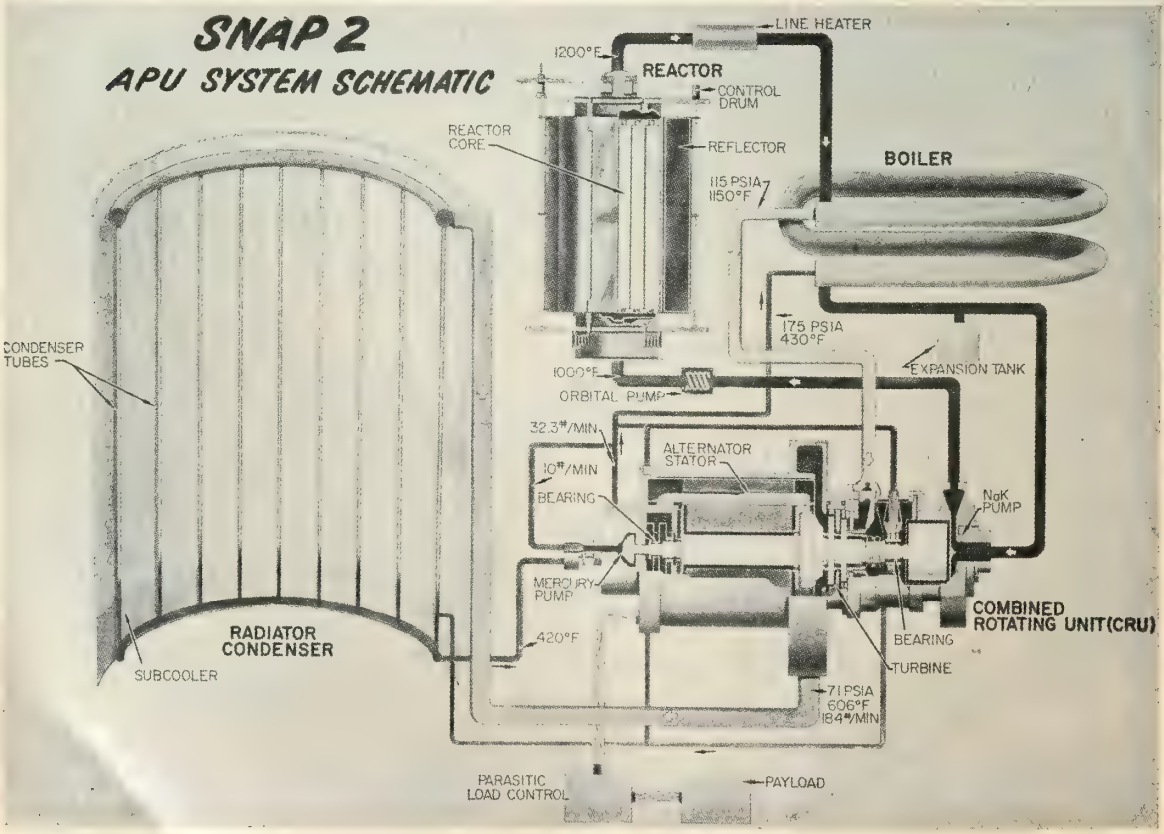
The thermoelectric converter comprises 30 10-watt modules. Each thermocouple hot junction is kept at temperature by contact with the external surface of the reactor's reflector. Each thermocouple cold junction is connected to a finned radiator.

Sufficient heat is rejected by the radiator to maintain the required temperature gradient between junctions.

The overall conversion efficiency of space systems using today's thermoelectric conversion materials is low, from two to four percent. Still, where only low power outputs are needed, the attractiveness of static operation brilliantly offsets such poor efficiencies.

For high-power outputs, the cost in efficiency would not be paid.

These nuclear auxiliary power units will soon be with us, if rate of progress is any measure. It was less than five years from the start of the SNAP pro-



SCHEMATIC POINTS UP fact that SNAP 2 nuclear auxiliary power unit (APU) operates as a Rankine cycle system.

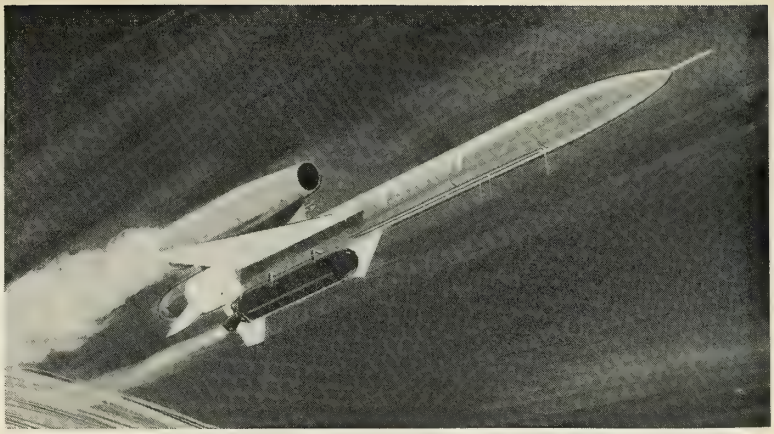
gram until the first compact reactor began operating. In another five years, by 1965, we are being promised SNAP 10, 2 and 8. It would be a pessimistic spacecraft engineer, indeed, who discounted the prospects of nuclear-derived electrical power for use in advanced satellites and probes.

SNAP 2 SYSTEM

Net elec. output pwr.	3 kwe
Reactor thermal pwr.	50 kwt
Elec. freq.	2000 cps
Voltage	110 volts
Radiator area	110 ft^2
Auxiliary Power Unit wt.	600 lbs.
Lifetime objective	1 year
Availability	1964
Cycle conditions	
Reactor outlet temp.	1200°F
Reactor inlet temp.	1000°F
Hg superheat temp.	1150°F
Hg boiling pres.	110 psia
Hg boiling temp.	924°F
Hg turbine exhaust temp.	600°F
Hg turbine exhaust pres.	6.8 psia
Radiation temp. (fin centerline)	580°F
NaK-78 flow rate	61.3 lbs./min
Hg flow rate	17.4 lbs./min
Reactor heat loss	5 kwt
Parasitic load	0.300 kwe
Control power req.	0.100 kwe
Rankine cycle eff.	0.22
Subcooling	200°F
Preheat pwr. (component ineff.)	2.00 kw
Boiler and pipe losses	2.00 kw
Overall system eff.	6%

SNAP 8 SYSTEM

Power	
Pwr. elec. net to payload	35 kw
Reactor thermal pwr.	300 kw
Radiator heat dissipation	255 kw
Heat losses	10 kw
Heat Transfer Areas	
Reactor core	25.8 $ft.^2$
Radiator surface	360 $ft.^2$
Lifetime objective	1 year
Availability	1965
Temperatures	
Maximum reactor fuel	1420°F
Average reactor fuel	1290°F
Average fuel surface	1270°F
Coolant inlet	1150°F
Coolant outlet	1350°F
Turbine-Alternator	
Turbine speed	20,000 rpm
Frequency	1000 cps, 3Φ
Voltage	43.6/75.6 volts
Reactor	
Critical mass	5.2 kg
Core dia. (core vessel ID)	9.2 in.
Core length (active)	11 in.
Radial reflector thick., Be	2.5 in.
Axial reflector thick.	1.5 in. BeO
No. control elements	4
No. safety elements	2
Peak flux	3×10^{12} nv
Temp. coeff.	-4×10^{-5}
Power coeff.	−0.2¢/kw
Reactivity/control drum	3%
Reactivity/safety element	4.2%
No. fuel rods	163
Fuel rod dia. (cladding OD)	⅝ in.



ARTIST'S DRAWING shows *Redhead-Roadrunner* in action at high level.

New Target Missile Shown

The shape of North American Aviation's new high- or low-level supersonic Army target missile—the *Redhead-Roadrunner*—was shown publicly for the first time late last month at the company's Columbus Division.

A full-scale mock-up of the missile's slender fuselage, minus the rear section and tail radome, had been assembled for antenna and radar selectivity testing. The rear sections were not needed for this program.

The $3,940,581 Army contract to North American, awarded on June 24, calls for fabrication and flight testing of the new missile system.

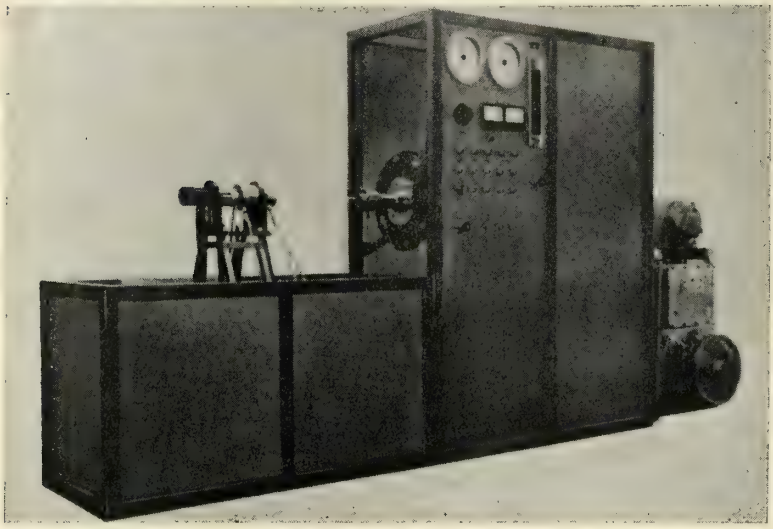
NAA has awarded Marquardt a subcontract for the drone's ramjet propulsion and associated fuel controls. It will be ground-launched by a disposable, solid-propellant booster rocket, presumably to be produced by NAA's solid propulsion operation at McGregor, Tex.

The 19-ft.-long, 1-ft.-diameter missile is designed to fly from subsonic speed through Mach 2, and to climb to more than 50,000 ft. on controlled target missions.

A stubby, six-ft. delta wing can be field-attached to the bird for added maneuverability on high-level supersonic flights; it is not needed for low-level missions. The missile, controlled by a pair of small, rear-mounted stabilizers, will be recoverable by parachute.



FULL-SCALE MOCKUP of new high- or low-level supersonic target missile being built for Army by North American Aviation's Columbus Division will be used for antenna pattern and radar reflectivity tests. Leadman George Miller is shown putting finishing touches on the missile.



MHD Continuous Flow Facility

A continuous flow of ionized gas with a velocity of 4500 meters/sec. at 10,000°K and an average conductivity of 1 mho/cm is provided in a magneto-hydrodynamic flow facility from MHD Research Inc.

In operation, a flow of gas is provided by a gas-stabilized electric arc capable of reaching a stagnation temperature of over 10,000°K. The hot gas proceeds through a mixing chamber into a supersonic nozzle and is expelled in an expanded condition as a low-pressure supersonic flow.

At the exit of this nozzle, the gas enters a constant-diameter channel contained within a watercooled transparent tube. While travelling within this tube the gas is available for experimental use. After leaving the tube it enters the heat exchanger where it is cooled and subsequently exhausted through the vacuum pump.

A control panel provides convenient grouping of all controls and indicators for the power, gas, coolant, vacuum, and accessory equipment. This panel is located adjacent to the operating area so that all controls and instrumentation are within continuous control and observation of the experimenter.

Circle No. 225 on Subscriber Service Card.

Electronic Accessories

An electronic chassis handle, a self-aligning shock locking block for electronic equipment cabinet chassis and two new full ball-bearing slides for electronic equipment packaging are available from Jonathan Manufacturing Co.

The two ball-bearing slides, type 150-QPD—quick disconnecting and pivoting; and type QD—quick disconnecting, both feature rapid disconnection of the chassis portion of the slide, positive lock in the extended position, extreme thinness and exceptional weight-handling ability. Both types of ball-bearing slide mechanisms are part of the "Thinline" (0.50 in. width max.) series.

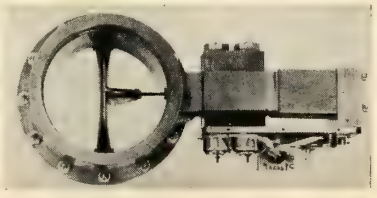
The "Shock-Block" is a pair of self-aligning keyed blocks, used to lock electronic equipment chassis securely in place to prevent magnification of shock and vibration by transmission from cabinet to chassis.

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Shearable Disc Valves

A hermetically sealed shearable disc valve is available in a range of sizes from B. H. Hadley, Inc.

The Hadley shearable disc valve (patent pending) has a non-aging metallic disc that provides zero leakage indefinitely, in the pre-sheared condition. Actuation is rapid either by pneumatic, hydraulic or pressure cartridge (squib) action. In the open position, there is full flow with minimum pressure drop. The sheared disc is completely retained, and no fragments are released into the fluid stream. Upon reclosure of the valve, after shearing, leakage is exceptionally low.



Circle No. 227 on Subscriber Service Card.

Nylon to Metal Welding

A two-step process has been developed by Plastic Associates for chemically "welding" nylon to metal.

The chemical welding method makes use of an epoxy paste that chemically unites with the metal surface on which it is applied. A separate solvent solution applied to the nylon part softens the surface and allows the nylon molecules to blend with the epoxy bonding agent as the latter hardens. The entire operation is performed at room temperature, achieving an extremely tough, shock-resistant union between the nylon and the metal within a few hours.

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Helium Regulator

A helium regulator developed by the Dyna-Matics Corp. makes it possible to control missile fuel tank pressures regardless of environmental conditions. The two-stage design of this new unit minimizes the effect of large flow ranges and variations in both temperature and inlet pressures.

Orthodox balancing devices, which usually require running seals, have been omitted in this new design, thus eliminating friction and leakage potentials. Static seals, poppet seals and synthetic material diaphragms are used, making the unit suitable for almost all gasses and fluids. Each of the seals is Teflon-seated to assure zero leakage at no-flow, lockup conditions.

Circle No. 229 on Subscriber Service Card.

High Load Cap Screw

Perfection of a cap screw utilizing the Aer-O-Torq recess for high torque strength has been announced by Aer-O-Line Manufacturing & Supply Co. Because the recess requires less metal for a given necessary driving torque, the new cap screws actually have less metal in the heads and the heads are up to 35% shorter.

In addition to their scientifically designed distribution of metal in the

heads of the new cap screws, the manufacturer states that the screws torque higher, distribute the load over wider bearing surfaces, provide more wrenching power and clamping force without indenting the fastened material.

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Magnetostrictive Cleaner

An ultrasonic cleaning system developed by the Harris Transducer Corp., a subsidiary of General Instruments, is on the market. The system features a proprietary magnetostrictive transducer.

Because of its exclusive strip construction, the system withstands tank operating temperatures up to 300°F, gives continuous long life operation and is simple to maintain.

Circle No. 231 on Subscriber Service Card.

Fractional HP Gear Motor

A fractional horsepower gear motor which uses a unique rectangular field stack, coupled with toroidal field windings, to obtain unusually high efficiency in a small package size has been developed by The Bendix Corp's Bendix-Pacific Division.



Approximately 1 3/8 x 2¼ x 4 3/8 in. and weighing 1¼ lbs., the unit is capable of delivering output power approaching 1/10 hp continuous duty to ¼ hp intermittent duty. Special heat dissipating techniques have been used to result in a low temperature rise during operation.

Circle No. 232 on Subscriber Service Card.

Hi-Temp Vacuum Oven

A laboratory oven, developed by Labline, Inc. has a temperature range from room to 260°C (500°F) within an 11 in. diameter x 12 in. deep stainless steel vacuum chamber.

The radiant heating elements are completely enclosed with no exposed-wire heaters to take up space. Heats from room to 500°F in one hour with temperature uniformity maintained within ±1°F at all settings.

Circle No. 233 on Subscriber Service Card.

Decade Counter Module

A Miniature Decade Counter Module—the DC-111—featuring a minimum of component parts, is available from Burroughs Corp.'s Electronic Tube Division. The unit combines the BEAM-X switch, Type BX-1000, with transistors in a circuit capable of resolving pulses at 110 KC. Electrical outputs are provided to operate remote NIXIE indicator tubes and printers, and to perform other circuit functions.

Circle No. 234 on Subscriber Service Card.

Primary Pressure Standard

A Primary Pressure Standard that provides a digital display of a pressure input or provides a positive indication when a desired pressure level is reached has been announced by Wallace O. Leonard, Inc.

This standard, which utilizes the Klose Technique, takes full advantage of the basic accuracy of a simple air dead weight tester while providing direct readout of pressure over a prescribed range.

The Leonard Standard has a typical accuracy of 1/50% of reading over the range of .4 to 250 psi including all errors due to friction, hysteresis, temperature, repeatability, resolution, linearity and readibility.

Circle No. 235 on Subscriber Service Card.

new literature

VIBRATION STANDARDS—American Standard Methods for the Calibration of Shock and Vibration Pickups, S2.2-1959, has been approved and published by the American Standards Association. It describes most calibration methods in use today, and covers specifically the three basic types—constant acceleration, sinusoidal motion and transient motion.

Circle No. 200 on Subscriber Service Card.

CONTROL SUBSYSTEMS—A four-page, two-color brochure, has been issued by the Instrument Division, American Electronics, Inc. The brochure outlines the capabilities of the Instrument Division in the development and packaging of electronic, electromechanical and mechanical subsystems for control systems in missile, space and aircraft vehicles.

Circle No. 201 on Subscriber Service Card.

PROPULSION FACILITIES—A 20 page two-color brochure is available introducing the purpose, personnel and plant of Amcel Propulsion Inc., a subsidiary established in 1959 by Celanese Corporation of America to create a comprehensive missiles program. Amcel's goal in research and development, as well as actual production is directed toward the development of highest quality liquid and solid fuels and fuel components for propellants and explosives.

Circle No. 202 on Subscriber Service Card.

MAGNET ALLOY—A new illustrated brochure describing properties and applications of an improved copper-nickel-iron ductile permanent magnet alloy of the generic "Cunife" type has been published by Hoskins Mfg. Co. Properties listed include high coercive force and energy product values.

Circle No. 203 on Subscriber Service Card.

SERVOMOTOR DATA—A four-page folder showing advance performance data for model 8 SM 461 Size 8 Servomotor has just been released by the Helipot Division of Beckman Instruments, Inc. The illustrated data sheet lists features of the new motor, shows dimensional outline drawings and torque-speed curves for the unit. In addition, construction features are delineated, and all principle electrical and mechanical characteristics are called out.

Circle No. 204 on Subscriber Service Card.

GOLD CLAD MOLY STAMPINGS—Bulletin Z-104, a one page technical data sheet, describing gold clad molybdenum stampings for silicon semiconductor devices, is now available from Accurate Specialties Co., Inc. The Bulletin completely describes the clad metal stamping consisting of gold clad molybdenum and its use as a base tab material in silicon semiconductors.

Circle No. 205 on Subscriber Service Card.

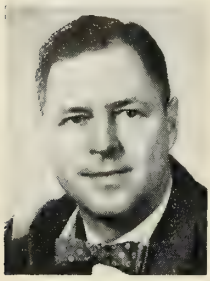
NUCLEAR EMULSION RECOVERY VEHICLE—A four-page brochure, designated PIB-47, describing the vehicle that will be used to obtain a profile picture of the Van Allen Radiation Belt is available from General Electric's Missile and Space Vehicle Department. It also contains general information on this project of the National Aeronautics and Space Administration. Illustrations include schematics of the vehicle's planned flight trajectory and its emulsion package, and photographs of the vehicle.

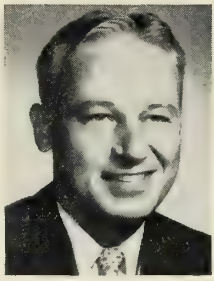
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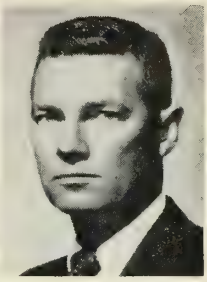
MISSILE PRODUCTS—A description of the many products Minnesota Mining and Manufacturing Co. produces for the missile and rocket industry is contained in a new booklet. The brochure is well illustrated, and describes in brief 79 products listed under such headings as adhesives and sealers, ceramics and refractories, coated abrasives, data duplicating and handling systems and elastomers-plastics-resins.

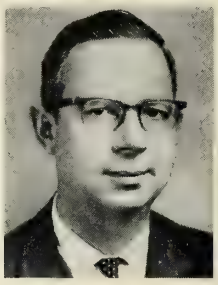
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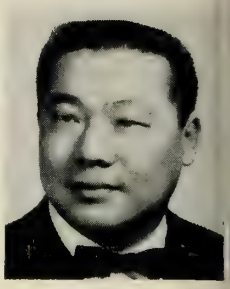
names in the news


STARY


BAUMANN


WALSH


BELL


CHAO

M. L. Stary: Named manager of Aerojet-General Corp.'s newly established Spacecraft Division at its Azusa, Calif. plant. The new division is an outgrowth of the Systems Division, established in 1958.

Robert J. Baumann: Appointed manager of the Systems Division, Beckman Instruments, Inc. Prior to his assignment as acting systems manager last December, he was a member of the corporate marketing staff.

J. Paul Walsh: Former director of the Space and Weapons Systems Division at C-E-I-R, Inc., promoted to director of the firm's Arlington Research Center. Prior to joining the firm he was deputy director of Project *Vanguard* and later joined IBM as systems manager of the Federal Systems Division.

William S. Bell: Joins the Washington, D.C. district sales offce of Radiation Inc. as assistant manager. Was formerly project engineer for the Vitro Corp. where he worked on the *Terrier, Talos* and *Polaris* missiles weapon systems.

Dr. W. Wai Chao: Former chief of research appointed director of Research and Development at Vickers Inc., division of Sperry Rand Corp. Prior to joining Vickers he directed engineering efforts on the second stage liquid rocket engine for the *Discoverer* program and altitude control rocket systems for Project *Mercury* and the *X-15* airplane.

Lt. Cmdr. Linwood L. Leftwich (USN-ret.): Former vice president of Feedback Controls, Inc. joins Cubic Corporation as senior staff engineer. He previously served as project officer, Guided Missile Test Instrumentation Systems, Bureau of Aeronautics where he was responsible for the development of the *AN/FPS-16* missile and satellite tracking radar.

George C. Connor: Elected senior vice president-marketing at Sylvania Electric Products Inc., succeeding **Barton K. Wickstrum** now executive vice president of General Time Corp.

Edwin Suuronen: Former engineer-business systems elected manager-Business Operations Evaluations and Developments in the Operations Research and Synthesis section of General Electric's Light Military Electronics Dept.

Carl J. Wenzinger: Joins the Goddard Space Flight Center, NASA, as assistant project manager of the Orbiting Astronomical Observatory. Was formerly with Cook Electric Co.'s Research Laboratories.

Dr. Joseph R. Feldmeir: Appointed associate director of Philco Corp.'s Research Division, with responsibility in long range planning of technical programs. Was associated with the Bettis Atomic Power Division of Westinghouse Electric Corp. where he directed research in the nuclear energy field.

Mervyn E. Shopenn and **Albert M. Waifer, Jr.:** Formerly with Tempo Instruments and International Standard Engineering, respectively, join Adler Electronics Military Products Division as communication systems project engineers.

Albert F. Lopez: Named head of the newly-created Intelligence Systems Dept. of HRB-Singer, Inc., Prior to joining the firm in 1952 he was an instructor in the electrical engineering department at the Pennsylvania State University.

John W. Corcoran: Appointed chief scientist in the Research and Development Division of Beckman & Whitley.

Thomas A. Pakenham: Former assistant vice-president for mechanical systems with General Bronze Corp., named vice president of manufacturing at Portland Industries Corp.

John Lyon Collyer: Chairman of the executive committee of B.F. Goodrich's board of directors appointed a director of Grumman Aircraft Engineering Corp., succeeding the late **Leon A. Swirbul.**

Dr. Jack S. Anderson: Former Royal Industries, Inc.'s vice president engineering for all subsidiaries joins Crane Co.'s newly-formed Systems and Controls Group as director of engineering. The group includes Hydro-Aire Co., Chapman Valve and Swartwout Companies.

Edward V. Z. Lane: Named director of market research and development for American Super-Temperature Wires, Inc., a subsidiary of Haveg Industries, Inc.

Alfred J. Koorey: Appointed senior engineer for Aerojet-General Corp.'s *Minuteman* activities at Cape Canaveral with responsibility for receiving and inspecting the propulsion systems and determining their flight readiness.

Jack R. Grieve: Former supervisor of non-destructive testing at Alco Products Inc., joins the Metallurgical Dept. of Superior Tube Co. where he will be in charge of non-destructive testing development for metal tubing.

A. A. Shamah: Joins the Sparton Electronics Division of Sparton Corp. as manager-marketing for its newly established eastern region. Formerly served as assistant sales manager with Servo Corporation.

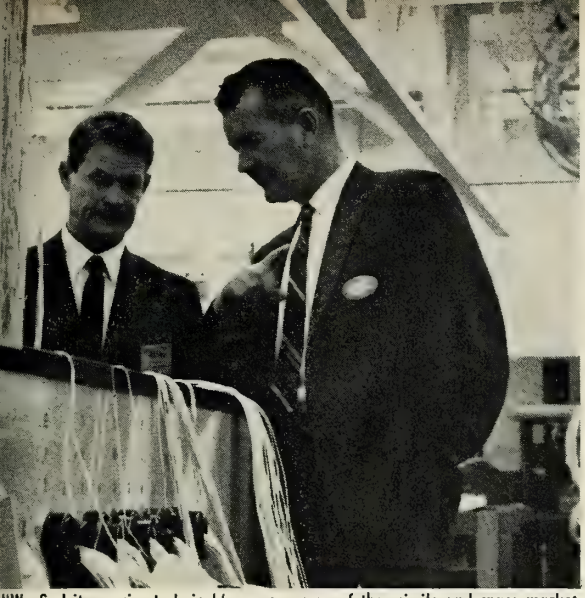
Thomas G. Lanphier, Jr.: Appointed to the newly created office of vice president-planning for Fairbanks Whitney Corp. Was formerly vice president and assistant to the president of General Dynamics Corp.'s Convair Division.

Dr. Sidney L. Simon: Former manager of Systems Engineering appointed chief engineer, Missile Electronics and Controls Divs., RCA Defense Electronic Products, succeeding **Dr. Robert C. Seamans, Jr.,** now with NASA.

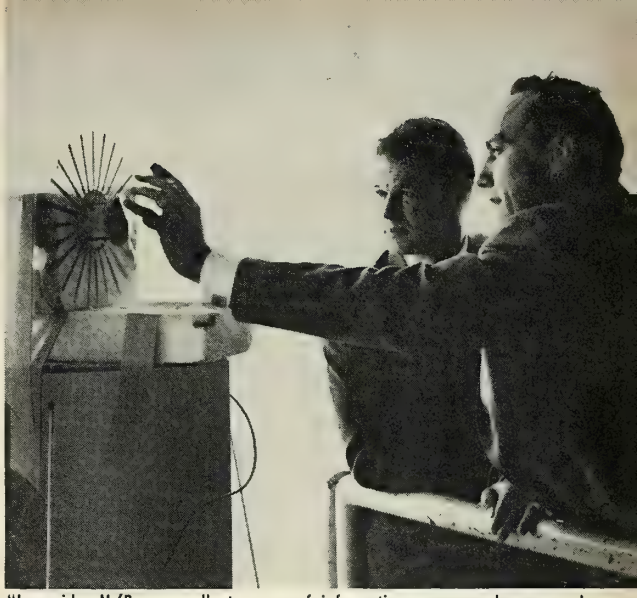
Harlan Tripp: Formerly manager of the ceramic bonding department of Gulton Industries, Inc., named director of research and engineering for Vitramon, Inc.

Jack Warner: Formerly with Space Technology Laboratories, Inc., and Gilfillan Brothers, Inc., joins the technical staff of Space Electronics Corp.

Henry F. Colvin III: Former chief of Flight Data Research and Development for Kollsman Instrument Corp., joins The Liquidometer Corp. as its manager of Advanced Development, Military Products.



"We find its concise technical/news coverage of the missile and space market very valuable in keeping up with developments in this rapidly growing field." R. P. Della-Vedova, Manager, Quality Assurance and Test Services, Satellite Systems, Lockheed Missiles and Space Division.



"I consider M/R an excellent source of information on new advances and applications in the missile/space field. It keeps us abreast of the state of the art in missiles and rockets for a better understanding of advanced requirements in antennas." A. F. Gaetano, Head, Electromagnetic Systems.

WHY DO SO MANY KEY PEOPLE AT LOCKHEED AIRCRAFT READ MISSILES AND ROCKETS?



1,080 PAID SUBSCRIPTIONS! In 1959 Lockheed Aircraft Corp. ranked *third* among all military prime contractors. Its missile and space achievements include the Polaris ballistic missile and the Agena satellite, plus many others. Therefore, it is natural for 1,080 of M/R's paid subscribers to be concentrated in Lockheed. And since many of these MISSILES AND ROCKETS subscriptions have high pass-along readership, there are many times that number of M/R readers.

Some of the many reasons why M/R commands intense readership at Lockheed are given in the picture story. They were obtained as a result of a recent visit to the company by M/R Executive Editor Clarke Newlon (insert).

These comments and those of other key readers in other missile/space companies clearly show what M/R has known all along . . . that the missile/space industry is a separate, distinct market with requirements which change almost daily . . . a market that can best be interpreted by undiluted, *weekly* technical/news coverage. It is this kind of coverage which makes M/R the leader . . . explains its deep, penetrating readership and acceptance.

"The weekly issues of M/R give us fresh coverage . . . not month-old news. Editorially it is well written, sprightly and lively." J. L. Shoenhair, Assistant Manager, Polaris Missile Section.



"M/R gives us what we want to read in the missile field. There is no waste of time wading through material foreign to our interests." L. H. Amaya, Manager of Lockheed's Digital Computer Operations.



contracts

ARMY

$19,500,000—**Hughes Aircraft Co.,** Fullerton, for "missile monitor" air defense command posts.

$11,341,510—**Western Electric Co. Inc.,** New York City, for *Nike-Zeus* production equipment. (Two contracts.)

$4,681,765—**Hughes Aircraft Co., Ground Systems Group,** Fullerton, Calif., for radar netting for AN/MSQ-18.

$3,000,000—**Beech Aircraft Corp.,** Wichita, Kan., for production of additional Beechcraft Model 1025 missile targets.

$2,750,000—**North American Aviation, Inc.'s Autonetics Division,** Downey, Calif., for continuing product engineering on the FADAC computer.

$2,593,038—**Motorola, Inc.,** Scottsdale, Ariz., for radar data transmitting and receiving sets and ancillary items.

$2,082,440—**Western Electric Co.,** New York City, for *Nike* spare parts and components. (Eleven contracts.)

$1,645,731—**Trailmobile, Inc.,** Springfield, Mo., for *Lacrosse* missile containers.

$1,300,000—**Sperry Gyroscope Co.,** for developing a super power klystron tube to be used with *Nike-Zeus.*

$1,000,000—**Sylvania Electric Products, Inc.,** for two ground antenna systems for Project *Advent,* a communications satellite network.

$996,774—**Northrop Corp., Radioplane Div.,** for target missile flight services.

$800,000—**Beckman Instruments, Inc., Systems Division,** Anaheim, Calif., for two analog-to-digital data acquisition and computing systems for use in conjunction with the *Pershing.* Subcontract from **Aetron Division of Aerojet-General Corp.**

$689,762—**Southern, Waldrip & Harvick Co.,** Long Beach, Calif., for SAC missile facilities, Mather AFB.

$545,000—**Chrysler Corp.,** Detroit, for engineering services on the *Redstone* missile.

$527,849—**The Martin Co.,** Orlando, for replenishment spare parts for the *Lacrosse.* (Eight contracts.)

$480,000—**Dunn Engineering Associates, Inc.,** Cambridge, for the construction of radome boresight and dish antenna test equipment for the *Hawk* system.

$276,117—**Douglas Aircraft Co.,** Santa Monica, for *Nike* spare parts and components. (Two contracts.)

$168,972—**Duval Engineering & Construction Co.,** Jacksonville, Fla., for 40x50 ft. unloading wharf, a structural steel unloading bridge 40 ft. long by 5 ft. wide and related work for *Saturn.*

$65,000—**Aero Systems Engineering Division, Aero Services Inc.,** Philadelphia, for a space age imagery interpretation and evaluation.

$48,434—**Firestone Tire & Rubber Co.,** Los Angeles, for repair parts for the *Corporal* missile system.

$28,382—**Astro-Electronic Products,** Princeton, N.J., for Project *Tiros* and ancillary items.

AIR FORCE

The Gabriel Co.'s Bohanan Manufacturing Co., Compton, Calif., for engineering, development, qualification and production of the hydraulic vernier actuators for the *Atlas.* Subcontract from **General Dynamics Corp.'s Convair Astronautics Division.** Amount not disclosed.

Hexcel Products Inc., Berkeley, Calif., for investigation of sandwich structures made with foam-filled honeycomb core. Amount not disclosed.

$5,500,000—**Douglas Aircraft Co.,** Los Angeles, for additional production of MB-1 *Genie* rockets.

$5,279,088—**Radio Corp. of America,** Camden, N.J., for on-site operation and off-site maintenance and logistics supply support for the Alaskan long lines system.

$417,347—**Melpar, Inc.'s Simulation and Training Systems Laboratory of the Data Processing and Support Systems Dept.,** Falls Church, Va., for design and fabrication of three trainers for the *Bullpup,* GAM 83 A/B.

$300,000—**Babcock Relays, Inc.,** Costa Mesa, Calif., for miniature BR-7 relays suitable for check-out and launch systems for the *Atlas.* Subcontract from **Consolidated Electronics Industries Corp.'s Technical Electronics Co. division.**

$235,000—**The Garrett Corp.'s AiResearch Manufacturing Co.,** Los Angeles, for development of a test space capsule.

$208,000—**American Bosch Arma Corp.'s Arma Division,** Hempstead, N.Y., for research and development of ultraprecise accelerometers for inertial guidance of future vehicles on extended space flights.

$200,000—**Melpar Inc.'s Ground Data Handling Equipment Laboratory,** Falls Church, Va., for developing ground support equipment for the FINDER system.

$47,670—**Federal Electric Corp.,** Paramus, N.J., for architect and engineer services necessary to prepare final instruction plans and specifications for FY-61 military construction program for DEW line.

NAVY

Thompson Ramo Wooldridge Inc.'s Dage Television Division, Michigan City, Ind., for manufacturing a television camera and transmitter that will fit into the nose cone of the 4½-in.-diameter *ARCAS* rocket. Amount not disclosed.

$3,200,000—**Sylvania Electric Products, Inc.,** Waltham, Mass., for electronic data processing equipment to direct movement of the radio telescope at the Naval Research Station, Sugar Grove, W.Va.

$2,900,000—**Minneapolis-Honeywell Regulator Co.,** for production of *ASROC* missiles.

$2,500,000—**Raytheon Co.,** Waltham, Mass., for work on electronic systems for *Polaris* (two contracts).

$666,000—**Dorne & Margolin, Inc.,** Westbury, L.I., N.Y., for manufacture of electronic countermeasure direction finders.

$1,010,000—**Fairchild Engine & Airplane Corp., Astronics Division** Wyandanch, L.I., N.Y., for manufacture of electronic countermeasure trainers.

$600,910—**The Fischer & Porter Co.,** Warminster, Pa., for a data acquisition and computation facility at the Naval Air Turbine Test Station in W. Trenton, N.J.

$58,974—**Philco Corp.,** Philadelphia, for services and materials to redesign the antenna system and burst delay computer of target detecting devices.

$36,992—**McCormich Selph Associates, Inc.,** Holister, Calif., for services and material and facilities to design study of "Hummingbird" rocket motor.

NASA

$900,000—**Chance Vought Range Systems Div.,** Dallas, for operation of the Project *Mercury* space capsule tracking station in the Hawaiian Islands.

$482,670—**Electronic Associates, Inc.,** Long Branch, N.J., for analog computing system.

$200,000—**Plasmadyne Corp.,** Santa Ana, Calif., for development of an electric arc jet rocket engine of a minimum thrust level of .01 lb.

MISCELLANEOUS

Pittsburgh-Des Moines Steel Co., Pittsburgh, for constructing the space simulator vacuum chamber for General Electric Co.'s Missile and Space Vehicle Div. at Valley Forge, Pa.

$3,200,000—**Waltham Laboratories, Sylvania Electric Products Inc.,** N.Y. City, for electronic data processing equipment.

$900,000—**Telecomputing Corp.,** Los Angeles, for tracking antennas.

reviews

DIGITAL COMPUTER AND CONTROL ENGINEERING, Robert Steven Ledley, McGraw-Hill Book Co., New York, 835 pp., $14.50.

Here is a computer book that can be easily understood and its material immediately applied by any engineer who has passed a course in integral calculus.

This observation is not meant to downgrade the book but rather is intended to point up the extreme readability of the text and its practicality. A voluminous amount of material is covered, and in great detail. Therefore, those readers who want only a general knowledge of digital computers and control engineering would do well to buy a thinner text.

The author uses typical engineering pedagogy by explaining first in terms of specifics and then in generalities. In fact, in one extensive example the author designs a computer from start to finish.

In keeping with the elementary character of the book—intended for senior undergraduate or first-year graduate students and non-specialists in computer engineering—it covers a broad spectrum of subjects.

Overall design of degital systems is covered in Parts 1 and 2; the logical design of digital circuitry, Parts 3 and 4; and the design of digital circuits, Part 5.

The book is recommended for readers who are concerned with design or operation or use of digital computers.

EFFECT OF HEAT TREATMENT ON THE METALLURGICAL AND MECHANICAL PROPERTIES OF 7AL-3MO TITANIUM ALLOY. P. L. Hendricks, WADC, Order PB 161363 from Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C. 109 pp., $2.50.

The metallurgical and mechanical properties of a titanium alloy were determined on a production size heat.

Determination of tensile properties, heat treatment, stress rupture, creep stability, compressive yield, modulus, and impact strength were investigated.

ADVANCES IN SPACE SCIENCE, Volume 2, edited by Frederick Ordway, III, Academic Press, New York, 450 pp., $13.

This second volume of technical monographs on space flight subjects serves as the first to give the reader palatable surveys of timely topics. Seven contributors, all experts in their respective fields, have succeeded in making their presentations readable by emphasizing physical concepts and clearing the reader's path of much mathematical underbrush.

The subjects covered and their authors are as follows: Experimental physics using space vehicles, Charles P. Sonnett; Tracking artificial satellites and space vehicles, Karl G. Henize; Materials in space, Frederick L. Bagby; Plasma propulsion devices, Morton Camac; Electrostatic propulsion systems for space vehicles, Ernst Stuhlinger and Robert N. Seitz; and Attitude control of satellites and space vehicles, Robert E. Roberson.

—when and where—

AUGUST

Cryogenic Engineering Conference, University of Colorado and NBS, Boulder, Colo., Aug. 23-25.

Western Electronics Show and Convention, Los Angeles Memorial Sports Arena, Los Angeles, Aug. 23-26.

AGARD, Combustion and Propulsion Panel, "Advanced Propulsion Techniques," Pasadena, Aug. 24-26.

International Union of Pure and Applied Physics, International Conference on High Energy Nuclear Physics, University of Rochester, Rochester, N.Y., Aug. 25-Sept. 3.

German Rocket Society, Annual Meeting, Hanover, Aug. 26-28.

University of Connecticut, Eleventh Annual Basic Statistical Quality Control Institute, Storrs, Aug. 28-Sept. 9.

Combustion Institute, Eighth International Symposium on Combustion, CalTech, Pasadena, Calif., Aug. 29-Sept. 2.

10th International Congress of Applied Mechanics, Congress Bldg., Stresa, Italy, Aug. 31-Sept. 7.

SEPTEMBER

Society of Instrument Technology and British Interplanetary Society, One-day Joint Symposium on Rocket and Satellite Instrumentation, Manson House, London, Sept. 1.

13th General Assembly of the International Scientific Radio Union, University College, London, Sept. 5-15.

International Summer Course on Solid State Physics, sponsored by: Italian Physical Society, in cooperation with NATO, CURATOM and National Committee on Nuclear Research, Italian Nuclear Energy Center, Varese, Italy, Sept. 5-24.

Society of British Aircraft Constructors Show and Flying Display, Farnborough, England, Sept. 6-11.

Electronics Industries Association, Second Conference on Value Engineering, Disneyland Hotel, Anaheim, Calif., Sept. 7-8.

Joint Automatic Control Conference, Massachusetts Institute of Technology, Cambridge, Sept. 7-9.

AGARD, Seminar jointly sponsored by AGARD and the Instituto Lombardo di Scienze e Lettere, "Propulsion for Astronautics," Varenna, Italy, Sept. 8-12.

American Chemical Society, 138 National Meeting, New York City, Sept. 11-16.

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has NO moving parts!

In operation, the action of an explosive compound establishes a large-area, permanent and unfailing contact. Contacts withstand any G-force, vibration or shock. The switch has a capacity of 20 amps. and is designed to operate in environmental temperatures from minus 100°F to 400°F.

In addition to standard, available units, modifications are readily made in size, configuration and mounting to meet any requirement. Bridge wire currents are adjustable and redundant bridge wires are optional. Time delays up to 10 seconds, single or multiple circuits, and any type of external contact, are also available.

The MIMX explosive switch has a fully contained reaction which does not contaminate its environment. Full information on MIMX explosive switches for your particular needs will be supplied promptly on request.

The research and development staff at MIMX specializes in ordnance systems, sub-systems and irradiated "plastics with memories". These capable and experienced technicians have been able to solve many unique and special problems in these fields. Engineering is backed with well-equipped and efficient production and quality control facilities. May we send you a brochure outlining the many ways we could serve you in special R & D projects?


Typical plastic mount.

mimx TRADE MARK

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Dept. M-80
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CHapman 5-1883

Circle No. 8 on Subscriber Service Card.

editorial . . .

The Missile Is Here to Stay

A U.S. BUSINESS publication recently inquired in a headline "Is Ballistic Missile Era Waning?" It went on to say:

"Missiles now in the works will have enough range, accuracy and payload to hit within less than a mile of any place on earth with a force of millions of pounds of TNT. What more, it's asked, could any ballistic missile do?"

We could point out any number of things (like reconnaissance and return) that missiles can do; we would prefer to point out that such a statement could only be made by someone with a lack of appreciation of the way the world moves.

Looking back, we can see that it would have been pleasant in some ways if man had stopped with the long bow and the sailing ship. Other progress might have died there too, but at least we wouldn't have the threat of instantaneous destruction hanging over our heads at all times.

The fact is that man does not cease to progress, for better or for worse. We do not know what the third and fourth and fifth generation of ballistic missiles will be like—but we are quite sure they will come.

They will come because man will devise ways to counter his fellow man's first- and second-generation missiles, making the third, fourth and fifth generations necessary. They will come because man in his terrible ingenuity will find ways to make weapons more deadly and more accurate and more difficult to counter.

It has always been thus and it probably always will be—until man reaches the millenium of disarmament. And even then some world (or cosmic) organization will have to maintain sufficient arms to enforce the peace.

The statement also ignores the fact that we are entering—perhaps being dragged is a better phrase—into the Age of Space.

Again, we don't know what the sixth, seventh and eighth generations of ballistic missiles will be. We don't know whether they will be designed to be fired from roving spacecraft, the moon or Venus. We don't know whether they will be part of a defensive force, a retaliatory force or just plain predatory—or even if they will be designed to inflict hurt on other earthly beings—but they will be there.

Finally, the statement ignores the virtual certainty that peaceful and commercial uses will be found for the ballistic missile.

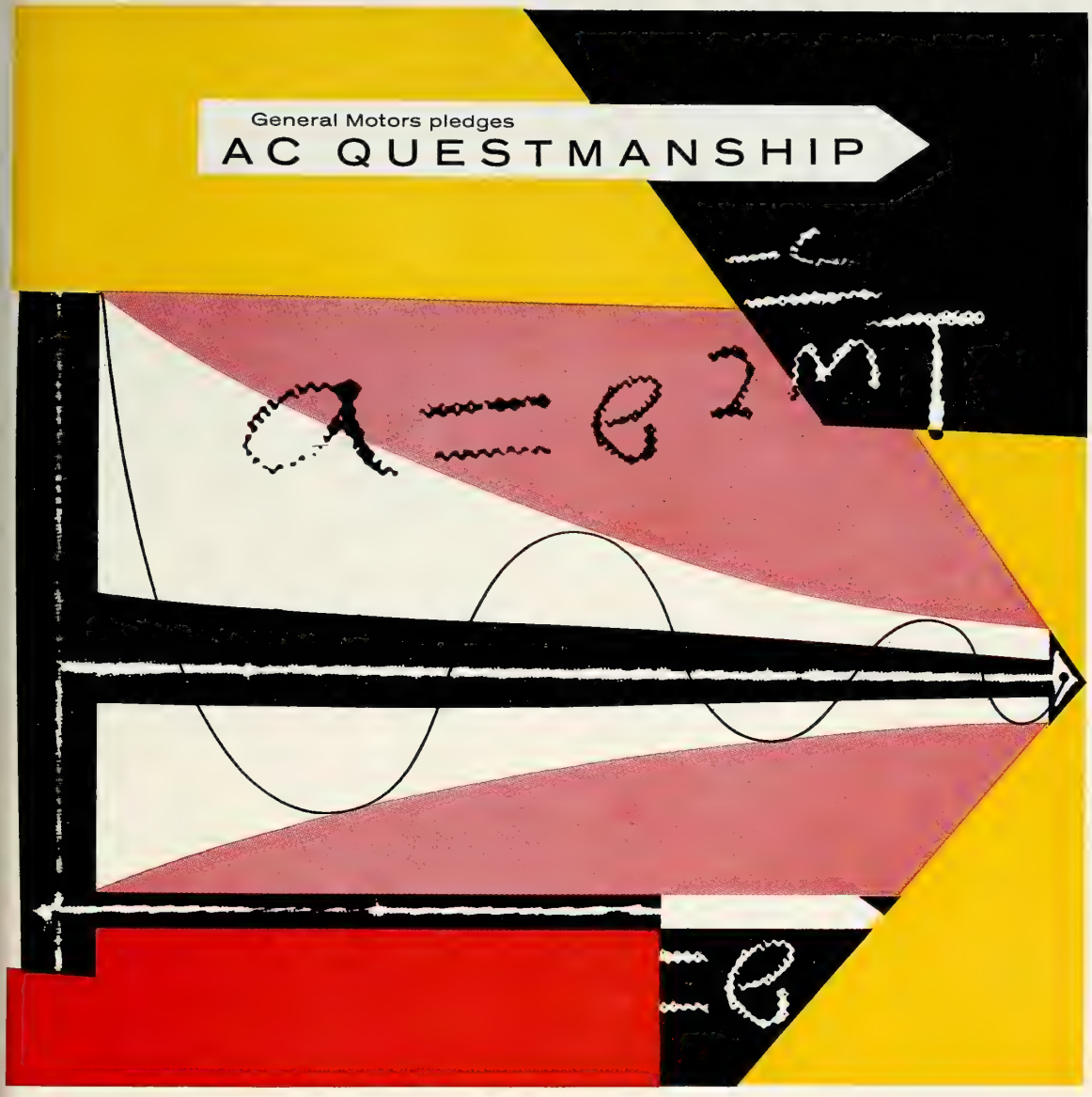
WHETHER you call it a spacecraft or a missile, whether it is manned or unmanned, the ballistic-trajectory vehicle will find everyday uses. It can carry mail. (Its air-breathing predecessors are already doing so.) It can carry cargo. It can carry passengers—although personally we prefer to wait awhile before being one.

Could anyone seriously think that the missiles which put *Echo* and *Discoverer XIII* into orbit are the last words in propulsion?

The applications the ballistic missile will find in defense, in exploration, in commerce—on this earth or in the heavens—appear to us to be practically limitless.

And saying that its era is waning seems somewhat equivalent to the well remembered words of those who said "Better get a horse"—or "the airplane will never sink a battleship."

Clarke Newlon



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2. Energize the system which causes the escape tower jettison rocket to fire. With the tower separated, barostats are armed to open parachutes and furnish the Astronaut's capsule a safe descent.

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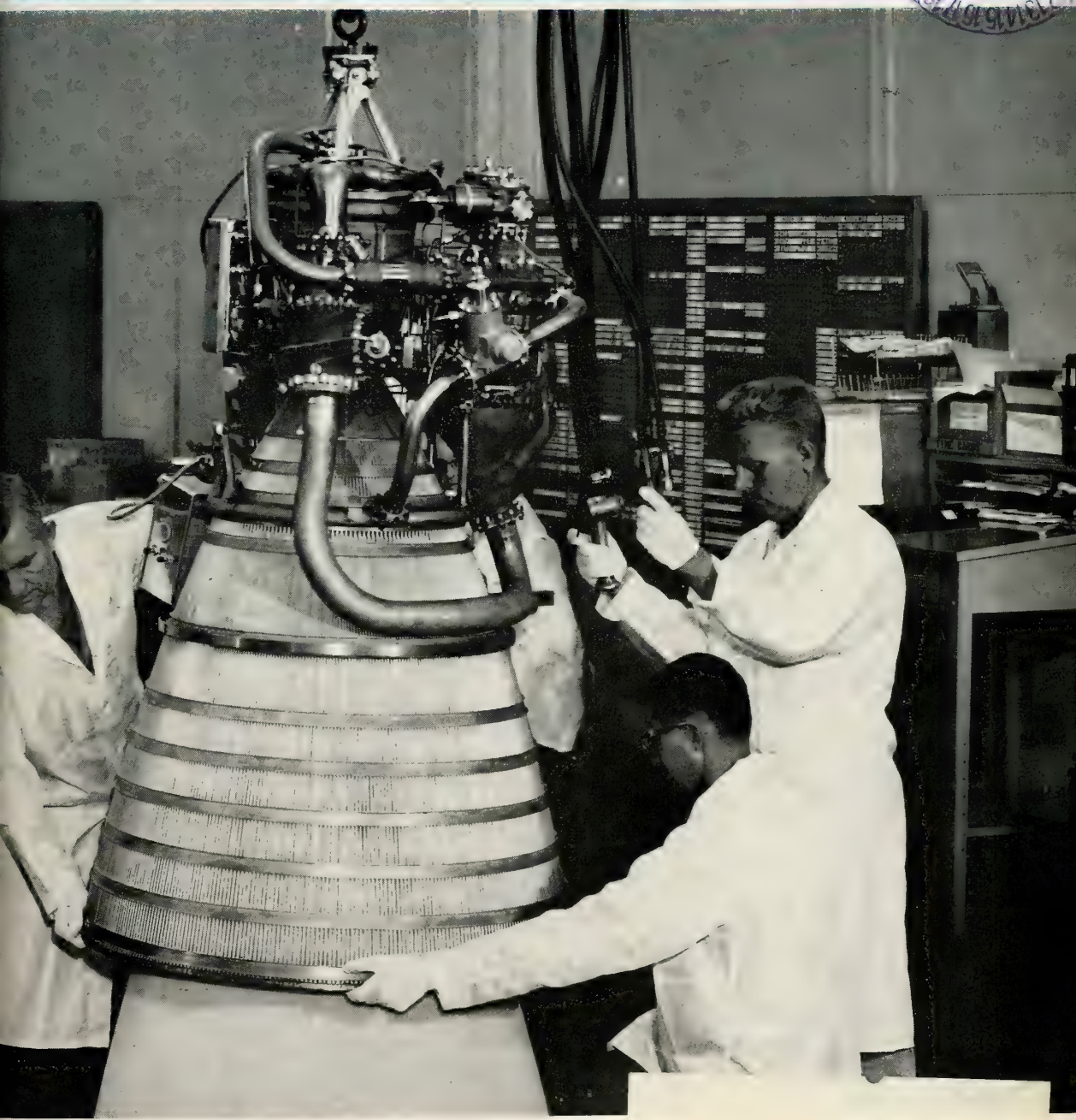
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AUGUST 29, 1960

missiles and rockets

THE MISSILE/SPACE WEEKLY

AUG 1960
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First Centaur Engine Delivered

B-70 Proposed as Recoverable 'Booster' . .
Congressmen Fear Man-in-Space Defeat . . 15
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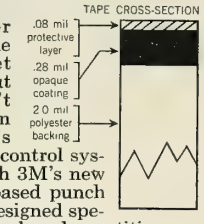
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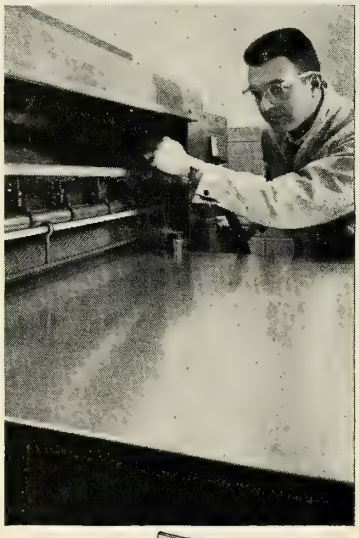
All these outstanding properties add up to literally thousands of passes through your equipment, even under unfavorable conditions. If you'd like to try your hand at punching holes in our product, call your local MAGNETIC PRODUCTS DIVISION representative, or check the box below.

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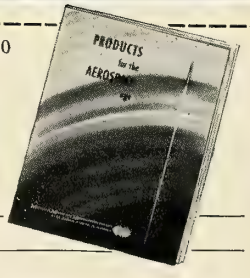
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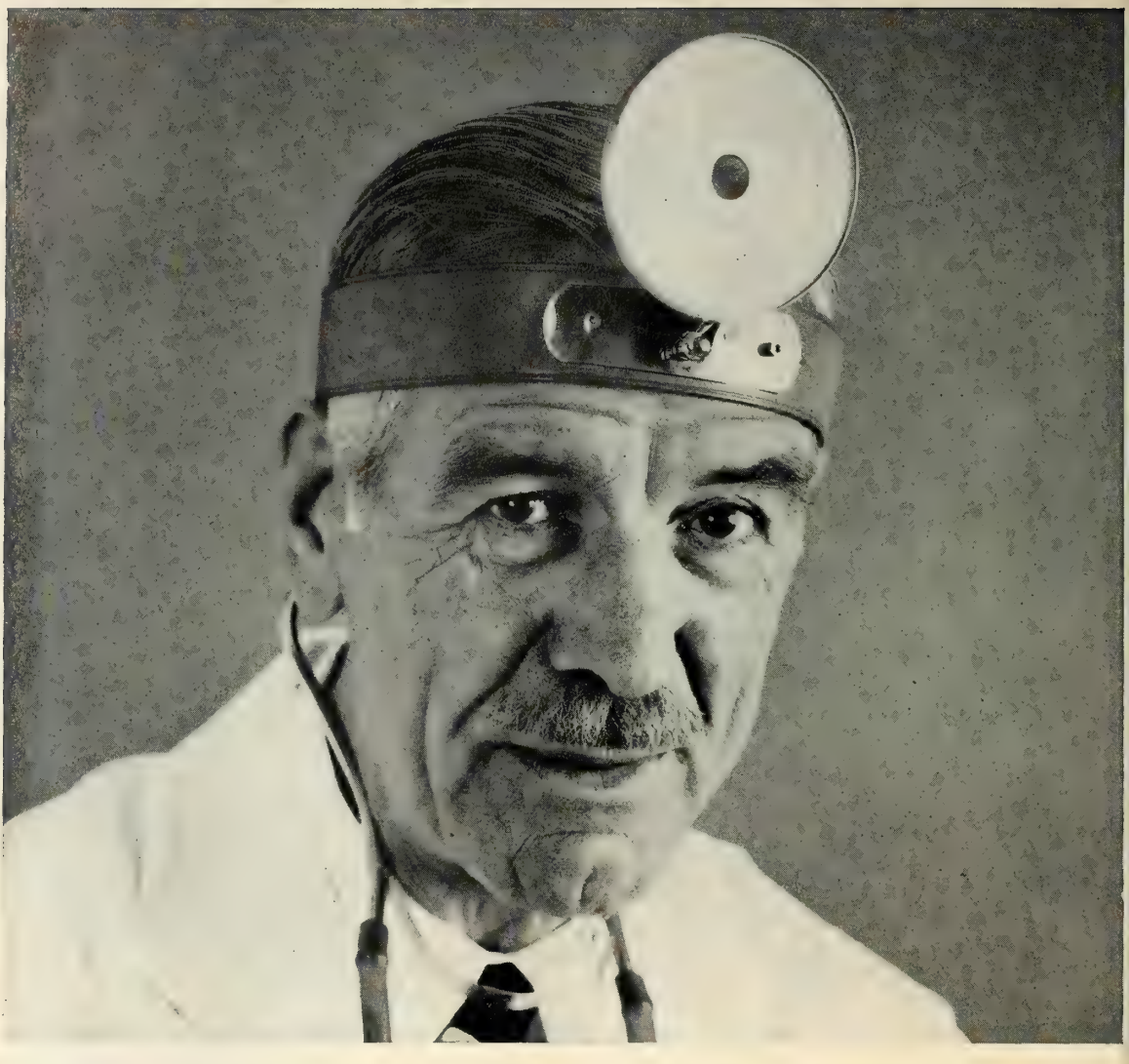
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THE MISSILE / SPACE WEEKLY

missiles and rockets

August 29, 1960 Volume 7, No. 9

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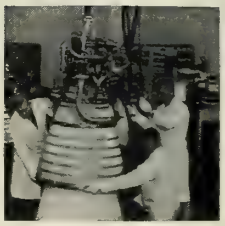
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THE COVER

Nation's first liquid hydrogen rocket engine, designed to power NASA's Centaur space vehicle, has been delivered by its maker, Pratt & Whitney Aircraft.

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letters

Triple Slip

To the Editor:

We have noticed in your July 18 issue (World Missile/Space Encyclopedia), under Strategic Missiles, that you have given credit to The Martin Company for the launcher systems for *Titan* missiles.

We of American Machine & Foundry Company (AMF) are doing the design, manufacture and installation of the launcher systems and would appreciate the credit, as we have a direct contract with the Air Force for this work.

R. McCardle, Acting Site Mgr.
Titan Installation & Activation Division
American Machine & Foundry Co.
Denver, Colo.

Through an oversight, M/R also erred in not crediting AMF with its role in development of the Minuteman rail car and its responsibility for Bomarc GSE. Our apologies to a major missile/space organization.—Ed.

Let's Fund Translation Now

To the Editor:

I found Paul Means' article on the efforts being made in developing a mechanical language translation program ("Auto-Translation Effort Lacks Focus," M/R, July 11, p. 22) an excellent review of the problems being faced. The article, however, did raise one or two questions in my mind.

The first is that it seems that a great deal of money and effort is being thrown into a project which is years away, while —in effect—very little money is being appropriated for solving the immediate problem: translating as much Soviet technical material as is necessary now. It seems ironical that we read every day that a lag in a critical area of as little as a year can make the difference between survival and destruction—while the authorities are content to allow at least a five-year lag in the translation program (which, while not ostensibly critical, really is).

The entire Russian translation program in the United States, which is actually producing results, at present costs less than $2 million a year. Several companies are engaged almost solely in this work; it has taken them years to build up the staffs to run out these translations and, in many cases, they do it at a loss simply because they are aware of the pressing need to maintain the program.

Moreover, when an adequate machine is provided it will be these companies whose staffs will have to provide the guidance necessary to check and recheck the accuracy of a vast amount of literature. I think that some attention should be given to these firms and to the problems they have run up against in attempting to broaden their program.

As an example, I should like to call your attention to the company called Consultants Bureau Enterprises, which not only translates more Russian scientific

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journals than any other company in the world, but which also translates, publishes and sells a large number of scientific Russian books used by almost every scientist in the country.

At this time the company has six or seven Russian journals (among them are Kinetics and Catalysis and the Journal of Structural Chemistry) which desperately require translation, but for which no funds are available. It is the kind of undertaking which should have support; I believe that if in some way you could point this out you would be performing a public service.

Mark R. Feller.
Manager, Research Dept.
Kalb, Voorhis & Co.
New York City

A-bombs for Allies

To the Editor:

Your Aug. 8 editorial ("How Bold, How Imaginative?") about "Bold Imagination," or meeting unknown dangers with attack, stinks to high heaven. You and your friends in the State and Defense Departments would have the United States arm West Germany with atomic weapons to again (make the Germans) potential aggressors in what you call the defense of the freedom of the world.

Discreetly, no mention of West Germany is made in your editorial; but, to some of us who understand the underhandedness of people like yourself, the intent is clear: arm the other guy and let him do the dirty work. May I advise you that by treaty West Germany, which is a part of NATO, is not supposed to have or to develop an atomic, bacteriological, or chemical war potential?

The United States already has a diverse and widespread world nuclear striking force. Let's keep it in our own hands where it belongs. Why don't you smart fellows who editorialize and run the Pentagon ever come up with any bold and imaginative ideas to bring peace to the world? If the world was free from warmongers maybe that would be the great first step to freedom of the individual man from political and economic slavery.

John Savas
Canton, Ohio

To the Editor:

Your Aug. 8 editorial regarding arming our European allies with atomic weapons makes a point that is generally overlooked. We talk a great deal about mobility and dispersion. What better dispersion could you have than extending our real defense and attack strength to a dozen NATO allies?

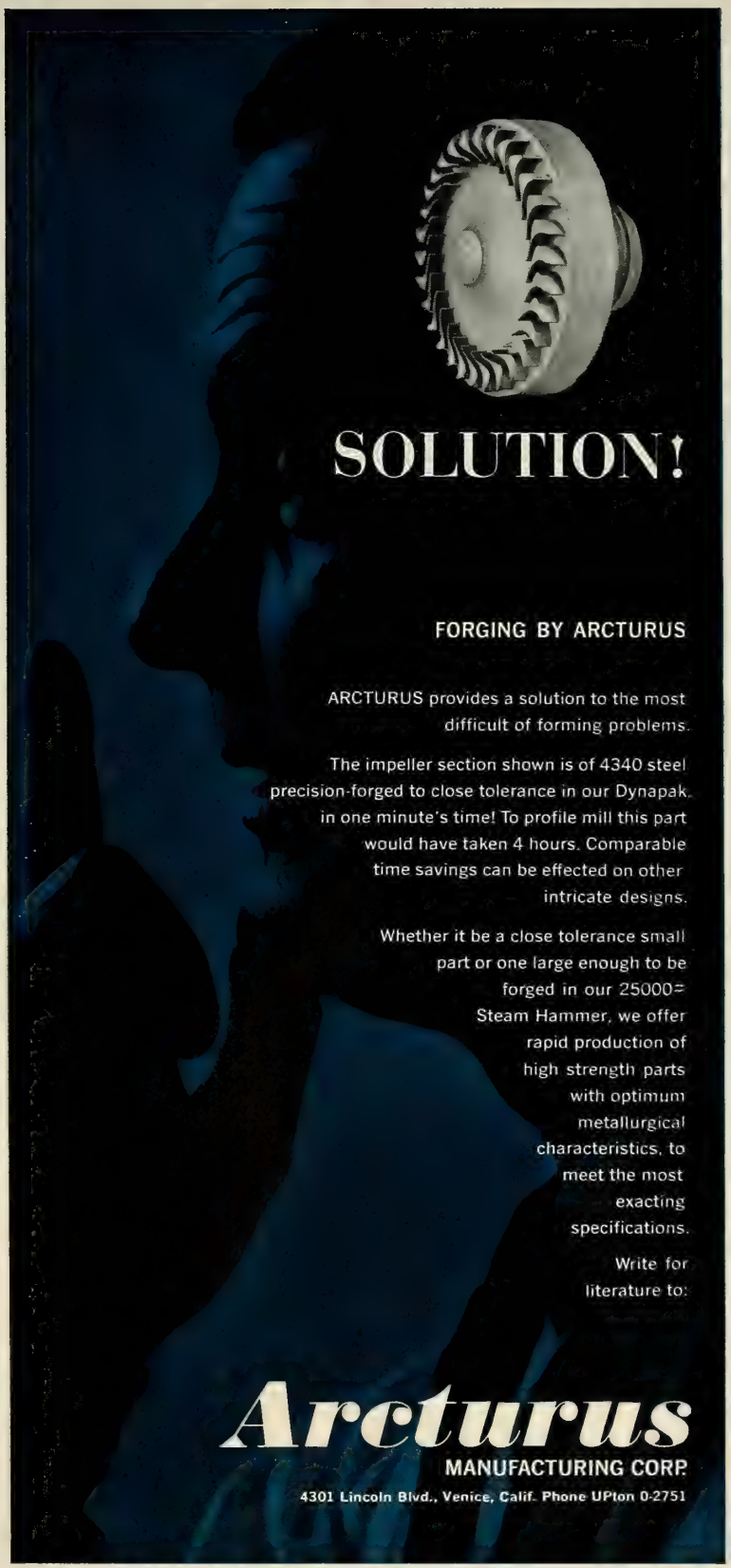
And, since the spreading of nuclear weapons seems inevitable, wouldn't the very factor of its commonness make control mandatory?

Carlton Thompson
Atherton, Calif.

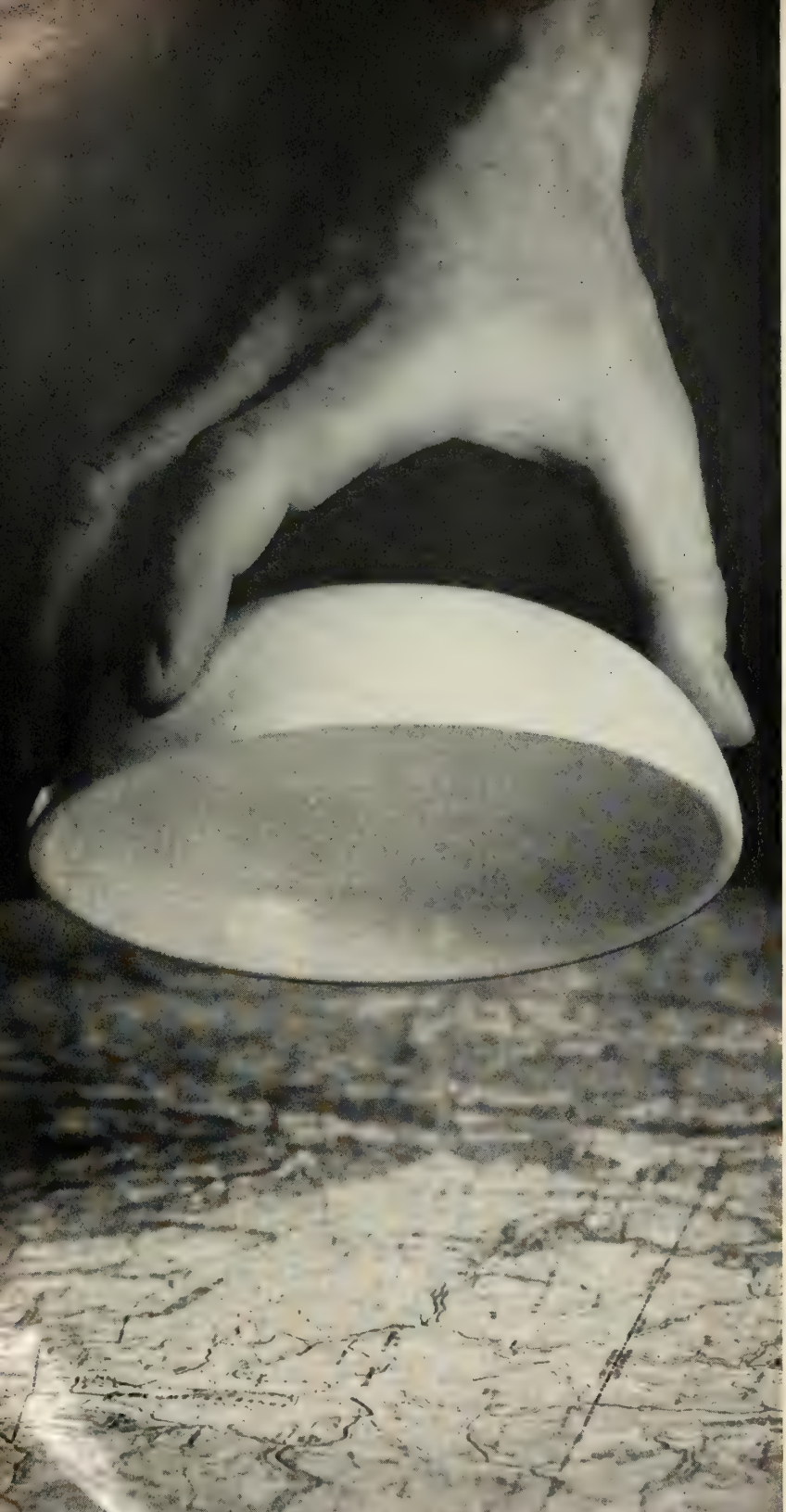
To the Editor:

. . . Isn't (our) holding on to our atomic secrets the very thing Russia wants most?

Peter Horn
Providence, R.I.



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The Countdown

WASHINGTON

B-70 Money Thaw Comes Slowly

The extra $100 million that the Administration has said it would unfreeze for the B-70 R&D program won't be flowing for awhile yet. The Defense Department, the Air Force and companies involved are trying to agree on a new program cut to the new financial pattern. The approximately $100 million would nearly double presently-planned Air Force funding of the B-70 in FY '61. But it is still far short of the original $400-million-plus program.

Super Polaris: How Soon?

Despite many words of praise, the Administration is still hedging even its announced bets on the Lockheed *Polaris* program. The Navy sought to push ahead in FY '61 with a $100-million R&D program. But the chances are that less will be made available. Also, weeks are slipping away. The apparently inevitable result will be the development of *Super Polaris* later—not sooner.

NATO MRBM Decision by Christmas

The NATO Council is expected to reach a decision by Christmas at the latest on which U.S. missile to buy to arm Western Europe with MRBM's. *Polaris* is still considered to have the lead, but the NATO countries are looking at other possibilities. (See page 16.)

Lulu Plays Double Role

The Navy's new compact nuclear—depth charge—General Mills' *Lulu*—can strike at enemy submarines two ways. It can be air-dropped from a plane or helicopter. And it—or a modification of it—can be launched by ASROC from a destroyer.

No Mourning for Space Act Changes

Few tears are being shed on Capitol Hill for the shelved Administration proposals to amend the National Space Act. The House—passed bill, which is expected to die in the Senate, is considered by a number of top congressmen to be only showcase tinkering for the most part. They prefer to try for more significant changes in the Space Act next year in the new Congress.

INDUSTRY

New Engine Readied for X-15 Flight

North American is getting ready to send its *X-15* on a flight for the first time with the new big XLR-99 engine. The date: The first week in September. This means the July 6 explosion during run-up has set back the program only about two months rather than three to six as believed in some quarters.

Advanced Sparrow Contract Expected

Some insiders expect the Navy to award a contract within the next few weeks for a new *Sparrow* propulsion system. The powerplant will be used for an advanced model of the Raytheon air-to-air missile. The big question is whether the Navy will decide on a packaged liquid or a solid propellant.

Another Buy by Litton

Litton Industries is understood to be getting ready to buy another electronics firm. Litton is reported to be negotiating for an Eastern component manufacturer—one of about 10 firms Litton would like to buy when the price is right.

Another Name for Ryan

Ryan Aeronautical is quietly considering a change in its public image. Specifically, company officials are considering a change in names. They want something that more closely reflects the company's interests in space and electronics.

Fairchild Official Switches to P.R.

Warren R. Smith, assistant to the president of Fairchild Engine & Airplane Corp., will resign Sept. 1. Smith will open a public relations and industry consultant office in Washington. He will continue to handle the Fairchild account.

INTERNATIONAL

Anglo-German Accord over Blue Water

Great Britain and Germany are understood to have agreed to produce jointly English Electric's *Blue Water*. The surface-to-surface missile may eventually be adopted as a NATO tactical weapon.

French Eye U.S. Nuclear Scorekeeper

The French Defense Ministry is considering the purchase of U.S. nuclear target scoring equipment. Interested ministry officials recently completed an inspection trip to the United States.

More Missiles at Farnborough

The Missile Park at the annual Farnborough Air Show next month in Britain will be 20% larger than last year. Among the feature attractions will be the Bristol-Siddeley Stentor engine, which powers the *Blue Steel* air-to-surface tactical missile.

British Aerospace Firms Consolidate

Three British firms—Vickers-Armstrongs (Aircraft), English Electric Aviation and Bristol Aircraft—have formed the British Aircraft Corp. The new corporation already has acquired control of Hunting Aircraft, Ltd.

The Overseas Pipeline

German firms are offering electronic systems to NASA . . . the French *Veronique* sounding rocket is carrying a 145-lb. warhead . . . the French Navy is planning to build another missile cruiser . . . reports persist that the Russians are launching big missiles from a site just north of Moscow.

New missions for the Agena

The Lockheed-built Agena satellite—used by the U.S. Air Force in its Discoverer, Midas, and Samos programs—has been chosen for another major program. The National Aeronautics and Space Administration plans to use a larger, more powerful version, the Agena B. NASA will use both Atlas and Thor boosters to launch it. Atop the Atlas, the versatile Agena B will vary from a 5000-pound earth satellite to an 800-pound space vehicle. Atop the Thor, it will be used for a new series of 1500-pound meteorological satellites. Lockheed is prime contractor and system manager for the Agena and Agena B.

LOCKHEED MISSILES & SPACE DIVISION
SUNNYVALE, CALIFORNIA



Agena is America's largest satellite, weighs 1700 pounds on orbit. Agena B is larger, has doubled fuel capacity.

OTHER LOCKHEED DIVISIONS: CALIFORNIA • GEORGIA • LOCKHEED ELECTRONICS CO. • LOCKHEED AIR TERMINAL • LOCKHEED AIRCRAFT SERVICE • LOCKHEED AIRCRAFT INTERNATIONAL • LOCKHEED, S.A. • PUGET SOUND BRIDGE AND DRY DOCK CO. LOCKHEED PRODUCTS: ELECTRONICS • MISSILES • AIRCRAFT • NUCLEONICS • SATELLITES AND SPACE VEHICLES • ROCKET FUELS AND MOTORS • AIRCRAFT MAINTENANCE • AIRPORT MANAGEMENT • SHIPBUILDING • HEAVY CONSTRUCTION

An M/R exclusive . . .

B-70 Proposed as 'Booster'

System developed by North American using B-70 and intermediate booster rocket could save billions of dollars

by William J. Coughlin

LOS ANGELES—Development of a new intermediate stage booster rocket with a thrust of some 300,000 lbs. is proposed by North American Aviation for use in a space system in which the B-70 would serve as a recoverable first-stage booster.

The system, consisting of a B-70 and the non-recoverable intermediate booster, could be used to orbit *Dyna-Soar, Samos, Midas, Discoverer* and other space vehicles. North American estimates that using the B-70 Recoverable Booster System (RBSS) would save the nation some $2.63 billion in its space programs over a 15-year period.

Details of the system, developed under Air Force study contracts, have been disclosed for the first time. The Air Force is giving serious consideration to the proposal for RBSS launch of *Dyna-Soar*. One major advantage would be the ability to launch the manned spacecraft in a horizontal position—impossible with the planned *Titan* boosters.

• **Easy adapting**—Modifications required to adapt the B-70 to a space role as a recoverable first-stage booster are few:

–Lengthening of main gear struts by three feet.

–Provision of fairing for payload.

–Provision of an escape chute so that the pilot of a manned vehicle such as *Dyna-Soar* can eject up through the B-70.

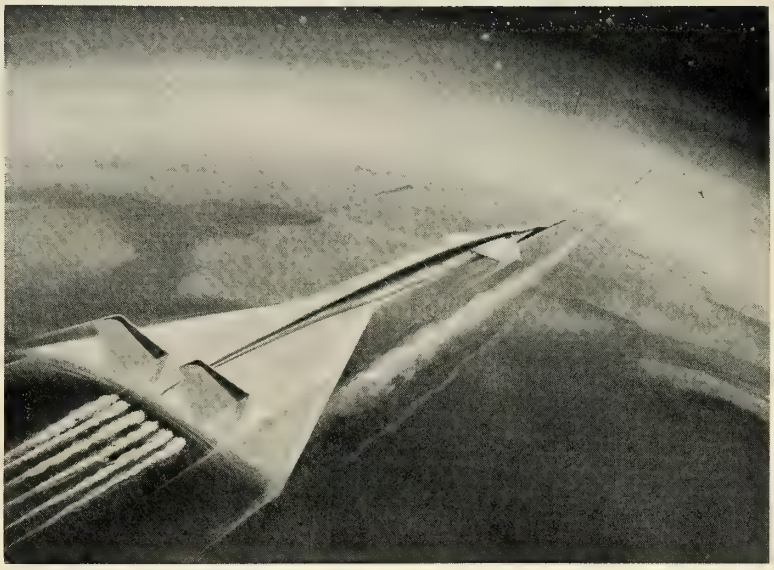
–Relocation of nose gear by moving it forward and providing for retraction into new payload fairing.

–Provision of attach and drop mechanisms.

–Elimination of unnecessary electronics and defensive armament.

The RBSS B-70 is expected to be less expensive than the military version. Cost for three of the aircraft is estimated to range between $140 million and $200 million, depending upon total B-70 procurement. No modifications are necessary to the propulsion, control or guidance systems.

The intermediate-stage booster rocket is needed because most orbital vehicles now planned will not be powered. The design proposed calls for a booster similar to a king-sized *Polaris* or *Minuteman* ballistic missile.



INTERMEDIATE BOOSTER takes off carrying space vehicle after dropping from B-70 in sketch by North American artist. Booster would drop away at about 20,000 ft.

Orbiting of *Dyna-Soar*, weighing between 10,000 and 15,000 lbs., would be accomplished by attaching the spacecraft to the top of the booster, which might be of the double, or Siamese, type to eliminate the need for lengthening B-70 main gear struts.

An orbital *Dyna-Soar* would fit snugly into the bomb bay of a modified B-70 with only its wings outside. It would rest atop the booster, which would be equipped with its own vectoring control system and faired into the bottom of the supersonic aircraft. The techniques employed would be similar to those developed by NAA for dropping of *X-15* rocket ship from a B-52.

Launch would be at Mach 3 above 70,000 ft. The Booster would drop off at about 200,000 ft. and the spacecraft's sustainer engine would take over. After burnout, *Dyna-Soar* would coast to apogee, using reserve fuel to kick into orbit after rotation into plane. Retro-rockets would be used for recovery from orbit.

One major military application of such a system is for satellite interception and inspection. The B-70 also could be used to launch a *Dyna-Soar* type vehicle as an orbital bomber.

• **Savings described**—But the role seen for the RBSS is far wider than its pure military application for vehicles of the *Dyna-Soar* type. North American has carried out a study for the Air Force based on probable national budget allocations for all types of military and civilian space programs for the period 1965-80.

This study indicated that approximately 50% of the tonnage to be placed in orbit will consist of payloads in the 5000-to-15,000-lb. weight category. For payloads above 15,000 lbs., North American assumed boosters of the *Saturn* type would be required. The B-70 was studied as a replacement for the others, such as *Atlas-Centaur*.

Use of the B-70 RBSS in these launches in place of nonrecoverable first-stage boosters was estimated to provide a net saving of some 66% in hardware alone. Financial savings per launch were estimated at $2-million—for a total of $2.63-billion.

Costs are based on the use of a

minimum of three of the RBSS aircraft, with the program envisioning eventual use by the military and National Aeronautics and Space Administration of between six and 10 of the B-70's fitted as recoverable boosters.

North American estimates that for a 10,000-lb. orbital payload, the cost/lb. in orbit will be about $125 with the RBSS. Comparable cost for a booster of the *Atlas/Titan/Saturn* type is estimated at $300/lb.

Costs are estimated on 2000 to 2500 launches for each RBSS B-70, crediting the aircraft with a service life of some 6000 hrs. The figures take into account development and use of the new intermediate booster.

• **Bigger payloads in future**—First aircraft for this use, if the B-70 program is expanded, probably would be No. 7 off the assembly line, available in 1963-64. The additional two aircraft, under present space goals, probably would not be needed before late 1967.

The B-70 is seen as easily adaptable to its role as space booster. Of its maximum gross takeoff weight of more than 550,000 lbs., some 65% is fuel. This means it could carry a payload of vehicle and intermediate booster totaling some 217,000 lbs. on the shorter-range space missions.

Employing today's cryogenic engines and fuels, the B-70 RBSS could put a 5000-lb. payload into a 300-mile orbit. As non-cryogenic systems become available, the weight penalty resulting from the requirement that several thousand pounds of fuel be carried for topping-off will be eliminated. This would up the payload to the point where 14,000 lbs. could be placed in the same orbit.

Improvement in fuels for the B-70 itself will mean an ability to exceed Mach 3 on a dash basis, since the aircraft is capable of Mach 4 for very short periods without encountering too severe thermal problems. This would provide a capability of placing 30,000 lbs. in a 300-mile orbit, increasing even further the savings possible with such a program.

The B-70, with a comfortable excess of thrust for takeoff, will be able to take large payloads through the sonic barrier if they are properly faired.

In addition to the new intermediate booster proposed by North American, studies also have been made of existing vehicles as potential space boosters. The B-70 could carry either *Polaris* or *Minuteman*. Although a single *Polaris* probably would lack the thrust to be an effective booster, a cluster of three *Polaris* missiles could be employed, according to North American designers.

• **Low drag at launch**—Major advantage of the RBSS lies in the fact that not only would Mach 3-4 energy be imparted to the payload on launching, but it would be imparted at an altitude where, with 98% of the earth's atmosphere lying below, there is very little drag.

To illustrate this advantage, the following example is cited:

From sea level, an *Atlas* booster can put about 3800 lbs. of payload into a 300-mile orbit. If this *Atlas* were hung from a balloon and fired at 80,000 ft., it would be capable of putting a 13,700 lb. payload into the same orbit. Modifying the nozzles to optimize the *Atlas* for launch at this altitude would up the payload to 18,300 lbs. If it could then be hung from a B-70 and boosted to Mach 3 before firing, it would be capable of putting 24,900 lbs. of payload into orbit.

Another way of putting it is that taking a given payload to altitude for launch makes it possible to decrease the size and cost of its booster. This could be done, in a limited sense, even with a B-52.

• **Added orbits**—It also is pointed out that use of the B-70 RBSS would add considerable flexibility to the U.S. space program now limited—by safety problems and availability of down-range facilities—to two launching sites in the continental U.S. The RBSS would offer a wide number of orbit injections where the intermediate booster would fall harmlessly into the ocean or in unpopulated areas.

Firing into an equatorial orbit also would be possible without the expense of establishing an equatorial launch base. To fly from the U.S. to a point on the equator with a maximum load of 217,000 lbs., launch its payload and return to the U.S., a B-70 would require in-flight refueling. But with lighter payloads, in-flight refueling would be unnecessary.

The Missile/Space Week

Samos to Get New Impetus

Brig. Gen. Robert E. Greer will push the high-priority *Samos* project in his new post as chief of all Ballistic Missile Division programs.

Lockheed Missiles and Space Division got formal confirmation of the $76.7-million contract it received in letter form from the Ballistic Missile Center. Work has already begun on a ground-space communications and control network for the Air Force *Discoverer, Midas* and *Samos* satellite programs.

New Nuclear Depth Charges Deployed

The Defense Department revealed that the atomic depth charge Lulu is now being carried in the fleet by antisubmarine warfare helicopters and aircraft. Lighter and smaller than the first nuclear depth charge, Betty, it was designed by the Naval Ordnance Laboratory and is produced by General Mills.

U.S. Goes Three for Four

About the same time the Soviets were launching *Strelka* and *Belka* into orbit: The U.S. Air Force shot instrument-loaded *Discoverer XIV* into a polar orbit from Vandenberg AFB, Calif. From Eglin AFB, Fla., a *Bomarc A* intercepted an "enemy" jet drone bomber heading for the Florida coast. The Navy fired another *Polaris* missile from Cape Canaveral. However, the Army's *Thor-AbleStar* launch vehicle for *Courier* communications satellite blew up 2½ minutes after launch.

The big news, though, was made the next day when an Air Force C-119 recovered the *Discoverer XIV* capsule in a spectacular mid-air snatch. Chances appeared good that *XVI* would carry the first orbiting primate.

Unstable Fuel Chemical Caused Blasts

Propellant manufactures and military installations have been warned to dispose of an unstable fuel element which caused two blasts at the Navy Propellant Plant, Indian Head, Md. The explosions, the first of which killed one workman and injured 20 others, were laid to a usually stable chemical which became unstable with heat or some other factor.

Soviet Describes Capsule Landing

Retro-rockets were used extensively to bring back the Soviet satellite carrying two dogs, according to the London *Daily Worker*. Soviet Prof. Ari Sternfeld disclosed that retros first slowed the vehicle, ejecting the capsule from orbit, then smaller retros corrected its flight toward earth, landing it within six miles of the predicted point.

Mercury slippage hit . . .

Congressmen Fear Man-in-Space Defeat

House Democratic leader concerned over military implications; Committee head sees Red manned launched this year

by James Baar

Key congressmen this last week bitingly attacked NASA for slippages in the *Mercury* program and warned that failure to put a man in space ahead of the Russians would result in a tremendous propaganda defeat for the United States.

At the same time, a number feared that the successful return of the Soviet "menagerie" satellite from orbit meant that the United States has already lost the race.

The congressional reaction came as NASA countinued to deny that *Mercury* has slipped about a year (M/R, Aug. 15) and more details of the Russians' 4.6-ton "space menagerie" were released.

NASA Chief T. Keith Glennan called the Soviet launching "a fine job," but said he did not regard it as a "major first"—only "just another step."

Others in and out of Congress regarded the launching as more significant. One top British authority—Prof. A. C. B. Lovell, director of the Jodrell Bank radio telescope—said he expected Russia to put a man into space "at any time."

• **Military implications**—The grimmest warning came from House Democratic Leader John W. McCormack of Massachusetts.

"What I'm afraid of is that now they're going to get ahead of us in putting up a military vehicle," he said. "The battleground of tomorrow is going to be outer space."

McCormack's statement hit directly at Administration policy. President Eisenhower has consistently contended that the military value of outer space is nil.

The House majority leader called for a hard-driving space program that would "coordinate the facilities and brains of the nation under strong leadership."

"We are facing an emergency and the effort should be made," he said. "The *Mercury* program has not moved as rapidly as I expected."

• **Mercury now anticlimactic?**—Chairman Overton Brooks (D-La.) of the House Space Committee said bluntly that he was "disappointed in the progress of the Project *Mercury* program," which he referred to as "a minimal experiment." He predicted that Russia will launch a manned satellite in October or "in any event before the end of the year."

"Whatever is done with Project *Mercury* after a Soviet success will be anticlimactic even if successful," he said. "This poses major, although not new, decisions for our government if we are not to suffer the kind of comparisons drawn between *Vanguard* and the early Sputniks."

Rep. James G. Fulton (R–Pa.), a top-ranking member of the House Space Committee, said "putting a man in space is worth $100 billion in foreign aid."

"You can only do it once," he said. "We should take it for its supreme value. But we're not settling down to the main event. We're spreading ourselves too thin."

Rep. B. F. Sisk (D–Calif.), another high-ranking member of the committee, said he has had "reservations about the *Mercury* program since the contract was let."

"The people running this thing have lacked the vision and foresight to anticipate the problems," he said. "They've never asked for enough money. They've continually underestimated and slipped."

Sisk also hit at the Administration's policies on man-in-space programs.

"We failed to make the broad approach," he said. "We could have gone ahead with something like *Dyna-Soar*, too, but the idea after *Sputnik* was to be somewhat economical."

• **Meadow landing**—The Soviets announced the recovery of their dog-carrying "menagerie" on Aug. 20—only one day after the Air Force successfully recovered in the air the 84-lb. capsule from *Discoverer XIV*. The *Discoverer* capsule contained no life.

The Russians said their satellite contained two dogs, some rats and mice, flies, plants, seeds and fungi. Its recovery marked the first time that living creatures had safely returned from orbit.

The satellite was launched into a nearly circular 198-mile orbit. The Russians said they observed the dogs on television during the 24 hours that the satellite was in orbit.

They reported that the satellite's retro-rockets were fired on command after the 17th circuit of the earth. A later report said the satellite and a capsule containing the animals separated after re-entering the atmosphere and landed safely in a meadow 6.2 miles from a predetermined landing area.

The two dogs—Strelka and Belka—were reported to have survived the trip "in perfect condition."

"The other biological subjects . . . also well sustained their stay in cosmic space and flight," Moscow Radio said. It added that one of the plants continues to blossom.

The Russians released photographs of the dogs taken while the satellite was in orbit and transmitted to earth. They also said they watched the orbiting dogs eat and function "physiologically" in a normal fashion.

• **Downgrading charged**—Congressmen repeatedly pointed to reports of the Soviet launching as evidence of where the United States stood in the space race.

Chairman Brooks noted that the Soviet satellite seemed to be a match for NASA's proposed *Apollo*. But he said that today *Apollo* is "only a designer's dream."

On the other hand, Brooks said that although Project *Mercury* is carefully planned with many types of safeguards, it has "some of the marginal capabilities of the kind associated with Project *Vanguard*." He said that if just a few things go wrong the project may not come off.

McCormack said the Administration has not made clear to the public "just how far behind we are, while it is evident that we are four to five years behind."

"There is no apparent appreciation of our relative position," he said.

"If the Russians didn't have anything, that balloon *(Echo)* would have been a fine thing. The Administration did the same thing with *Sputnik I*—downgrade it."

McCormack paused pointedly.

"The approach is wrong," he said. "Our policy should be not to catch up but to go ahead. That isn't our policy today."

Norstad reopens . . .

NATO Wary On Polaris; Wi

Allies are confused by lack of hard data and firm U.S. policy on competing programs; interservice struggle examined

by Donald E. Perry



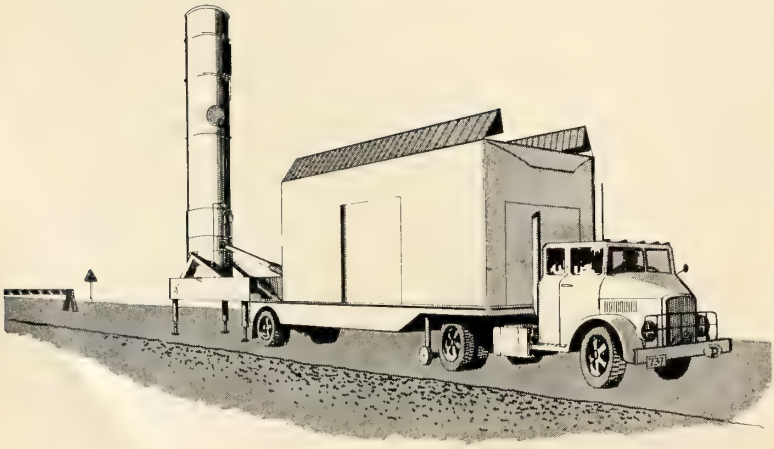
Reports from Europe indicate that America's NATO allies may want to explore the possibility of obtaining some missile other than *Polaris* to fill their need for a medium-range ballistic missile.

SHAPE Commander Gen. Lauris Norstad, M/R has learned, has asked Defense Secretary Thomas Gates whether other missiles may be made available if NATO changes its requirements.

Gates is reported to have suggested *Polaris* to the NATO defense ministers in March as the only U.S. weapon that can be adapted in the '62-early '63 period to meet their requirement for a "mobile, land-based missile system."

The Defense Secretary reportedly has promised to answer Norstad's query on or about Sept. 15, and to provide him with a detailed report on what missile systems, with what capabilities, will be available for NATO from now through 1975.

Gates' answer obviously could have a great effect on the fortunes of several U.S. missile programs—the Army's *Pershing* and the Air Force's projected TBM (tactical ballistic missile), in addition to the Navy's *Polaris*.



UNDER DEBATE: artist's conception of Polaris fired from mobile land vehicle.

Norstad's action could mean that NATO nations want to back off on range and operational dates if it would give them a more desirable system. This would be a door-opener for the Air Force—anxious to promote its TBM follow-on to the air-breathing *Mace*, and the Army—hungry for a range extension for *Pershing*.

But the prime reason—and this is conceded even by the services and manufacturers which have been pushing their individual programs—is that NATO has been given too many missile sales pitches on paper, without sufficient technical data or U.S. policy to back them up. NATO nations question touted availability dates and alleged capabilities, because DOD hasn't firmly decided what program or programs it wants.

This lack of accurate data and firm policy decisions has, many observers feel, strained the ties which bind NATO. How, they ask, can these allies agree on such things as range desired, hard or soft sites, a mobile, land-based system, use of warheads or sea and inland waterway launch capability, when the U.S. hasn't made program decisions?

• **Background**—While it is difficult to separate the chaff from the real thing, there is definitely bitter in-fighting behind closed doors. Washington observers say Norstad's query was occasioned by his own technical staff and political pressure from some NATO member nations who are not completely satisfied that the submarine environment-designed *Polaris* can be adapted in the 1962, early 1963 time period to provide a "mobile, land-based missile system."

Polaris proponents say it can. They concede some countries are not satisfied with the planned land-based *Polaris* system. However, they say these nations, perhaps deliberately, have not been given sufficient data. Nor, they say, has it been satisfactorily expounded that a mobile, land-based missile system should *not* be the only requirement. They contend that offshore ship and inland-waterway barge

hop Around

launch capabilities, the capability of NATO nations to use their own warheads, longer range, and a system in being, should also be considered.

They are accusing the Army and Air Force of bedfellowship in a mutual effort to sink *Polaris* in NATO. While the Army and Air Force both want the weapon and the mission, *Polaris* proponents say, they are doing some trading. Norstad, they say, is being pressured by his own service to keep the NATO requirement to a land-based system in order to qualify the Air Force's TBM concept.

On the other side, TBM and *Advanced Pershing* proponents are charging the Navy with trying to ram-rod through the State Department a policy decision supporting *Polaris* as the NATO weapon. They go so far as to say Gates' firm offer of *Polaris* to NATO took the Air Force and Army completely by surprise.

This has been branded as pure poppy-cock by the *Polaris* people. Observers say the offer of *Polaris* to NATO had been before the Joint Chiefs of Staff in March. The Army and Air Force reportedly sided against the Navy, claiming that *Polaris* was not suitable for NATO's MRBM requirement.

Observers said this was why the Air Force got mad when Gates made the offer:

–The Air Force was nearing completion of a study for its own TBM, SOR-161 (Systems Operational Requirement). It had even directed Ballistic Missiles Division to start development of the TBM, or TBMX as it is known in some quarters. Some FY 1961 funds reportedly were diverted and more funds were to be asked in the FY 1962 budget if the JCS should agree on the requirement. The new, non-profit Aerospace Corp. (broken off, because of Congressional criticism, from Space Technology Laboratories), had been assigned major responsibilities for the selective 200-1500-mile range system which was being promised for the 1965-75 time period.

The Army bristled because:

–It had its own program to extend *Pershing's* range to 1000 miles up for consideration by Gates and the JCS. Availability was being promised for late 1963 or early 1964. Principal effort would be to cut down weight of 682-pound guidance system, allowing more propellant in first stage, virtually doubling thrust.

The Army felt that if NATO would wait one year it could get a better land-based system in the improved *Pershing*. Further, the limited-range *Pershing* due to go to U.S. troops in Europe in 1962 could handle more than 70% of the NATO targets in the interim, with full coverage the following year—along with added capability to disperse the system to more distant nations and launch points.

Where does this leave Gates? Among the ticklish problems which will have to be decided in his answer to Norstad are:

1. Whether to let the *Polaris* offer stand? This could open him to partisan political criticism because of his former position as Secretary of the Navy and because of political objections that *Polaris* is being touted as the missile epitome of the Administration.

2. Whether to assign the Army a tactical missile role by extending *Pershing*'s range, qualifying it as a possible NATO MRBM and opening the roles and missions struggle again between tactical Army and air power?

3. Whether to keep the Army in its Wilson-imposed range limitation but permit it to develop a longer-range *Pershing* for the Air Force and possible NATO use. The Army, some observers say, is willing to make this concession.

4. Call for a new Air Force TBM system with availability in 1965.

Many people feel that Gates could score a major political and budgetary coup by permitting Army to develop a longer-range *Pershing* for the Air Force. If both services would agree, Gates could be known as the first Secretary of Defense who got the Army and Air Force to work together.

Some observers say the technical and missions side of the Air Force has by no means convinced the money holders that there is a separate requirement for a "Cadillac-version" of the MRBM in the TBM form incorporating the latest state-of-the-art for the period 1965-75. Guidance and GSE alone for the proposed AF TBM would run some $350 million. Many, even in the Air Force, feel this would be hard to come by.

NATO nations have good reasons to be confused with the slaps and counterslaps in the programs. Here are a few:

Against Polaris:

–In the 1965-75 period it will be technically behind the state-of-the-art while the TBM will be more "advanced."

–Its 28,000-lb. weight is against it as a "mobile, land-based system." (This is ammunition for the Army, which proudly cites *Pershing's* 10,000 lbs.)

–A submarine-designed system can not meet the stringent environmental conditions—shock, propellant grain temperature, electronics environs, etc. —of a "mobile, land-based system." (Again *Pershing* is mentioned: 20G shock cited, solid-grain capability to withstand 140-plus or minus temperature variation spread using –25°F as the medium, electronics designed for the ground, etc.)

–*Polaris* can not become a land system by its touted 1962 date.

Polaris counters:

–The TBM system which also would have to be deployed on foreign soil, would cost more than $1 billion just for development. Few technological "breakthroughs" could be expected to make it worthwhile. Further, it would put an unnecessary drain on industrial facilities and manpower. It's a "paper" promise and could not meet a 1964 date. *Polaris*—assuming the 2500-mile bird is realized—has its growth factor for the 1965-75 period.

–It's a system in being and "we don't have to wait until there's a tail-fin on next year's model." (1964 for advanced *Pershing* and later for TBM).

–It has 1000-mile range now, which *Pershing* does not have, and the 200-1500 mile range for the TBM again makes it questionable whether a new development program is worthwhile.

–A new guidance system for *Pershing* could be more of a development program than a new propellant program.

–*Polaris* would permit a nation such as France to use its own, still not fully-developed heavy nuclear warhead.

–Its capability of launch from merchant ships and barges in off-shore coastal waterways can pacify those nations (Britain, for example) which would like to have them off home soil. Further, this would strengthen the U.S.'s strategic *Polaris* capability, since launching submarines could be detached from European waters.

–It can meet the 1962 NATO date with the A1P because the mobile land system would only entail putting the submarine launch tube on mobile or tracked vehicles which would settle any environment problem (They don't consider there is any problem and cite the number of launches from Cape Canaveral). The tube also could be used as a shipping container and the pop-up effect could be used either in hardened or soft sites.

Discoverer Monkey Shot May Get Higher Priority

LOS ANGELES—Just how soon a monkey is launched into orbit in the *Discoverer* program may depend on the amount of political pressure applied as a result of recent Soviet space successes.

A spokesman for the Air Force Ballistic Missile Division said here "It is not likely" now that *Discoverer XV* will carry a primate aloft. He admitted, however, this still is a possibility if the monkey shot is given a higher priority.

His statement conflicted with reports from Washington that the Air Force definitely plans to attempt recovery of a monkey from orbit with *Discovered XV*.

Discoverer XV is scheduled for launch sometime within the next two weeks.

"We may have lost a little bit due to the Soviet accomplishments," Maj. Gen. Osmond J. Ritland, BMD Commander, said. "But it means we are in very tough competition in missiles and space."

• **Assurance sought**—Sources here said it is likely that two or perhaps more shots may be attempted before the primate is launched. It is known that Col. C. L. Battle, *Discoverer* Program Director at BMD, is anxious to have a reasonable assurance of a safe return before the shot is attempted. This will depend on successful recovery of two more shots, in his opinion.

The program moved closer to the life support launch with successful mid-air recovery of the capsule from *Discoverer XIV* on Aug. 19. *Discoverer XIV* was launched from Vandenberg Air Force Base at 12:57 PM, Aug. 18. An Air Force C-119 from the 6593rd Test Squadron made a successful mid-air snatch of the re-entry capsule 27 hours later, 300 miles northwest of Hawaii.

The aircraft, piloted by Capt. Harold E. Mitchell, made two unsuccessful attempts to recover the capsule before hooking it on the third try. The chute was snagged by a trapeze-like recovery gear strung between two telescoping steel poles trailing beneath the fuselage. A grappling hook then secured the chute and its capsule. The capsule was winched aboard by nylon cable to mark completion of a 450,000-mile journey through space on 17 earth orbits. It was the first mid-air recovery.

Dyna-Soar Invitation

Invitations to bid will go out early next month, M/R has learned, for the communications-data link and primary guidance subsystems for the Dyna-Soar boost-glide vehicle.

Some 86 firms attended a pre-bidders conference Aug. 10 at Wright Air Development Division at Dayton. Forty-two out of 48 firms indicated an interest in bidding on the communications-data link; 24 of 38 firms indicated they wanted to bid on the guidance subsystems.

Each firm has been given details on requirements. A deadline for bids will be set when the invitations to bid are issued.

Red Rockets Seen Able to Down U-2

Was reconnaissance pilot Gary Powers' U-2 knocked out of the sky from an altitude of 68,000 feet? If so, what Red rocket has this capability?

Powers testified at his Moscow "show" trial that it "was at that altitude I was struck down by something—I have no idea what it was. I didn't see it."

The consensus of Western observers present was that the U.S. aviator had not been brainwashed and that his answers were given firmly and without restraint.

Many American rocket experts think the Russians have such a capability. They point specifically to the *SA-4* anti aircraft missile, which should be able to destroy aircraft at altitudes much higher than 68,000 feet.

It is also entirely possible that a Russian air-to-air missile such as the *M-100A* fired from a late-model MIG could have done the job.

U.S. intelligence experts did not believe that the U-2 had been hit by a "remarkable rocket," as Premier Khrushchev described it, because this had not been detected by U.S. radar tracking Powers. They speculated that the plane had stalled trying to change altitudes.

But Powers' testimony—and the conviction with which he apparently gave it—indicated that the view from the radar scope may have been deceptive.

• **U.S. birds could do it**—Many U.S. antiaircraft missiles could hit aircraft flying at the U-2's altitude. *Bomarc-A*'s ceiling is above 68,000 feet, *Bomarc-B*'s more than 70,000 feet.

The maximum ceiling of *Nike-Hercules* is more than 150,000 feet.

The Soviets may be having trouble with antiaircraft missile guidance. A direct hit would have destroyed the U-2 and its pilot. It seems more likely that Powers' craft was hit by shrapnel from a missile detonated by a proximity fuze.

U.S. intelligence has known about the *SA-2*, which corresponds to the *Nike-Ajax*, and the *SA-4* for some time.

Disclosure of the *SA-4* by the U-2 and other intelligence sources gave high priority to such projects as *Skybolt*, because bombers could not fly out of reach of the newer Soviet missile.

It is also known that the Russians are developing an antimissile missile designated the *SA-6*. This missile may be further along in development than the *Nike-Zeus*, and may already be in production.

It is not thought that the knowledge that Russian rocketry may have been able to knock down a U-2 will alter Air Force planning in any way. It has been known for some time that future use of bombers will be as mobile missile launchers flying out of reach of enemy antiaircraft defenses.

The U-2 as a reconnaissance tool was becoming obsolescent at the time of Powers' flight. It will be superseded in the near future by reconnaissance satellites such as *Midas* and *Samos*.

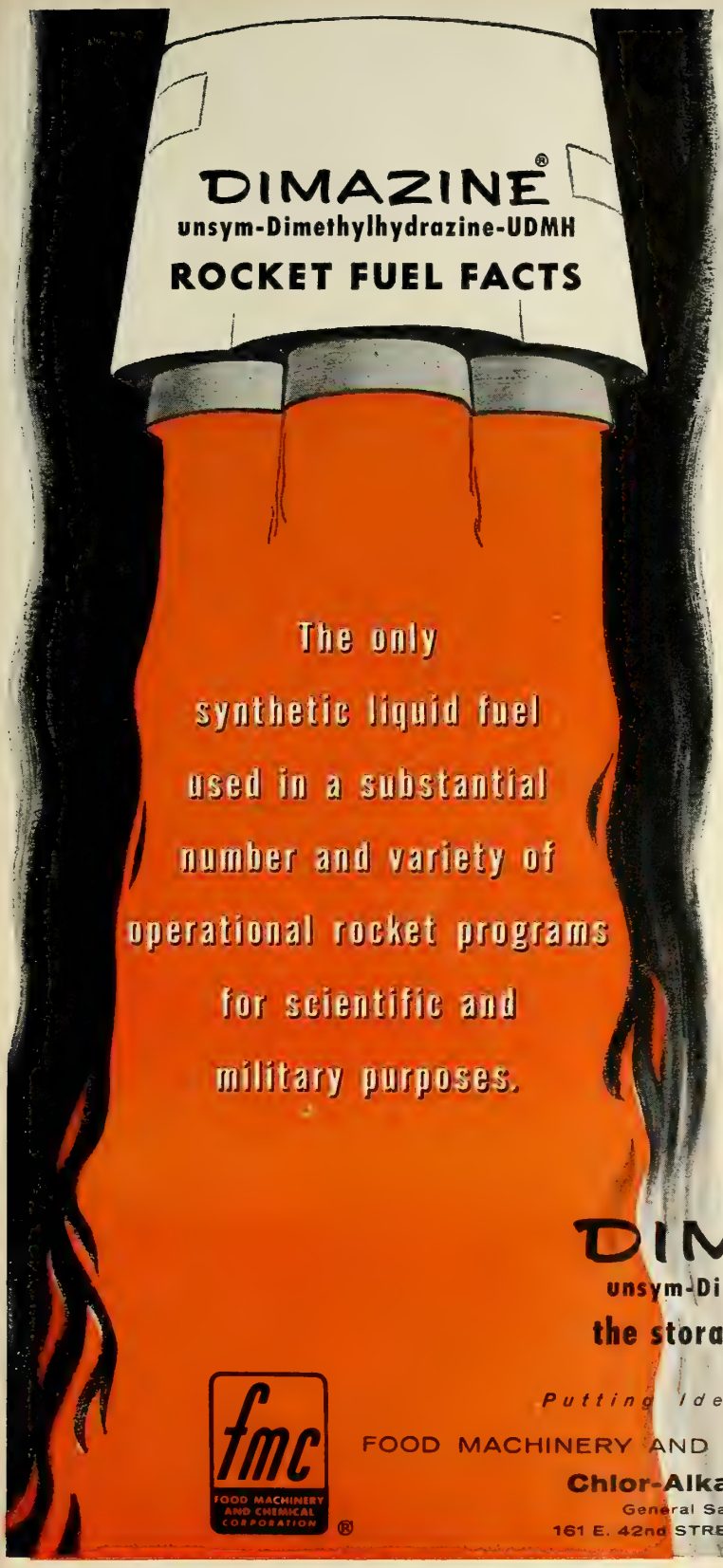
Echo's Varying 'Twinkles' Point to Irregularities

"Twinkling" of the *Echo* satellite varies so greatly that some observers feel that it must be due to irregularities in shape or variations in orbital path.

Engineers at Kollsman Instrument Corp.—using a Kollsman Astro-Tracker—have reported equivalent star magnitude changes ranging from +1.0 to −0.5 and altitude variations from 966 to 985 miles. They feel that changes of such magnitude cannot be attributed to high cloud coverage or atmospheric changes.

Observations were made during routine tests of a star tracker used in celestial navigation systems. The system automatically tracks stars to obtain precise data for navigation by aircraft, missiles, and submarines. Accuracy is reported to be within minutes of arc.

Calculations at the Smithsonian Astrophysical Observatory, Cambridge, Mass., also indicate orbital changes due to sunlight pressure. Computations show that the satellite's perigee is coming 1½ miles nearer the earth each 24 hours. This daily change is predicted to double soon, then slowly decrease and eventually change direction.



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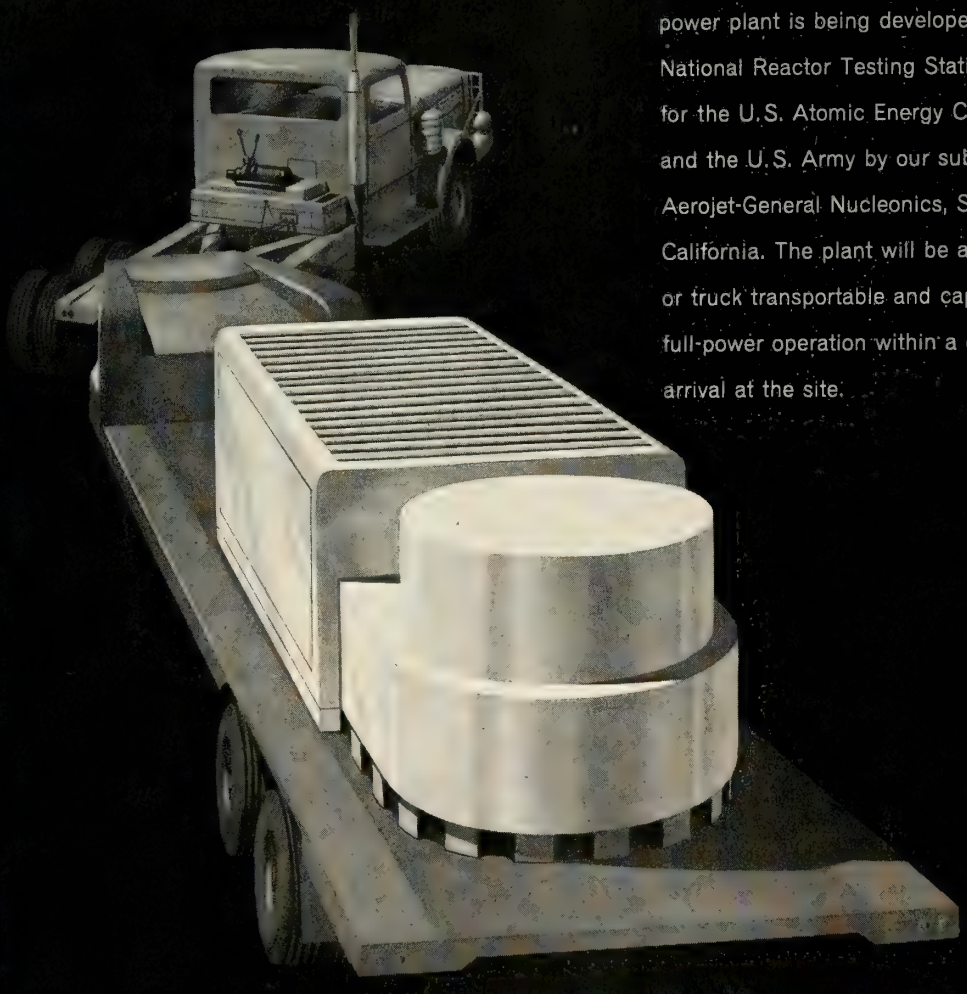
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The Countdown

ELECTRONICS

5-Ton Feed to Scan Big Dish

The 1000-ft. fixed reflector of the AF-ARPA radio telescope in Arecibo, P.R., will be scanned by a mobile line source feed rotating like a giant pendulum about its center. The unique feed—to be designed by TRG, Inc.—will weigh five tons, measure 101 ft. in length, and contain 768 radiating slots.

X-15 Guidance Works

Inertial guidance in the *X-15* rocket ship worked extremely well in the recent record-breaking 26-mile-high flight, according to reports. The Sperry system provides critical attitude, speed, altitude, and re-entry control data to the pilot and to airborne and ground-based recorders.

Hughes Transistors Yield 4 gc

Parametric mode transistors that operate at ultra-high and microwave frequencies have been developed by Hughes Aircraft. Demonstrated recently in a mixer-oscillator circuit invented at Lenkurt Electric, the Hughes transistor reportedly produced nearly 4 gc (kmc) at 10% efficiency.

Bendix Gets Advent Contract

A $2-million contract for Project *Advent* satellite communication equipment and associated ground terminal has been awarded by the Army to Bendix Systems Division. *Advent* includes several different advanced communication satellite systems.

Transistors Show Big Gain

Transistor sales for first six months of 1960 were up 67% over the same period last year. According to EIA, sales topped 60 million units; dollar volume was close to $153 million.

GROUND SUPPORT EQUIPMENT

Saturn Test Facility Begun

Construction has started on a dynamic test facility for *Saturn* at NASA's Marshall Space Flight Center. The installation will accommodate the complete three-stage space vehicle for structural, mechanical, and operational tests.

Dual Array Raises Resolution

The resolving power of radio telescopes may be increased by using two small antennas rather than one large one, according to two astronomers at England's Cavendish Laboratories. They recently reported a method of changing the position of two small antennas to cover successively the area of a large reflector. Information received is mathematically combined to produce one output.

PROPULSION

Ground-effect Problem Critical

Various configurations for flame deflectors at launch pads and silo bottoms still are being investigated. As booster thrust increases, ground-effect problems become more critical. Newest approach for high-thrust launches is a pad configuration resembling an anechoic chamber wall.

Arc Plasmajet Engine Contract Awarded

Plasmadyne Corp. has been selected by NASA to develop a one-kilowatt electric rocket for space-vehicle attitude control. Test objectives of the 12-month, $200,000 contract call for an engine with a minimum thrust level of 0.01 pound.

ASW ENGINEERING

ASROC Production Funded

Minneapolis-Honeywell has received an additional $2.9 million for production of *ASROC*. The new contract brings to $4.9 million total funds awarded to M-H for development of the antisubmarine rocket.

Porpoise Sonar Good to 5 Miles

Much-publicized porpoise studies are in earnest. The porpoise can emit "sonar" signals ranging from 450 cps to 190 kc, and possesses almost incredible ability to discriminate between objects. He can find schools of fish at ranges up to 8000 yards. ASW researchers would like to know how it's done. They are also interested in how the porpoise can adjust to extremely rapid pressure variations without ill effect.

Other Sea Inhabitants Drafted

The Navy is also studying salmon, seals, and whales, with research goals similar to those of the hydrodynamic studies of the porpoise. Marine biologists say the Russians have done much work in these areas; they complain that underfunded U.S. work is hampered by having only four oceanography vessels, against some 50 such Soviet ships.

MATERIALS

World's Strongest Wire?

Steel wire for plastic motor cases reaching tensile strengths of 575,000 psi has been developed by National Standard Co. The new wire is about twice as strong as ordinary carbon steel wire.

Refractory-Metal Ductility Improved

Electron-beam processing and critical composition control in tungsten and molybdenum has resulted in a substantial improvement in ductility. Stauffer-Temescal Co. found that in addition to easier working, the finished product shows increased shock resistance.

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ROCKET NOZZLE THROATS

Friction Research Grinds to Halt

Frictional behavior of metals in space environment is barely known; consistent theory of friction still undiscovered

by William Beller

WHEN TWO METALLIC surfaces rub across each other in a vacuum, surprising things begin to happen. Oddly enough, government research agencies are not bothering to find out what they are.

From early work, this much is known: the friction coefficient—the ratio of tangential force to perpendicular force—often rises precipitously. It can fall, too—in some instances becoming less than in air.

The two surfaces can conceivably become strongly welded together.

Many of the phenomena are not known. A consistent theory of friction, in air or vacuum, is still to be devised.

Aerospace applications of the friction of metals in a vacuum are countless. Wherever one surface moves across another, there is a problem. In particular, friction coefficients are needed for the design of any exposed bearing in a spacecraft. Such bearings could be on shafts that rotate antennas, that orient solar cells or mirrors, or that move control surfaces during the aerodynamic phases of flight.

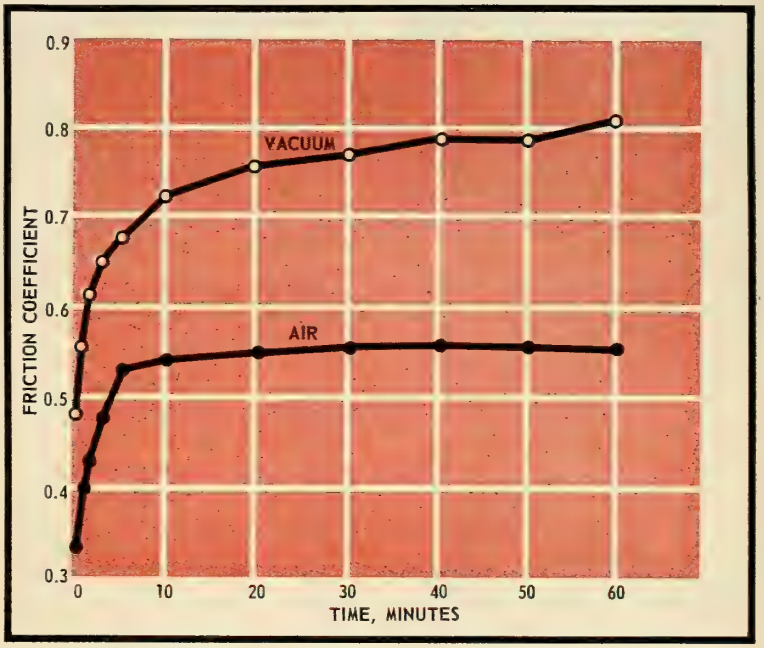
Basic research is needed to enable scientists to predict friction coefficients —with good fortune perhaps even to synthesize them.

Yet an M/R inquiry of federal agencies charged with supporting or engaging in such research disclosed that nothing is being done about the problem. The reasons given are lack of interest or lack of money—or both.

One government department-head scientist maintains that there is no point in studying high-vacuum friction, especially with space applications in mind, because any designer worthy of his name would be lubricating his surfaces. Rather, "the stress should be laid on research on films and such."

But another engineer countered forthrightly, "He's in the biplane era. The problem of sealing in the lubricants is as big as the one of friction." He added that "all the seals are able to do is delay the onset of exposure to ambient. Time will clean any surface and burst any seal."

One of the few reports that give engineering data on high-vacuum friction was written by Litton Industries' Space Research Laboratories. It was derived from work the company did under an expired Air Force Office of Scientific Research contract.



AVERAGE OF FRICTION data for 19 metal pairs. "Vacuum" data was taken as soon as pressure in the environmental chamber reached 3 x 10^{-6} mm Hg or less.

In this report, there is a listing of friction data for metal specimens exposed to a vacuum. The information was found experimentally and is shown in summary form in this article.

• **It's a poor theory**—In most problems concerning a friction force, the engineer has a fairly easy time of it. Both the load force and the resulting friction force are assumed to be uniformly distributed over the contact area.

Then, as Leonardo da Vinci pointed out in the 15th Century, "Friction produces double the amount of effort if the weight be doubled."

Although modern theory does explain some of the grosser effects of friction, it cannot do the most important job of such a scientific theory—provide a way to predict friction coefficients.

Along the same line, SRL's director of research, Siegfried Hansen, complains that we are not even able "to adjust parameters to achieve desired friction coefficients for specific engineering applications, except to the extent that tests for these specific conditions have been carried out and results tabulated."

One of the long-standing friction theories is Coulomb's. In it, prominence is given to the microscopic irregularities of presumably plane surfaces. Surface-to-surface contact of two blocks is assumed to take place at many points and with random angularity.

The friction force is taken to be that needed to cause one block to slide up the contact planes to a new interlocked or stable orientation of contact areas.

Although some authorities accept the general concept of this theory, many others reject it as being grossly inadequate.

Some recent investigators look upon

friction as a function of the forces between the molecules of two surfaces that are in range of each other's atomic fields. Again, authorities do not agree.

It is generally felt that, until the nature of molecular forces is much better known, attempts at understanding friction must be made at the microscopic rather than the molecular level.

• **Welding called friction clue**—A hypothesis that has intuitive as well as some experimental appeal, and is widely accepted at present, is the adhesion or welded-junction theory. It holds that the initial points of contact between two surfaces are extremely small and therefore loaded beyond their elastic limit. They yield, plastic flow takes place, and the contact areas increase in size and number until the load can be supported. Typically, the actual contacting area of the two surfaces may be only 0.1% of the surfaces' mating area.

Some advocates of the welded-junction theory believe that the localized temperatures at the load-bearing points of contact reach melting temperatures. Other experts say that the action is in the nature of a cold weld.

One of the most earnest workers in the field of welded-junction theory is Cambridge University's F. P. Bowden. He brings out the following points:

(1) The real area of contact A between two surfaces where the load is W is given by $A = W/p_m$, where p_m is the metal's yield pressure.

(2) Even when loads of only a few grams are applied to the surfaces, the local pressures between them may be great enough to cause metal flow. When large flat surfaces are used, it does not mean that the real pressure is much less, merely that the points of contact are more widely distributed.

(3) As a rough approximation to the friction force, we may write $F = As$, where s is the shear strength of the junctions. In addition to this factor, the surface irregularities of the harder metal may penetrate the surface of the softer one, thereby requiring work to plow tracks along one of the surfaces. If the metals are of similar hardness, there may also be some interlocking of the surface irregularities.

The adhesion theory lends understanding of the experimental fact that friction is largely independent of surface area.

The theory also provides for the fact that friction is dependent on load—since the real area of contact is dependent on load.

Further, the theory accounts for the fact that the friction coefficient of most metals is of similar value.

There are problems, though. Hansen proposes this teaser: In a plastic material such as copper, the yield stress in shear is about one-half the compressive yield stress. Weld theory indicates that the friction coefficient can never exceed 0.5. Yet experimental values of the coefficient for vacuum-cleaned surfaces rise as high as 6.

The discrepancy is clear: it is explained away by a vague statement that the area of contact must somehow increase when motion begins.

• **A surprising finding**—In their friction experiments, SRL made a unique discovery. Friction occurs in two modes.

In the first one, there is an extremely low friction coefficient. Here there is practically no wear or distortion of the metal surfaces.

On the other hand, the second mode characteristically has a very high friction coefficient and rapid destruction of the two surfaces moving with respect to one another. (In the SRL experiments, the friction model was a blunt point running over a block's surface.)

In the first or "sliding" mode, the friction coefficient is low, varying very little from 0.1. In the second, the coefficient is greater than unity.

By careful experimental work, it was possible to slide the point five to six inches in the nondestructive mode. Generally, though, the first mode held for only one or two inches and then deteriorated suddenly.

Summary of Friction Data for Metal Specimens

MATERIAL			FRICTION COEFFICIENT					
			IN AIR			IN VACUUM		
Upper Block	Lower Block	LOAD (lbs.)	Start	10 min	60 min	Start	10 min	60 min
Aluminum 99%	Aluminum 99%	7.0	0.50	0.78	0.78	1.10	1.57	1.57
Aluminum 2024T4	Aluminum 2024T4	7.0	0.52	0.54	0.57	0.50	0.50	0.35
		14.0	0.57	0.59	0.59	0.61	0.75	0.59
Beryllium Copper	Beryllium Copper	7.7	0.46	0.57	0.58	0.71	0.87	1.10
		14.7	0.44	0.89	0.70	..	.	..
Brass Com'l ½ Hd	Brass Com'l ½ Hd	7.7	0.31	0.32	..	0.43	0.50	0.71
		14.7	0.37	0.39	..	0.40	0.55	0.60
Copper 99+%	Copper 99+%	7.7	0.26	1.04	1.04	0.32	1.22	2.00
		14.7	0.40	1.14	1.15	..	.	..
Stainless Steel 304	Stainless Steel 304	14.7	0.29	0.47	0.51	0.32	0.62	0.93
Steel 52100	Steel 52100	14.7	0.13	0.66	0 70	0.25	0.41	0.45
Stainless Steel 304	Aluminum 2024T4	7.7	0.29	0.39	0.40	0.38	0.39	0.34
Aluminum 2024T4	Stainless Steel 304	7.0	0.30	0.40	0.37	0.49	0.50	0.50
Brass Com'l ½ Hd	Stainless Steel 304	7.7	0.36	0.35	0.39	.	..	..
Stainless Steel 304	Brass Com'l ½ Hd	7.7	0.21	0.32	0.39	0.32	0.67	0.84
Brass Com'l ½ Hd	Beryllium Copper	7.8	0.26	0.28	0.36	0.50	0.77	0.89
Beryllium Copper	Brass Com'l ½ Hd	7.7	0.28	0.34	0.38	0.49	0.62	0.90
Copper 99+%	Steel 52100	7.8	0.32	0.38	0.55	0.77	0.97	0.96
Steel 52100	Copper 99+%	7.8	..	..	..	0.58	0.79	0.85
Cadmium Plate	Cadmium Plate	7.7	0.26	0.44	0.39	0.43	0.43	0.31
Chrome Plate	Chrome Plate	14.7	0.33	0.59	0.85	0.11	1.30	1.30
Nickel Plate	Nickel Plate	7.7	0.33	0.33	0.30	..	..	..
		14.7	..	..	..	0.28	0.41	0.39
Silver Plate	Silver Plate	7.7	0.36	0.60	0.50	0.69	0.99	0.99

Analysis showed that the first mode exists when the surface film, whether a lubricant or an oxide, prevents the formation of adhesion bonds between the sliding point and the plane.

The second mode occurs whenever a point encounters an obstacle large enough to prevent free sliding, or possibly when the lubricant film breaks down locally and permits strong adhesion.

Thus the friction coefficient is made up of two parts: a constant sliding part equal to 0.1, plus a variable shearing part that is greater than unity.

Experimental values of 5 or 6 are explained by an increase in the area of shearing contact relative to the area of sliding contact. This increase results from the removal of surface film by chemical or physical cleaning, or by exposure to vacuum.

• **Metal behavior in a vacuum**—In SRL's vacuum work, all the specimen pairs were tested in air and in "immediate" vacuum. The term "immediate" is used to indicate that the specimens were not subjected to a long outgassing in vacuum. Rather, they were tested as soon as the vacuum reached the desired value, a period of about one hour. The test then continued for another hour, a time long enough to reach equilibrium.

The specimens were considered to

be representative of unlubricated metal parts prepared by standard machining operations in an ordinary atmospheric environment. The test procedure envisioned that these specimens would then become part of some system that is launched into space.

Behaviorial trends are brought out clearly in the curve constructed by averaging corresponding ordinates in all the individual data.

–The friction coefficient starts out at about 60% of its final value and then quickly increases as surface breakdown takes place.

–In air, a relatively stable final value is reached in about 10 minutes. In vacuum, the final value is reached more slowly, corresponding with the rate of flow of absorbed gas out of the blocks through the rubbing surfaces.

–The average coefficient values for vacuum tests are only about 50% higher than the averages for air. This is the result of the immediate vacuum technique and is not representative of thoroughly cleaned and outgassed blocks, which can give values far greater than unity.

The results reported here barely scratch the surface of the friction problem. An adequate theory of the phenomenon is needed, one that can both predict and build up friction coefficients. At the same time, data on the frictional behavior of materials in a vacuum are vital for design of long-lived satellites and space probes. What is most important is an awakened interest and sponsorship of basic research.

Norton Produces Advanced Silicon Carbide Refractory

The nozzles of fluorine-fueled rockets may contain a newly developed high-temperature refractory from Norton Co., Worcester, Mass.

The material may also be used in blast pads or test stands, where fluorine-containing exhausts usually raise merry hell.

The refractory, "Crystolon 63," represents a major advance in silicone carbide technology.

The silicon carbide refractory most often used in the United States is oxide-bonded. Its individual grains are held together by clay or glass. It presents problems in corrosion resistance and in structural applications. But it is cheap.

Present nitride-bonded silicon carbides are refractories with very desirable corrosion resistance and structural properties. But they are so expensive that they are termed "exotic" refractories, especially in massive installations.

The new carbide will do everything a nitride-bonded carbide can do, but at a price comparable to that of oxide-bonded carbides.

• **Impact on industry**—The biggest commercial application seems to be in the aluminum reduction cell. In the main, these cells have not changed substantially since about 60 years ago, when Charles M. Hall used one to extract aluminum from alumina.

Experimental use of Crystolon 63 indicates a possible 75% reduction in wall thickness and a substantial decrease in power requirements.

Other applications include melting and alloying of high-purity metals, transferring molten metals, and use as a structural ceramic for package boilers and incinerators. Company spokesmen expect nothing less than a full-production turn to this new development at Norton.

The actual effectiveness of silicon carbide refractories is determined by the bonding agent. The nitride bond is the hardest to attack. Samples of 63 have passed 28 days in an atmosphere of steam and air at 1100°C; showed no metal penetration after seven-day baths in molten aluminum, lead, zinc and cryolite; and exhibited a strength of 7000 psi at 1250°C.

Electronic applications are numerous. Norton labs are growing silicon carbide crystals with controlled impurities. Single-crystal rectifiers have been produced using this material; eventually, transistors may be developed. Use of the silicon carbide would extend the operating temperatures of such devices well above the melting point of germanium and silicon transistors.

Nitrate-bonded shapes are most likely to prove successful as microwave absorbers. Much activity in this field is aimed at absorbing or attenuating the power from a high-frequency transmitter—rather than have a signal on the air. In high-power applications, these attenuators reach red heat. Crystolon 63 is being evaluated in this area.

Hinges for Titan Silos



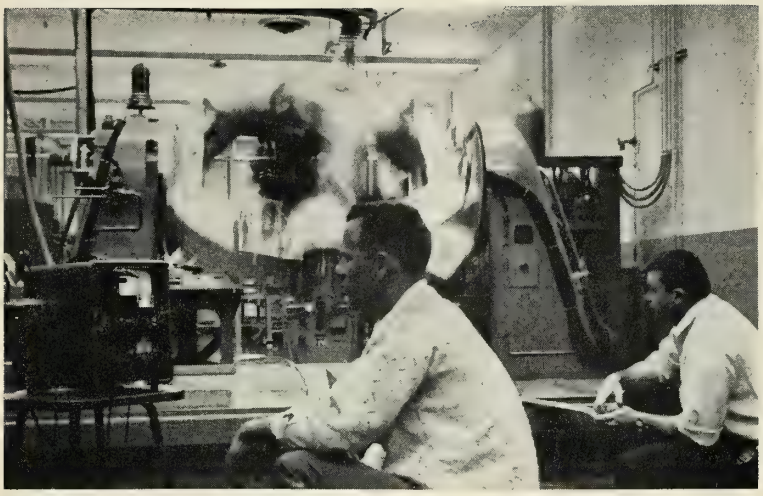
MAMMOTH 600-TON hinges will be used to open the doors of underground Titan launch silos. Nearly five feet high, this is one of a set flame-cut and machined by Lukens Steel Co. for American Machine & Foundry Co.

AF Funds 250,000 Gauss Magnet Laboratory at MIT

The Air Force will finance the building of the world's most powerful magnet at the Massachusetts Institute of Technology.

An array of generators will be able to produce a continuous magnetic field rate at 250,000 gauss (A gauss is the electromagnetic unit of magnetic induction—one maxwell per square centimeter). This rating is more than 500,000 times larger than the earth's magnetic field.

The $9.5-million contract awarded by the Air Research and Development Command is expected to considerably broaden the search for new knowledge in matter and energy.



MOTION OF THREE-AXIS flight simulator table is evident as gimbal rates are checked out by technicians at Lockheed's Missile and Space Division.

Flight Simulator Credited With Speeding Up Polaris

A three-axis flight simulator made a major contribution to the *Polaris* IRBM abbreviated time table, says Lockheed's Missile and Space Division.

It was used to checkout guidance and flight control systems of the Navy's most advanced missile at its Sunnyvale, Calif., plant. Company engineers feel the simulator also saved dollars by minimizing required test flights.

The simulator is used in conjunction with an analog computer especially designed for angular position and motion testing of the guidance package. The system employs direct hydraulic drive to obtain its tremendous power and wide range.

Basically, the flight simulator consists of a hydraulic supply, accumulator, console and flight table. It operates in a closed loop, using the analog computer and flight control system hardware.

• **3-axis simulation**—Simulation of position and angular motion is achieved by means of three independently controlled gimbals whose axes can be related to pitch, yaw, and roll motions.

Each gimbal uses a vane type hydraulic actuator controlled by a pressure feed-back hydraulic valve. The actuators are designed to provide fluid cushioning to prevent damage to the gimbal when rapidly operated over its complete excursion range. In addition, each gimbal has fixed rubber stop pads.

A removable fixture provides a bridge between the roll gimbal mounting tracks and the cart used to transport the guidance package.

There are servo amplifiers for each gimbal. Although the basic design of all three are the same, different plug-in compensation networks are used in each. The servo amplifier is dc drift stabilized. It converts the sum of the dc input signal and error signal from the feedback potentiometer into dc current which actuates the control spool on the gimbal servo valve.

There are two types of feedback information given to the servo amplifier. Position feedback is provided by a linear potentiometer with an accuracy of within 0.015% and a feedback sensitivity (200v across 350°) of 1.75°/v. The feedback potentiometer is on the actuator end and is the one nearest the gimbal. These potentiometers are always connected to the console plus or minus 100 vdc.

Acceleration feedback is provided by an accelerometer mounted on the gimbal. The signal is amplified by an ac amplifier and then fed to the servo amplifier. The accumulator smoothes out surges in the hydraulic line due to varying load and supplies reserve power for peak demand.

The analog computer is connected to all servo amplifier inputs by the control panel. A two-bay rack console houses all the electronics (except for the associated computer) for the system. The computer serves as the nerve center and control spot for the simulator and all information is fed into the computer. Results are recorded in the computer room.

High Accuracy Obtained By Atlas Gyro Check Stands

Rotational accuracies within ±2.5 seconds of arc are being achieved with the sidereal rate stands used to check *Atlas* ICBM gyros.

Such complex test devices have been employed by Arma Division of American Bosch-Arma Corp. to counteract the effect of the earth's rotation. This is the only effective means of providing a standard for checking performance of precision gyroscopes around which the Arma inertial guidance system is built.

The stands were developed and built by Vinco Corporation in Detroit, Michigan. Mounted equatorially, each inertial system is sidereally driven by the test table. Sanborn "150" oscillographic recording systems collect test results.

• **Two million-to-one gear ratio**—The gyroscope and tooling are mounted on a 24-inch diameter face plate, which is attached to the north end of the main or polar axis spindle. Embodied in the gear box is a differential drive to obtain an over-all gear reduction ratio of 2,154,101.8625:1.

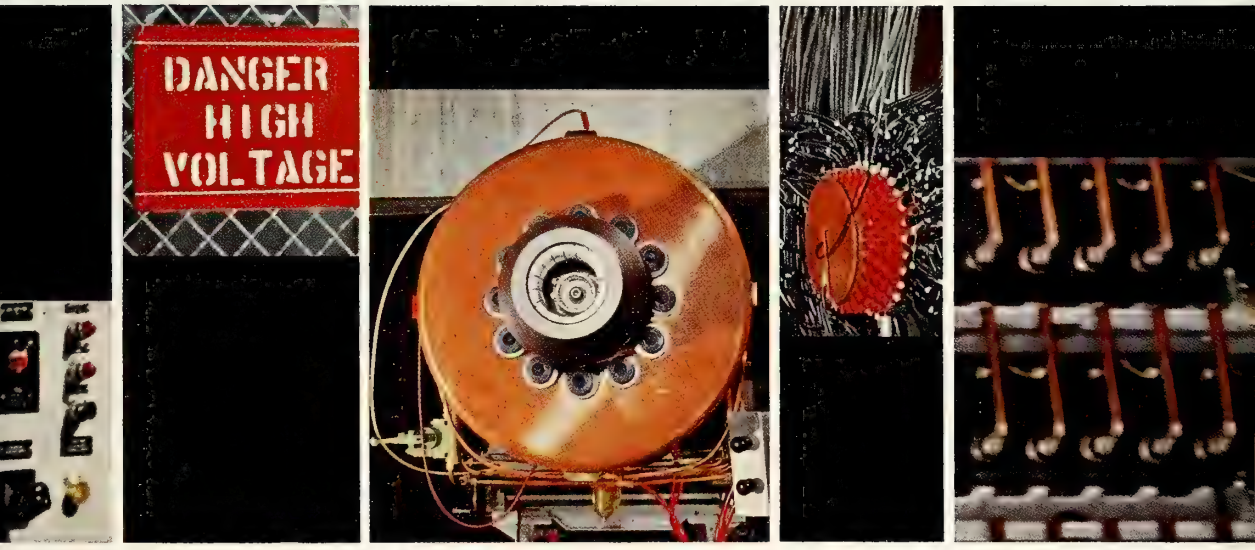
The last reduction in the gear train is a hardened and precisely ground gear (19.6875 in. pitch dia.) and worm set, having a zero backlash adjustment. Rotational accuracy between any two positions of the face plate is guaranteed to 5 sec. of arc. A series of multiple output speeds is provided by means of change gears.

Azimuth and elevation adjustments in the base of the stand provide for final alignment of the equipment after being placed in permanent position. A precision level provides for monitoring the alignment periodically after making final adjustments.

A 1500-rpm synchronous motor drives the main spindle through a change gear box and a final precision worm and gear reduction. The controlled frequency input (50 cycles, 115v) to the motor is derived from a 100-kc oscillator, frequency dividers and a power amplifier. A precision electronic counter continuously monitors the frequency.

The oscillator and dividers are designed to produce a stable output signal throughout a wide temperature range, according to Vinco.

HOTSHOT

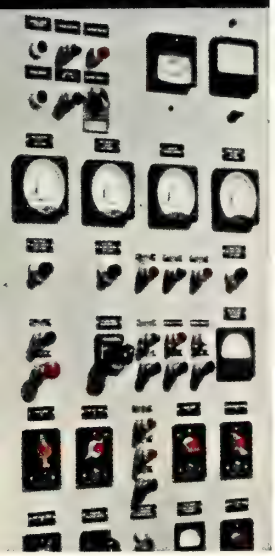


Westinghouse Capacitive Storage System for McDonnell's new Hotshot Wind Tunnel Delivers 7,000,000 Joules in 3 Milliseconds with a Peak Current of 4,000,000 Amperes

See following pages

1

The Trigger: Operator's control panel by Westinghouse activates tremendous flow of energy for new hypervelocity impulse wind tunnel.



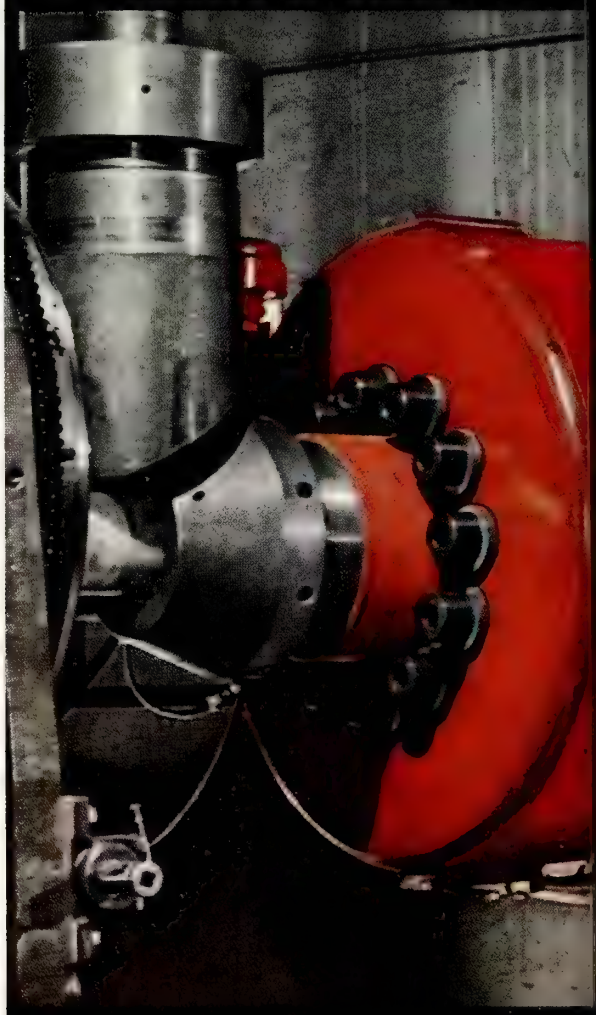
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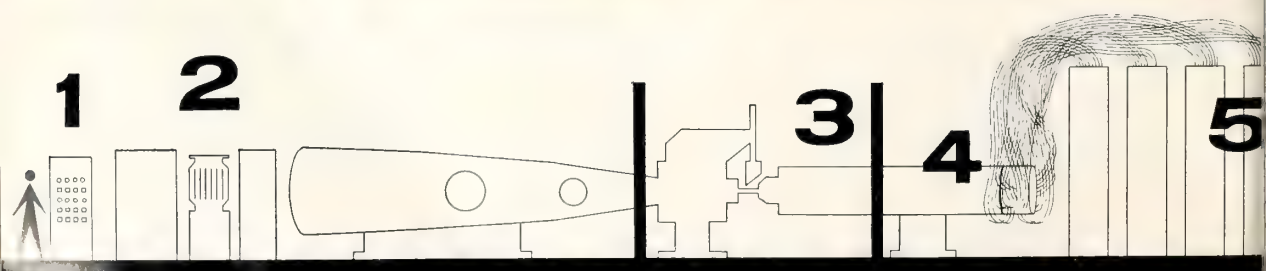
The Hot Stuff: High-Voltage equipment is tucked away in this enclosed area. Westinghouse transformer-rectifier—combined with a bi-stable amplifier regulator—charges capacitor bank to predetermined level.



3

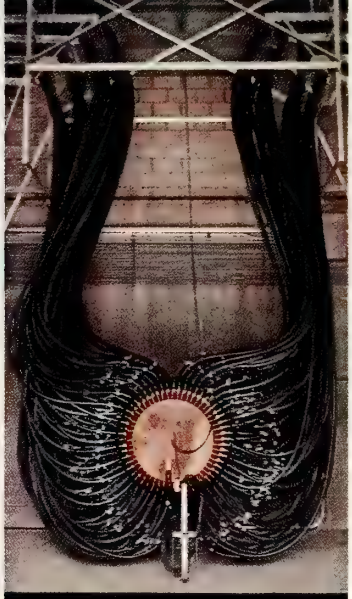
The Cannon: Uniquely designed coaxial conductor delivers arc energy to compressed air, raising pressures and temperatures several orders of magni-





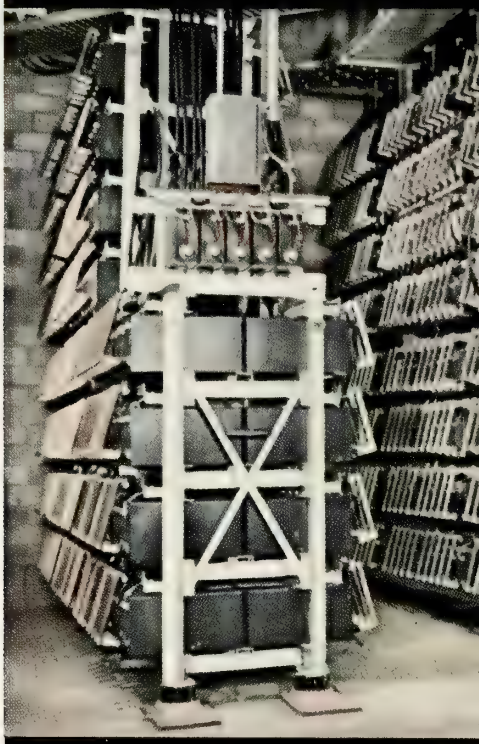
tude. Air explodes into the tunnel simulating hypersonic re-entry speeds of aircraft and missiles at altitudes above 100,000 feet.





The Supply Lines: 230 spaghetti-like cables converge in rear of cannon to deliver peak currents to 4,000,000 amps.

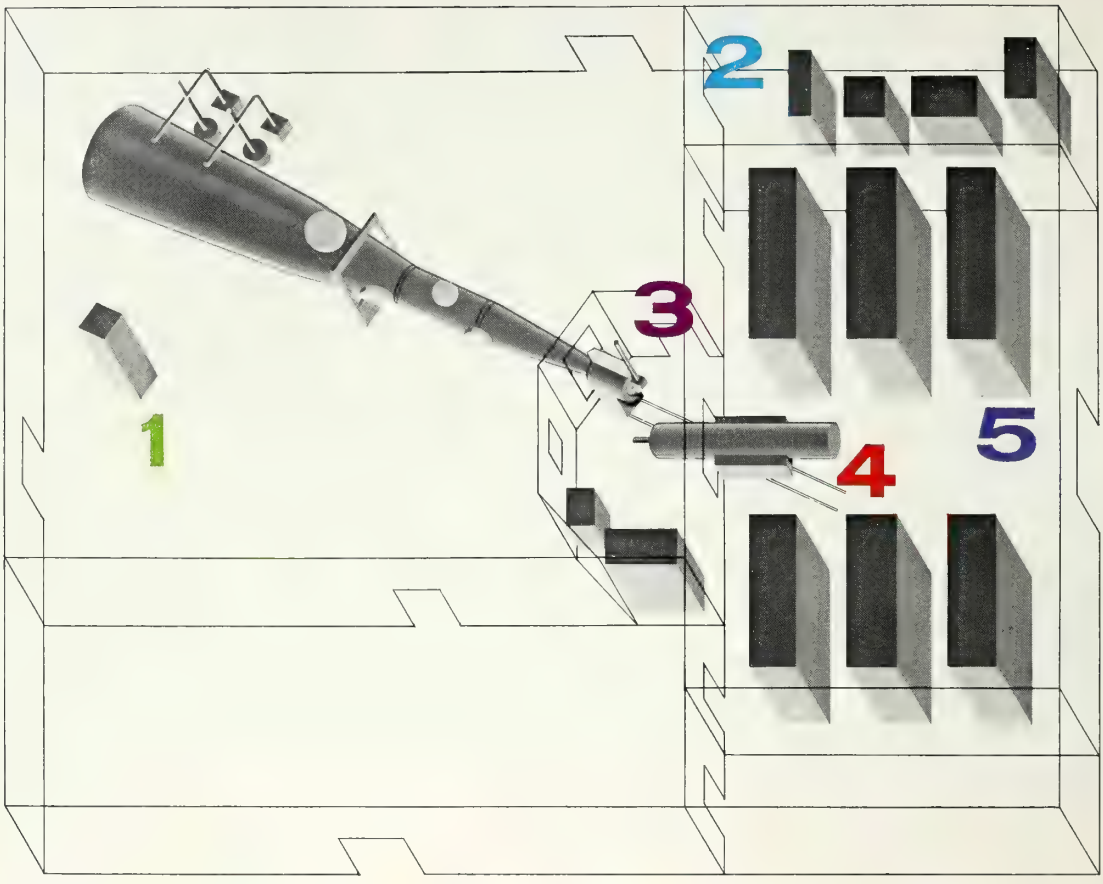
4



The Arsenal: Twenty-nine Westinghouse custom-built racks, each containing 80 fused capacitors, are bussed together in groups of ten, and connected by coaxial cables to the collector.

5

Within six months after receipt of contract Westinghouse delivered and installed this capacitive energy storage system for McDonnell Aircraft Corporation's new "Hotshot" wind tunnel at St. Louis. This facility is now providing vital data at a small fraction of the cost of actual flight testing. This same capability for quickly providing reliable equipment can help you solve your aerospace R & D problems. Contact your Westinghouse sales engineer. Or write: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. You can be sure . . . if it's Westinghouse.



1. Creating outer space environment on earth starts with this control station for McDonnell Aircraft Corporation's new hypervelocity impulse wind tunnel. Operator can automatically or manually control the entire facility from this Westinghouse cabinet.

2. High-voltage equipment charges the capacitors (Figure 5) to a predetermined level up to 12 kv, with ±1% accuracy in 30 seconds. At 12,000 volts, seven megajoules of energy stored in this bank is delivered to the arc chamber in just 3 milliseconds.

3. In actual test, arc chamber is filled with compressed air and the tunnel is evacuated. Then, electric energy surges into the heavy walled arc chamber. Pressure increases to 100,000 psi. Temperature to 14,000°F. Heat vaporizes diaphragm separating arc chamber from the tunnel. High pressure air races through a converging-diverging tungsten throat to produce hypersonic velocities in test section.

4. The collector-cannon — main artery of the energy storage system — is composed of coaxially oriented conductors connected to the arc chamber. Carriage mounting permits axial motion of the conductors and simple connectors allow disconnection from the arc chamber. A lateral 45° swing allows connection to a second tunnel. Such flexibility permits operation of either tunnel with only one power pack, one capacitor bank, and one collector.

5. Twenty-nine racks of capacitors, sprouting 230 coaxial cables, enable this system to discharge electrical energy at an average of 2⅓ million kilowatts. That's more than the combined impulse power of Grand Coulee and Hoover Dams. Built-in expandability allows for a growth capability to 10,000,000 joules.

Westinghouse

JI-92506

Subcontractors to Westinghouse:
The Calvert Company, Rocky River, Ohio for the cannon
The Phelps Dodge Copper Products Corporation, New York for the coaxial cables.

Explosion Forms Saturn Manifolds

Unique method developed at NASA's Marshall Center uses explosive charges in plastic bags filled with water

HUNTSVILLE, ALA. — An unusual method of explosive forming is used in the manufacture of LOX manifolds for the big *Saturn* booster.

Usually, explosive forming takes place with both the explosive charge and the object to be formed under water. *Saturn* manifolds, however, are formed by an explosion in a water-filled plastic bag.

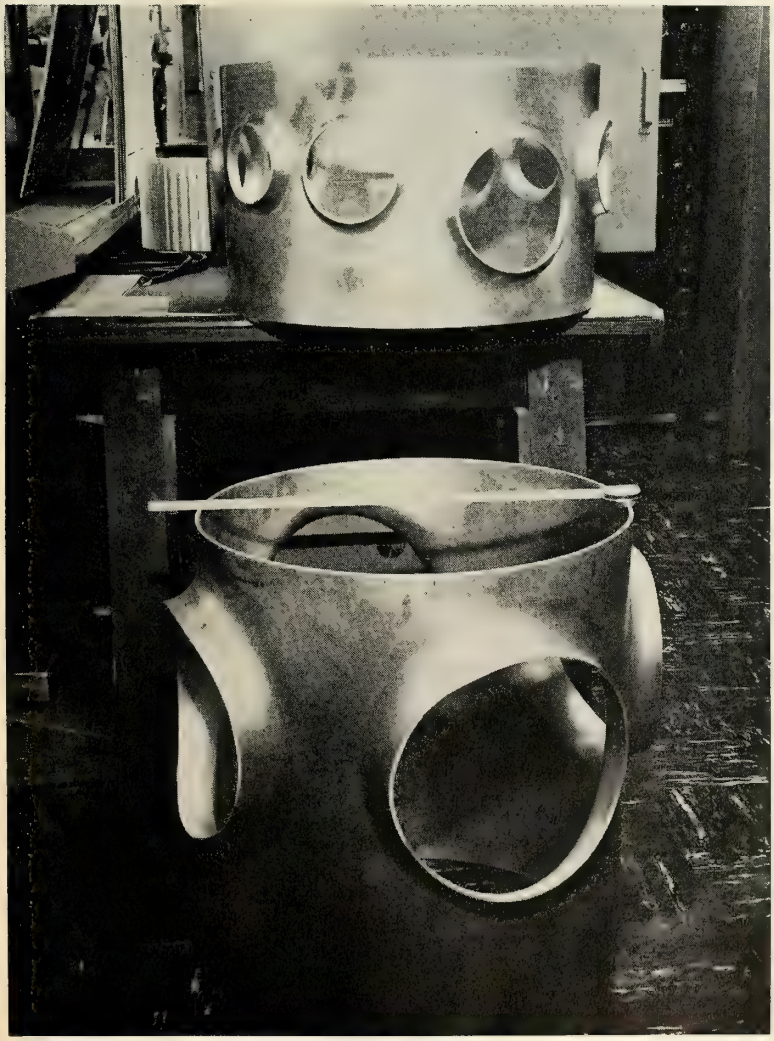
The manifolds, like all parts of the *Saturn* booster, are manufactured by the Marshall Space Flight Center, transferred last month from the Army to the National Aeronautics and Space Administration.

The cylindrical manifold blanks are put together from four drop-forged pieces of 5052H32 aluminum alloy. The pieces are welded together at Redstone Arsenal. Then the cylinder is sent to Olin Mathieson at East Alton, Ill., for explosive flaring of the outlet holes.

Olin Mathieson cuts the holes—for instance, four 12-in. holes in the 22-in.-diameter rear manifold. Then a big plastic bag of water, containing the explosive charge at the center, is put inside and set off. This first explosion improves the circular shape.

Next, smaller bags, with smaller charges, are set off in each of the four holes. Two charges are exploded in each hole.

The process was developed by Earl A. Hasemeyer, aeronautical structural material research engineer in the Fabrication Laboratory of the Marshall Center.



SATURN LOX manifolds shown after explosive flaring of outlet holes by Olin Mathieson in a process invented by research engineer Earl A. Hasemeyer.

Titan II Fuel

Olin Mathieson Wins Contract for Hydrazine

Olin Mathieson Chemical Corp. has won a $25-million Air Force contract to deliver hydrazine for the *Titan II* program. The contract calls for deliveries to begin in 1961 and continue for three years.

Stanley de J. Osborne, president, said a major part of the supply will be produced at a new plant in Saltville, Va., which Olin Mathieson is building for the Air Force at a cost of $14 million.

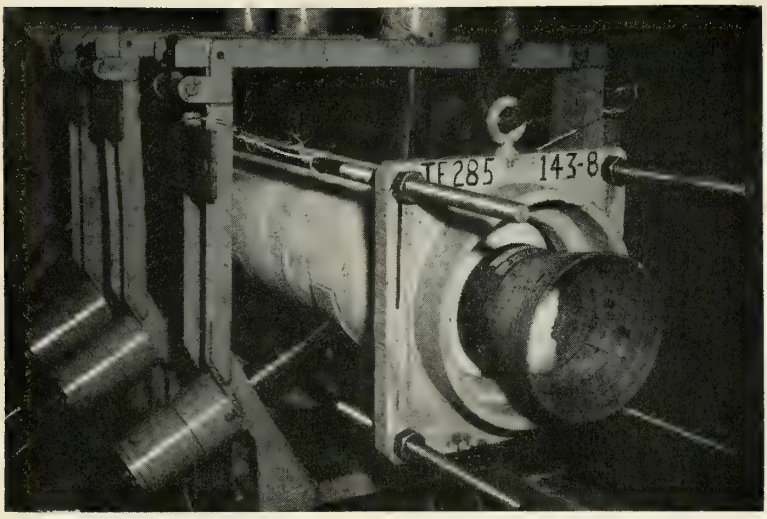
Titan II fuel will be a 50-50 mixture of anhydrous hydrazine and unsymmetrical dimethyl hydrazine (UDMH). Olin Mathieson, which says it is the nation's only manufacturer of anhydrous hydrazine, will supply all of that type. Nitrogen tetroxide is the oxidizer for the storable *Titan II* propellant combination.

Anhydrous hydrazine is made from ammonia, caustic soda and chlorine, all of which are manufactured by Olin Mathieson. Olin Mathieson began research on hydrazine in 1946 and started commercial production at Lake Charles, La., in 1953. The company now produces about 4,000,000 lbs. a year, partly for such uses as regulating plant growth, inhibiting rust and combatting poultry disease.

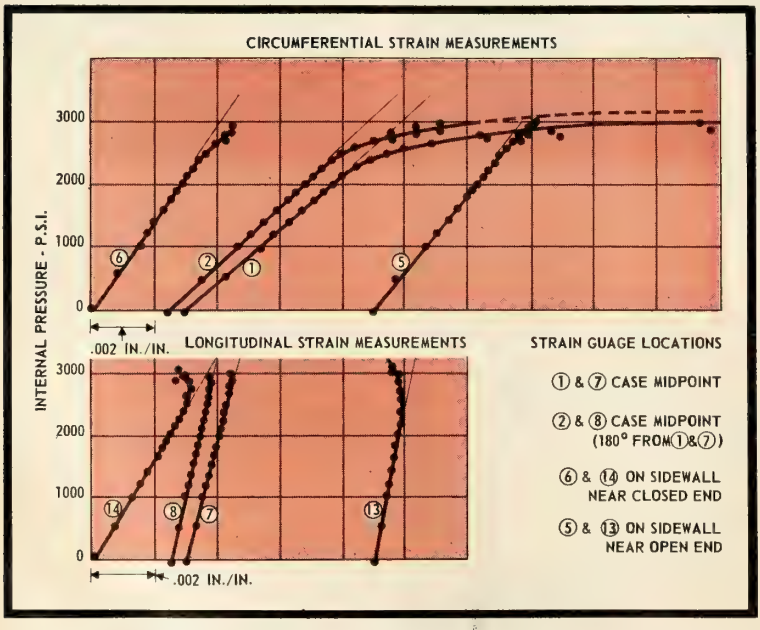
Construction has already begun on the Saltville plant, announced in April. Operations are to start March 1, 1961.

Aluminum Gains as Motor Case Material

Test firings show high performance and promise of big savings; Alcoa researches to raise size limits set by welding



ALUMINUM ROCKET engine chilled to –65°F prior to firing. The one-piece 7178-T6 alloy cases were successfully tested at ambient and elevated temperatures.



STRAIN MEASUREMENTS on case tested to burst occurring in hoop tension through sidewall. Note reversal in longitudinal strain near failure. This is believed to be caused by a decrease in length as the hoop stress increased the diameter.

by John F. Judge

COMMERCIAL high-strength aluminum proved itself a serious contender in the solid-motor case field in a series of recent test firings.

The cases were fabricated from high-strength 7178-T6 aluminum alloy by the Aluminum Company of America through a combination of forging, extruding, sizing, and machining operations.

The first set of firings involved monolithic aluminum cases. The second set utilized one-piece aluminum liners wrapped with cold-drawn steel wire, a development of Precision Structures, Inc., of Berwyn, Pa.

One of the wire-wrapped cases performed successfully even though all of the conditions were exceeded because of a misfire. As a direct result, serious damage to the test stand was avoided.

• **Welding problems**—Aluminum's strength-to-weight characteristics make it an ideal material for motor case construction. The main limitation is in the metal's welding properties—the high-strength alloys are extremely difficult to weld and even when this is accomplished, the weld does not develop a high percentage of the parent metal strength.

Thus there is a size limitation; one-piece construction is required to attain maximum efficiency.

An intensive program at Alcoa directed at larger monolithic cases produced the chambers fired in the first set of tests. These chambers do not represent the absolute ultimate size in monolithic construction, but the large ICBM-type motors are still out of reach without some sort of joining procedure.

The monolithic chambers are 12 in. in diameter and 45 in. long, with wall thicknesses of 0.210 in. The design yield internal pressure of 2575 psi was successfully met. Burst tests, with failure in hoop tension through the sidewall, reached 3160 psi. This is a steel equivalent stress of 246,000 psi.

Based on a minimum wall thickness of 0.196 in., one case developed a bursting stress of 94,000 psi and exhibited a strength-to-weight ratio of 935,000 in. In steel equivalents, using



HITCOMB...WOVEN-NODE HONEYCOMB CORE

Woven Node
Bonded Node

a new high in high temperature structural core material

HITCOMB is a new concept in core for high-temperature sandwich panel applications. HITCOMB, made by a unique three-dimensional weaving process, demonstrates isotropic physical properties at elevated temperatures, since it has square cells and does not depend on an adhesive bonded node line.

This material is already showing superiority through structural applications in space craft capsules, as well as in structural heat shields. HITCOMB fiber glass core exceeds all physical property requirements of specification MIL-C-8073A. It is available in fiber glass and REFRASIL® for use where ultra-high temperatures may be encountered. Both REFRASIL and fiber glass forms are currently available with many of the popular resin systems such as phenolics, phenyl-silane, silicones, polyesters and epoxies.

Write for Technical Products Bulletin PB6-2

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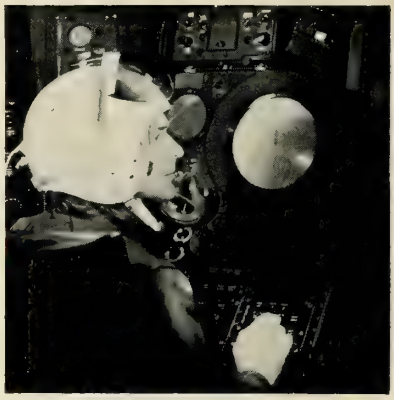
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The elements of guidance and control:







Data Acquisition and Application Subsystems—IBM has proven capabilities to provide real-time man-to-machine and machine-to-machine elements of weapon guidance systems. In addition to the Bombing-Navigation system with its visual displays in the B-52, IBM also provides interface devices to apply this system to air-launched missile guidance. Federal Systems Division experience in air-based and ground-based guidance systems is proven in operation.

Data Communications Subsystems—The SAGE data processing system, heart of America's air defense network, embodies advanced communications devices and techniques required to filter and direct an enormous flow of data. Designed and built by the Federal Systems Division, the AN/FSQ-7, an advanced system in operation, embodies processing and communications power to direct defense operations as well as to guide missiles from remote sites.

Data Processing and Control Subsystems—Now in development, the Advanced Bombing-Navigation and Missile Guidance system is another example of IBM's "closed-loop" system capability. This system satisfies the operating requirements of high-speed, long-range weapon systems. Compact, reliable equipment such as this and Federal Systems Division's computer for the Titan missile guidance system are the result of IBM's vast background in data processing and control.

all systems capabilities of IBM

IBM's experience in data processing and data communications, supplemented by an extensive background in data acquisition, adds up to a three-way capability for developing, producing and integrating total automated systems. This capability is being advanced through continuing research in miniature high-speed devices for high-reliability guidance systems of the future.

Federal Systems Division, 326 East Montgomery Avenue, Rockville, Maryland IBM

a density of 0.283 for the ferrous metal, this burst pressure is 264,000 psi.

According to Alcoa, one of the most significant aspects of the development program is that no failures under biaxial loading in pressure vessels have occurred at stresses below the guaranteed minimum mechanical property level for 7178-T6—the highest strength commercially available aluminum alloy.

• **Wire wound**—Precision Structures was responsible for the structural design of the wire-wrapped cases. A set of aluminum liners with all thicknesses cut to less than 0.095 in. was delivered by Alcoa; Precision enveloped them in cold-drawn steel wire.

The wire-wrapped Alcoa cases attained a strength-to-weight ratio in excess of 1,000,000 in. at burst. The cases have been proof-tested to a steel equivalent of 248,000 psi without distortion or permanent set.

L. C. Becher of Precision says the wire wrapping technique can attain a weight reduction of approximately 25% over plain aluminum or steel. In strength-to-weight ratio comparisons, wire wrapping will surpass monolithic steel cases at half the cost—and almost meet beta titanium at 1/15 the cost.

To overcome aluminum's size limitations, Alcoa is developing methods and design approaches in high-strength aluminum welds.

Alcoa is also hard at work in experimental high-strength aluminum alloys which may show efficiency increases as high as 15% over the current 7178-T6 member of the Al-Zn-Cu-Mg family.

Space Cabin Atmosphere Generated Through Algae

A duplication of the natural life process may provide oxygen for manned space stations.

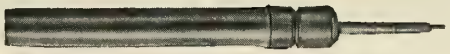
Scientists at Tapco Group, Thompson Ramo Wooldridge Inc., have succeeded in producing oxygen from carbon dioxide.

In the TRW gas exchange system, algae in aqueous media is pumped from a central reservoir through an irradiating light system. After irradiation, the algae is cooled to remove the excess heat produced in the light system.

The algae is mixed with filtered CO_2 enriched air from the cabin through an air injector. The gas-algae mixture is admitted to a gas-liquid separator where oxygen enriched gas is separated from the culture. The culture moves back to the central reservoir and the oxygen-enriched gas is circulated to the cabin. This is breathed by the crew who, in turn, exhale carbon dioxide; the cycle starts again.

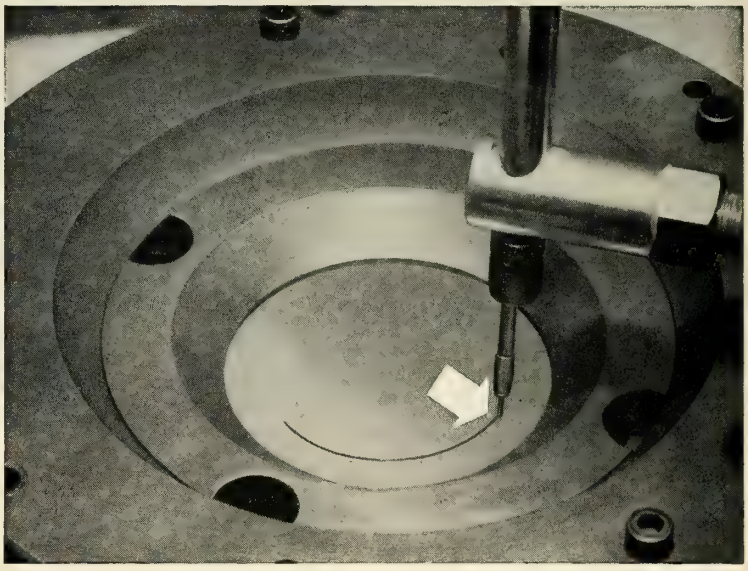
The culture produces oxygen through photosynthesis.

Another "impossible" job done by the Airbrasive...



...cutting tungsten

abrading • cutting • deburring • stripping • drilling • cleaning • scribing



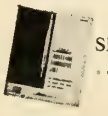
Comstock & Wescott found: "The most practical way to cut tungsten sheet without cracking!"

Here was a tricky job for the Airbrasive. Comstock & Wescott, Inc., Development and Research Engineers, Cambridge, Massachusetts, had to cut 0.005" thick tungsten sheet into circular components for missile systems. Mechanical cutting methods caused the brittle tungsten parts to crack. *The Airbrasive did it successfully!*

How does the Airbrasive work? It obtains its precise cutting action from a high-speed jet of dry gas and abrasive particles that quickly cuts, slices or abrades, as needed, almost any hard brittle material... germanium, silicon, glass, alloy steels, ferrites, mica, ceramics and others.

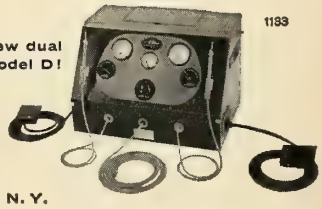
Important too... the cost is low. For under $1000.00 you can set up your own Airbrasive cutting unit!

Send us samples of your "impossible" jobs and we will test them for you at no cost.



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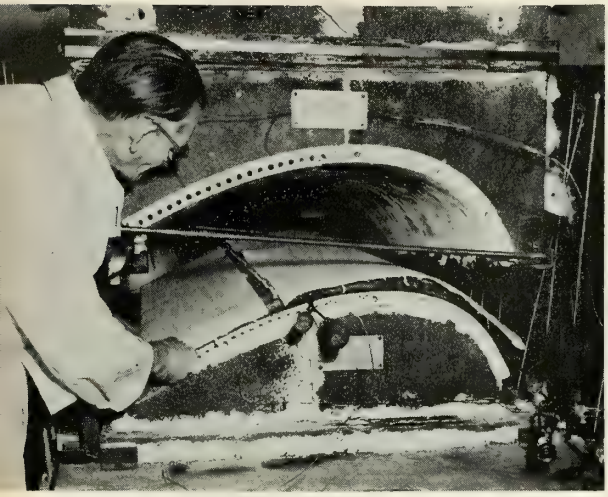
New dual Model D!



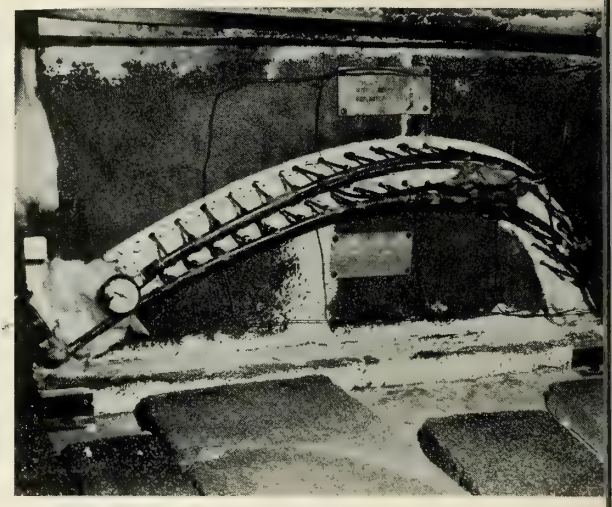
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Avco Process Cuts Cost of Brazing



HONEYCOMB CORE sandwich arrangement is placed between the ceramic platens. Holes in the platen are for heating and cooling purposes.



AVCORAMIC BRAZING PROCESS in operation. Nichrome calrod heating units bring the system up to temperature. Thermocouple controls are used in maintaining the correct heat period for the B-70 structural section.

ALMOST ANY SHAPE and size of stainless steel honeycomb can be brazed with a significant reduction in cost from present techniques through a new process developed by the Nashville Division of Avco Corp.

The method is currently being used to manufacture sections of the aft fuselage and some of the bulkheads for the B-70 bomber. The six-figure contract with North American Aviation extends over the next several months.

• **Avcoramic brazing**—The essence of the new process is a ceramic material with excellent thermal shock properties. The ceramic can be cast with tolerances of 0.003 in. yet it is easily worked into any required shape.

The ceramic is used to make brazing platens. Holes are put through the material for heating and cooling purposes. The surface of the platen acts as a contour form for brazing the stainless honeycomb.

The steel sandwich material is enclosed in a steel envelope which is then placed between matched ceramic platens.

The ceramic is heated electrically to the proper brazing temperature and held for a short, controlled time period. Cooling is rapid since the medium can be forced through the same holes which contain the heating elements. It is possible to reach sub-zero temperatures if necessary.

To assure close contact of the parts to be brazed, a vacuum is maintained in the envelope and pressure is applied to the ceramic platens.

Maximum strength is achieved through ageing at elevated temperatures.

A representative configuration using precipitation hardened steel requires about 14 hours from start to finished heat treated product.

Avco is currently studying other applications for the Avcoramic process. The method is suitable for other structural metals including titanium.

Investigations into the problems of re-entry led to the development of a number of ceramic finishes and compounds at Avco's Research and Advanced Development Division. The brazing process at Nashville is one unrelated area in which this research paid off.

Re-entry Brake Materials Studied

The Air Force is sponsoring $250,000 worth of research aimed at developing a flexible, high-temperature material for use in advanced space vehicle re-entry deceleration devices.

Two Massachusetts firms—Arthur D. Little, Inc., Cambridge, and Fabric Research Laboratories Inc., Dedham—are handling the project which calls for the development and evaluation of sample cloths.

Possible candidates are those materials which can stand the extreme environments and yet be made in fiber form so as to be applicable to expanded brakes. These substances do not possess many of the desirable properties of the textiles usually used in parachutes.

Completed studies at ADL investigated the external conditions which might be encountered during re-entry and the fibrous materials which might be applicable.

FRL evaluated the re-entry environment in terms specific to a novel chemical reaction process in a similar study. Details of this process were not disclosed. Both firms will use these studies as background for the current contract.

A further complication is a re-

quirement for air permeability much lower than that of conventional parachutes—eliminating one contender, conventional wire cloths.

Another current obstacle in "exotic" fibers is their cost—over $2000 per pound.

About two thirds of the current program is being done at FRL. Another phase at FRL has to do with the development and evaluation of 2000°F resistant drag chute materials made of quartz fibers and high temperature finishes.

The practicality of a quartz fiber chute is not certain but some evidence exists in its favor. According to FRL, successful completion of the quartz program may cut a year or more from the lead time of an operational reentry drag device.

Both firms will work closely together in considering the most promising materials—high temperature alloys, refractory metals, ceramics, graphite, and organic fibers—in addition to the chemical reaction approach.

New Sealing Method Adds To IR Receiving Range

A new technique for sealing germanium windows to infrared detectors will result in extending the receiving range beyond 25 microns, says Philco Corp.

Developed by its Lansdale, Pa., division, the method is based on painting a glass frit/amyl acetate mixture on the surface of a germanium disc and then fusing it to glass having a comparable thermal coefficient of expansion.

This results in a vacuum-tight seal that is mechanically and thermally stable, according to division special products manager Dr. C. H. Sutcliffe.

Detectors using the more conventional silicon or sapphire windows limit IR radiation reception to 9 or 6 microns, respectively. In using the new method to extend ranges to the longer wavelengths, the germanium window can be coated to peak in this range, he said.

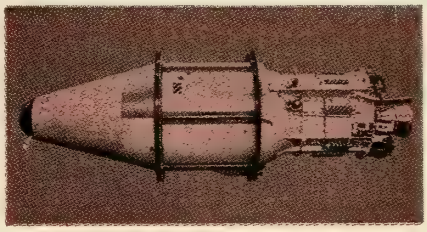
G.E. Group to Study Army Missile Vulnerability

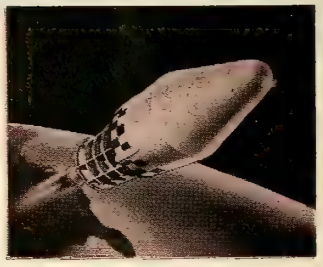
A mathematical model will be developed by the Special Programs Section of General Electric's Defense Systems Department in a study of the vulnerability of various Army missile systems.

Missile systems will be examined under peacetime, limited and general warfare conditions. The environmental and operational hazards in each phase will be in the form of equations derived from basic data.



FOR THE VITAL DISCOVERER PROGRAM





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DORSETT

telemetry components

Telemetry components designed and precision built by Dorsett Electronics will be aboard specially instrumented Lockheed Agena Space Vehicles to be flown in the Discoverer Satellite Program.

Lockheed Missile and Space Division is the latest in a long list of missile and satellite prime contractors to buy Dorsett telemetering components for advanced aerospace research programs.

Typical of the telemetering equipment originating at Dorsett Electronics is the Model 0-8 subcarrier oscillator. Requiring only 6 volts at .7 (nominal) milliamperes primary power, this all-silicon transistor unit provides excellent temperature stability for drift-free data. With its compact packaging, the Model 0-8 is ideal when electrical power is limited, space and weight are critical, and environmental extremes are to be encountered.

For more information on the products and capabilities of this fast growing team of telemetering specialists or on technical career opportunities, write today!

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Located in Sunnyvale and Palo Alto on the San Francisco Peninsula,
Lockheed is the systems manager for such satellite programs as:

DISCOVERER, MIDAS AND SAMOS

The following outstanding career opportunities are available in:

SYSTEMS INTEGRATION

Requires advanced degrees or extensive and varied experience in aircraft, missile or space system technology in any of the following areas:

SYSTEM CONFIGURATIONS: Including proposals, preliminary design and system equipment synthesis and optimization.

DESIGN INTEGRATION: Including dynamic design review and integration, and compatibility surveillance of all space vehicle subsystems, ground support and booster interfaces.

TEST ENGINEERING: Including component, subsystem, and vehicle test engineering.

PERFORMANCE ANALYSIS: Including pre- and post-flight satellite and interplanetary trajectories, propulsion, power supply, instrumentation, guidance and attitude stabilization control, tracking, communications, and command electronics.

TECHNICAL WRITING – SENIOR: Senior technical writers with experience in preparation of system and subsystem engineering analysis reports or closely related documentation. Related technical degree or equivalent required.

VEHICLE DEVELOPMENT

AIRCRAFT STRUCTURES AND EQUIPMENT INSTALLATION DEVELOPMENT: Requires BS degree or equivalent with minimum of 5 years' experience. For work on design of airborne instrumentation installation and design of pneumatic, hydraulic, and fuel handling system installations.

PROPULSION DEVELOPMENT: Requires rocket propulsion experience in the following areas: liquid rocket engine development, pneumatic pressurization component development, hot gas generator development, and liquid rocket propulsion system analysis.

DESIGN ENGINEERS: With a minimum of 5 years' experience in the design and layout of aircraft or missile systems wiring.

INTERNAL ELECTRICAL POWER SYSTEMS DEVELOPMENT RESEARCH ENGINEERS: For work in research and development of power systems consisting of batteries, inverters, and solar auxiliary power supplies.

PYROTECHNICS AND ORDNANCE DESIGN: Requires complete knowledge of pyrotechnics that may be applied to development of pyrotechnic/mechanical devices.

GUIDANCE AND CONTROL DEVELOPMENT: Requires outstanding educational background in EE or Physics and experience in servo theory and dynamics, for mathematical analysis and synthesis of orbital guidance and control systems. Requirements also exist in the development and test of guidance and control components.

Engineers and Scientists: If you are experienced in work related to any of the above areas, you are invited to write: Research and Development Staff, Dept. H-29C, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA, • CAPE CANAVERAL, FLORIDA • HAWAII

Exhibits Overflow at WESCON Show

LOS ANGELES—Some $12-million worth of advanced Space Age electronics gear was on display here last week for 35,000 engineers and technicians gathered for the annual Western Electronics Show and Convention (WESCON).

The four-day meeting, combined with technical sessions and marketing discussions, was the Largest yet held. An all-time record of 987 exhibits overflowed the Los Angeles Sports Arena and officials said another 300 qualified exhibitors had to be refused due to lack of space.

The theme of the show, appropriately enough, was "Rush Hour in Space."

One of the largest missile and space exhibits was that of Texas Instruments, Inc. TI displayed a nose cone programer for *Minuteman* designed to insure safe ejection of the test data capsule before impact, as well as the digital flight programer which sequences launch and flight functions in the *Titan* ICBM. This was a transistorized 6.4-lb. package. Also shown by TI was an FM/FM telemetry system for Moon and planet probes. Another exhibit was a TI airborne PCM telemetry package which packed 64 analog channels, plus a serial digital data channel and five 8-bit parallel digital data channels, into a 25-lb. ½-cu. ft. unit.

Lockheed Missiles and Space Division put its emphasis on the *Agena-B* and Hughes Aircraft displayed five new welders for the electronics industry.

• **Instant algebra**—Autonetics Div. of North American Aviation, Inc., set up a Recomp computer at the show to solve time-consuming algebraic equations on the spot. This was a demonstration of Autonetics' new RAFT (Recomp Algebraic Formula Translator) programing technique. The object was to show that advanced computer or programing backgrounds are not necessary when RAFT is used with Recomp, an Autonetics product. Key Recomp features include a compact magnetic memory disk with a 4096-word, 8000-instruction capacity, built-in floating point arithmetic and simplified programing.

DoAll Co., Des Plaines, Ill., showed for the first time a machine that slices ingots of rare metal such as germanium into wafers one-hundredth of an inch thick in production of transistors and other electronic components. According to the company, the tool will increase productivity up to 50% in cutting rare and expensive metals.

• **Cost - cutting semiconductor**—Transistron Electronic Corp., Wakefield, Mass., displayed a major new semiconductor device which it termed a fundamental contribution to the industry. Called a Binistor, it permits a significant reduction of peripheral components in switching circuitry. Transistron expects the device to form the heart of many digital systems. It says the Benistor is compatible with present circuitry and does not require major systems design changes. It is said to achieve significant savings in cost, space, weight and solder connections.

Hoffman Electronics introduced for the first time a new family of rugged, high-conductance silicon diodes developed by its Semiconductor Div. These are designed for applications requiring an extremely small, lightweight rectifying device capable of withstanding severe environmental conditions. A feature of the new diodes is their encasement in a 400-milliwatt package.

• **Many new lines**—Synthane Corp. of Oaks, Pa., announced a new flame-retardant, industrial laminated plastic for printed circuit and other electronic applications. Micro Gee Products, Inc., Culver City, Calif., unveiled a new angular oscillating table for subjecting gyros, accelerometers and guidance systems to extremely smooth sinusoidal motion for precise frequency response tests.

Automation Development Corp., Culver City, introduced a newly developed line of low-cost digital servo components for automatic control applications. This pulse-operated series of transistorized step-servo motors and companion controllers, a new pulse generator and a new dc/power supply line were being shown for the first time.

Also in the power line, Raytheon's Power Supply and Voltage Regulator Operations announced a new series of heavy-duty, regulated dc power supplies ranging in output from 3 to 1000 volts and from 50 to 3000 watts.

Computer Control Co., Framingham, Mass., displayed a new series of plug-in, high-speed digital modules priced at less than $20 per flip-flop.

Astromics, a division of Mitchell Camera Corp., showed a compact latching relay which it said can be battered with a hammer without damage.

• **Radical depositing method**—Athom Electronics, Sun Valley, Calif., described a new technique for depositing numerous alloys and other materials onto virtually any substrate material, including ceramic, glass, bakelite, Teflon, mylar, fiberglass, quartz and mica. This "plasmionic mono-crystalline film deposition" process was said to be a radical departure from the "sputtering" of alloys onto a substrate material. It is accomplished in a high vacuum of alloys onto a substrate material. It is accomplished in a high vacuum.

Nuclear-Electrical Conversion Cell

The direct conversion of nuclear energy to electrical energy by a thermionic converter has been announced by General Atomic Div., General Dynamics Corp.

The cell's operation depends on the "Edison effect." Electrons are boiled out of a hot plate, or emitter, by the heat from the fissioning of uranium. The resulting electron stream, the electrical current, is collected on an adjacent cold plate called a collector.

Cesium vapor is used in the gap between the emitter and collector to enhance the rate of power production.

The cell's heat source came from a nuclear fuel element made of uranium carbide and zirconium carbide. Highest power run in the tests produced 90 watts electrical output at a power density of 21 watts/cm^2 delivered into an external load.

Efficiency of converting fission heat to electrical energy went as high as 10%, the operating temperature being about 3500°F.

A metal vapor, such as cesium, is used to (1) step up the rate at which the electrons boil out of the emitter; (2) reduce the energy loss at the collector; and (3) become an ionized gas, or plasma, which causes the current to pass readily through the region between the emitter and collector.

The tests were part of General Atomic's program of research and development in direct conversion, which is being carried out with support from the Rocky Mountain-Pacific Nuclear Research Group.

THE SPOTLIGHT'S ON PERFORMANCE

with CEC's newest strain gage pressure transducers



And the accent's on versatility! As a family, these three cover a pressure range from 0 to 10,000 psi in gage, absolute, and differential models...always provide top performance, even in applications with great extremes of environmental conditions.

Above, TYPE 4-325 is the smallest—only 8 grams—and extremely valuable where size is critical. Differential models cover the range from ±5 to 50 psi, while absolute and vented gage units measure pressures from 10 to 200 psi. Write for *Bulletin CEC 1630-X5*.

Outstanding TYPE 4-326 has the finest inherent performance capabilities of any comparable product now manufactured. It's rugged—usable in a 1000 g environment—and measures absolute and gage pressures from 0 to 10,000 psi. Write for *Bulletin CEC 4326-X1*.

New TYPE 4-328 has a built-in thermal heat shield, making it ideal for airborne applications. Sealed gage and absolute models are available for low, medium, and high-pressure measurement. *Bulletin CEC 4328-X1*.

Other strain gage pressure transducers in the CEC family are described in *Bulletin CEC 1308-X22*.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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mergers

MINNEAPOLIS-HONEYWELL Regulator Co. has formed a new Special Systems Division for complex integrated control systems for industrial and military applications. John W. Morrison has been picked to be general manager for the new division, at Pottstown, Pa.

ELECTRO-OPTICAL SYSTEMS has organized Micro-systems, Inc., a wholly-owned subsidiary to be engaged in manufacture and sale of microminiaturized electronic components and devices utilizing solid-state and advanced semiconductor technology.

APPLIED ELECTRONICS CORP. has purchased Flight Electronics Corp., West Chester, N.Y. No changes in personnel or operations are anticipated other than an increase in the research and development end of the business.

ATLANTIC RESEARCH CORP., through its U. F. Flare Division, has established a new technical service and liaison facility to serve the U.S. Naval Ordnance Test Station, China Lake, Calif. Located adjacent to the Naval Station in the City of Ridgecrest, the new facility is served by company airplane from Division headquarters at Saugus, Calif., near Los Angeles.

LABORATORY FOR ELECTRONICS, INC. has acquired an interest in Segnalemento Marittimo ed Aero, Sp.p.A (SMA), Florence, Italy. SMA is producer of marine navigation radar and microwave, infrared, lighting and signalling equipment.

ANTENNA SYSTEMS, INC. opened a new Engineering Laboratory adjacent to its present manufacturing facility in the Hingham Industrial Center. The 3500-sq.-ft. building will centralize all engineering activity for the firm, including mechanical structural and electrical design.
Aereo, Sp.p.A (SMA), Florence, Italy.

GENERAL MOTORS CORP. Defense Systems Div. has bought a 104-acre facility for extensive research in underwater instrumentation. The ocean-view site was formerly held by the Aerophysics Development Div., Studebaker-Packard Corp., and later taken over by Curtiss-Wright Corp.

TRANSVAL ELECTRONICS enters the space propulsion field with the acquisition of an ion engine which has been under development in West Germany for the past 10 years.

McGRAW-EDISON CO. sold its Edison storage battery business to The Electric Storage Battery Company. The division, now known as the Nickel Alkaline Battery Division, continues to manufacture the nickel-iron battery invented by Thomas A. Edison.

←——Circle No. 11 on Subscriber Service Card.

PACIFIC SEMICONDUCTORS, INC. is moving its administrative offices to a newly-completed module of a $10-million Diode and Rectifier Facility in Lawndale, Calif. The Thompson Ramo Wooldridge subsidiary will retain its Culver City buildings, with about 350 employees in several departments. The new 193,000 sq. ft. facility will house 1700 employees.

ELECTRO-TEC CORP. has contracted to buy a 10-acre site in West Caldwell, N.J. for construction of a 23,000-sq.-ft. plant. The proposed facility will house the company's executive, marketing and fiscal offices, engineering and R&D groups, and a prototype manufacturing department. Research activities of Precimet Labs. will be quartered in the building.

financial

Consolidated Electronics—Net sales for first six months totaled $46.5 million, with consolidated net income amounting to $2 million. No comparison was was made with the previous year's figures because of changes in corporate structures.

Motorola, Inc.—Net sales for six months were $143.5 million and profits were $6.5 million—both new records for Motorola. Last year's totals, previous records, were $128.9 million and $5.9 million. Second quarter sales and earnings were also record makers—sales up to $73.2 million from $65.2 million and profits improving to $3.5 million from $3.3 million.

Jack & Heintz—Net income of $771,000 for the first half of 1960 jumped considerably over the sum of $97,000 for the same period in 1959. (Company lost nine weeks of production time in the second quarter last year because of an employee strike.)

Garrett Corp.—Preliminary fourth quarter sales figures reached $57.8 million and preliminary net earnings totaled $1.7 million. Unaudited figures disclosed year sales to be $224.4 million and earnings $5.6 million.

Air Reduction Co.—First six months sales were record breaking at $104.9 million, compared with $101.8 million in 1959. First half income was $7.9 million, topping 1959's first half total of $7.8 million.

Textron, Inc. During the first half of 1960, Textron had sales of $164.3 million with earnings of $6.3 million. Same period in 1959 brought sales of $146 million with earnings of $8.5 million, before non-recurring income of $2.5 million. Second quarter sales this year were $81.8 million with earnings of $2.9 million.

Circle No. 12 on Subscriber Service Card. →

NEED A TAPE RECORDER?

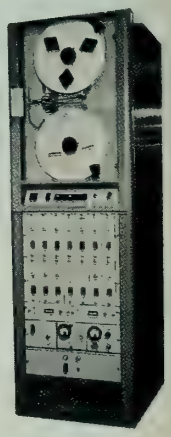
CEC has five *new* recorders and more coming soon! For 14-channel record and reproduce capability in an instrument with all solid-state electronics, look into the new PR-2300 Portable Recorder – it goes anywhere in just 30″ of vertical RETMA rack space.

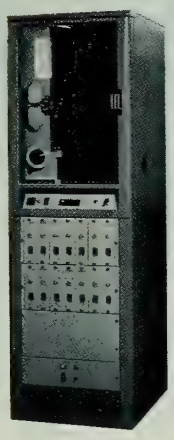




CEC's new DR-2700 Digital Recorder/Reproducer is 100% transistorized with tape speeds to 150 ips and command rates to 200 per second, with unrestricted programming.

And here's a new improved version of CEC's most famous Recorder/Reproducer . . . the GR-2500. It handles Analog, FM, PDM, CM, and digital modes, has interchangeable plug-in amplifiers.



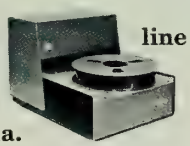


Engaged in critical data analysis? Rely on CEC's new GL-2510 Continuous-Loop Recorder / Reproducer – with 14 Analog, FM, or PDM plug-in amplifiers and six tape speeds from 1⅞ through 60 ips.

Completely mobile and ideal for airborne use, the new AR-2100 Recorder provides 14 channels in Analog, FM or PDM modes... all in a rugged, lightweight die-cast case.



Rounding out CEC's line of tape instrumentation equipment is the 5-055A Automatic Tape Degausser. This new unit accepts reels from 7″ to 14″ dia. and widths from ¼″ to standard 2″ TV tapes. Erases to -70 db.



FOR MORE INFORMATION: PR-2300 Portable Recorder – Bulletin CEC 2300-X6; DR-2700 Digital Recorder / Reproducer – Bulletin CEC 2700-X2; GR-2500 Recorder / Reproducer – Bulletin CEC 1576-X2; GL-2510 Continuous-Loop Recorder / Reproducer – Bulletin CEC 2510-X2; AR-2100 Mobile & Airborne Recorder – Bulletin CEC 2100-X2; and 5-055A Automatic Tape Degausser – Bulletin CEC 1631-X2 – or call any CEC sales & service office.

DataTape Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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INDUSTRY'S BEEN WAITING FOR THIS



LING'S NEW PERMANENT MAGNET BABY SHAKER

First of its kind in the country, the new Ling Permag LPM-25 Shaker meets industry's urgent demand for a small shaker for light component testing and back-to-back calibration. With the LPM-25, the manufacturer of electronic tubes and small components can economically give his products a full vibration test, or use as a production quality control. Strict linearity throughout the wide 5-20,000 bandwith (first resonance above 10 kc with one accelerometer) is provided by a unique suspension system. Special features include: Back-to-back calibration up to 100g without special mounting devices, aged permanent magnet, low driving power, excellent linearity, total distortion for 10g 1% over most of the frequency range, shaker trunnion isolation which reduces vibration transfer to supporting structure. Available as a complete laboratory system, ready to plug in and operate. For details on this revolutionary development in vibration testing, write Department MR-5 at our Anaheim address.

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LING ELECTRONICS

The new Baby Shaker shown at the left and below fills one of industry's most pressing needs. It is the result of Ling's usual practical approach to problems in its field—find the problem, then solve it. Check the specifications below against your own requirements. The design of the LPM-25 is just one more proof that whatever your needs in high power electronics you can rely on Ling for new solutions to old problems.



FORCE RATING, NOMINAL . . . . . 25 lbs.

FREQUENCY RANGE . . . . . 5-20,000 cps.

STROKE, CONTINUOUS DUTY . . . 0.5 inches (peak-to-peak)

MOVING ELEMENT, WEIGHT . . . . . 0.22 lbs.

ARMATURE STUD . . . . . .⅜ inch diameter. Upper and lower mounting hole 10-32 thread, lower hole intended for mounting reference accelerometer

POWER SUPPLY . . . . . .100 watts

FIELD SUPPLY . . . . . .none

AIR SUPPLY . . . . . optional above 50-watt input: compressed air needed for continuous operation over 13 pound force.

DRIVE COIL IMPEDANCE . . . . . 16 ohms

CROSS TALK . . . . . Below 5% to 2 kc
Below 3% to 500 cps.

DIMENSIONS . . . . 10¼" x 6¾" x 10¼" overall

SHAKER AND TRUNNION WEIGHT . . . 38 lbs.

SPECIAL FEATURES: Back-to-back calibration up to 100g, direct Teflon Bearing, aged permanent magnet, low driving power, high linearity, total distortion for 10g approximately 1% over most of the frequency range. Trunnion with rubber shock mounts to isolate shaker vibration from base.

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ELECTRONICS
HIGH-POWER ELECTRONICS FOR VIBRATION TESTING • ACOUSTICS • SONAR

IAF Congress Finds No Agreement on Space Control

STOCKHOLM—Space Law and the problem of when is a spy not a spy got a lot of attention at the International Astronautical Congress here, particularly at the panel set up by America's Andrew G. Haley, IAF General Counsel and Past President.

As was expected, nothing was solved and it seemed apparent to most observers this was a problem which would wind up inevitably with the United Nations. Russia declined to participate and even declined to comment on the subject, saying it had no experts present.

The Powers trial and the RB-47 incident were obviously close to the minds of all participants.

Introducing the Stockholm colloquium, C. Wilfred Jenks, a lawyer from the International Labor Office in Geneva, observed that international control of space is part of a far-reaching disarmament program. The farther nations went toward disarmament the greater are the chances of agreement being reached on space control, he observed.

Professor John Cobb Cooper of McGill University, Montreal, Canada, an acknowledged expert on air law, pointed out that before any plan for international control of outer space can be adopted three preliminary problems must be settled: what is meant by "outer space," the present rights of sovereign states in outer space, and that international control of outer space is not inconsistent with provisions of the Chicago Convention of 1944.

Professor Cooper's views were supported by Belgium's Dr. J. G. Verplaetse, who stressed that it would be wrong to set up an entirely new set of rules for outer space control when air law is already well defined. He suggested that air law might be modified to take into account spacecraft. He warned that outer space is still largely an unknown and as such cannot yet be regulated.

• **Sedov re-elected**—At the end of the meeting, Russia's Professor Leonid Sedov was re-elected as IAF President. Elected vice presidents were Dr. H. Seifert, U.S.; Dr. L. Shepherd, Great Britain; Professor R. Pesek, Czechoslovakia; Professor J. Peres, France; and F. Staats, West Germany.

J. Stemmer of Switzerland continues as Secretary, and Haley as General Counsel.

The next IAF Congress will take place in New York City in October, 1961. The precise dates will be fixed later. The New York meeting will be organized by the American Rocket Society. The 1962 meeting probably will take place in either Bulgaria or Yugoslavia.

The IAF admitted to membership West Germany's Deutsche Astrinautische Gesellschaft and the Italian Rocket Society. Due to the continuing dispute between the two Portuguese rocket societies, it was not possible to admit either to IAF membership.

Two new scientific committees were established by IAF here—one on satellite tracking and the other on space medicine. A working group was set up to discuss a new constitution for the organization. A publishing committee for the proceedings of the IAF was also created.

Report Finds Few Faults in DOD Procurement Policies

Department of Defense procurement problems can and should be solved administratively rather than by legislating a "requirement that good judgment be used."

This was the gist of the *Report on Procurement* just issued by the Congressional Committee on Armed Services. Nothing much was found wrong with present policies that couldn't be cured by a little better management.

Taking an especially hard look at negotiated procurements—the subject of much recent criticism—the committee took note of the limitations and "indispensable prerequisites" to formal advertising for procurement. They concluded that much modern military buying doesn't fit within this concept and, therefore, some contracts must be negotiated. And, they found, negotiation does not necessarily mean no competition.

The Committee decided that all of the major contract types now in use have their place and can be good or bad, depending on how they are used and administered. They also concluded that procurement authority cannot be unduly centralized and some authority must be delegated.

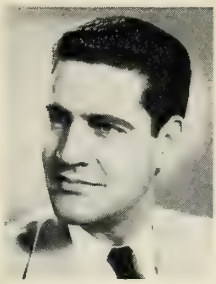
Several amendments and revisions to procurement regulations were recommended. These were generally mild and suggested changes in degree rather than drastic legislation. Chiefly, the proposed amendments would encourage more procurement by formal advertising whenever practicable.

Sen. Leverett Saltonstall (R-Mass.) voiced the hope that the suggested amendments might help small business.

names in the news



DANIELSON



WILKINSON



TRIBERT



TEASDALE



SCHWARTZAPFEL

August A. Danielson: Named vice president to head up GB Electronics, Inc. He joined the organization in 1926, became chief engineer in 1937, and most recently was vice president in charge of the General Bronze Brach Division.

D. A. Wilkinson: Elected manager of the newly formed Product Planning and Market Research sub-section at General Electric's Light Military Electronics Dept. He will continue as manager-*Sidewinder* marketing for the department until a successor is named.

Claude Tribert: Former operations manager, promoted to operations vice president at Portland Industries Corp. He was responsible for the firm's *Bomarc* missile program, and will continue in this capacity.

A. R. Teasdale, Jr.: "An authority in missile guidance control" joins The Martin Co.-Baltimore corporate engineering staff, where he will head a corporate group of consultants. Was formerly manager of the Electronics Division of Temco Electronics and Missiles Co., and prior to that an electronic controls specialist with the Convair Division of General Dynamics Corp.

Wilbert Schwartzapfel: Former project director with Booz, Allen Applied Research, Inc., in charge of technical and scientific consulting on military systems research and development, joins General Electric Co.'s Special Programs Section as manager of Missile Systems Engineering.

Dr. John L. Schwab: Special assistant to the U.S. Army Director of Research and Development, joins General Motors, Sept. 1, as head of the Advanced Planning Department for the Defense Systems Division.

Dr. David van Tijn: Former senior staff scientist for Applied Science, Inc., promoted to Director of Research.

Lawrence John Schlimgen, Theodore W. Steele and **Richard Morrell Zehr:** Join the technical staff of The Oxford Corp. All were formerly with Bell Aerosystems Corp.

Carl G. Gottlieb: Appointed manager of the Armament Division of Universal Match Corp. **Max E. Norman,** former avionics systems engineering manager, succeeds Gottlieb as head of what will now be called the Avionics and Electronics Dept. **Earl E. Biermann** will head the newly formed Heavy Military Equipment Dept., which is a result of combining the Heavy Equipment Engineering Dept. and the Armament Fabrication Dept.

Winston O. Faith: Elected director of development of the Microcircuitry Laboratory for Varo Mfg. Co., Inc. Prior to joining the firm in 1958, he was senior system design engineer with Chance Vought Aircraft, and then group engineer with the Automatic Controls Group, Temco Aircraft.

J. W. Hinchliffe: Former director of Subcontract Marketing, named to head Northrop Corp.'s newly-established Commercial Products Marketing Section of the Norair Division. **Lee H. Smith,** director of customer service, is now director of Ground Environment and Subcontract Marketing.

Dr. Nicholas Yaru: Head of Hughes Aircraft Co.'s radar laboratory's microwave department, elected associate laboratory manager, research and development. Also, **Samuel Langberg** and **William R. Welty** named associate laboratory manager, product engineering, and chief scientist, respectively.

Howard Gleason: Former assistant to the president, Southwestern Industrial Electronics, appointed vice president for manufacturing.

Ralph T. Dosher, Jr.: Appointed manager of the Automation Products Dept. for Texas Instruments Inc. Geosciences & Instrumentation group, with responsibility for engineering, manufacturing and marketing of electronic component reliability testing systems, semiconductor test equipment and special contract products.

Richard W. Powell: Joins Telecomputing Corp. as vice president and manager of its Electronic Systems division, succeeding **Berne N. Fisher,** now President and general manager of the firm's Value Engineered Products, Inc. subsidiary. Powell was previously division manager of Aerojet-General Corp.'s Avionics Div., chief development engineer at G. M. Giannini & Co., Inc., and prior to that research engineer for Lockheed.

William E. Vogel: Named chief engineer-Manufacturing Research and Development at Dana Corp. Was formerly with Atlas Drop Forge Company, a Dana subsidiary.

James M. McCarty: Former chief engineer and marketing manager of Chicago Aerial Industries, named vice president-engineering of J. A. Maurer, Inc. He succeeds **J. F. G. Miller.**

Ted C. Combs: Vice president-engineering, Zero Manufacturing Co., appointed chairman of the Container Design Section, Packaging & Handling Division, American Ordnance Association.

Richard W. Cook and **Joseph P. D'Arezzo:** Elected vice president of American Machine & Foundry Co. Both were formerly divisional vice presidents.

James E. Borendame: Former director of marketing services for Acme Steel Co., joins Fanstell Metallurgical Corp. as director of marketing and public relations.

Carlos C. Wood: Joins United Aircraft Corp.'s Sikorsky Aircraft division as engineering manager, succeeding **Michael E. Gluhareff,** who is retiring as of October 1. Mr. Wood resigned as director of advanced engineering planning for the Douglas Aircraft Co., Inc., after 23 years engineering service.

Bruce R. McFadden: Appointed engineering manager for the Packaged Electronics Division of Amphenol-Borg Electronics Corp. Formerly supervised electromechanical design in Sylvania Electric Products, Inc.'s Data Systems.

John Spitzer: Joints the Semiconductor Division of Sylvania Electric Products Inc., as supervisor of advertising and sales promotion. He was formerly product promotion supervisor for the Univac Division of Sperry Rand Corp.

Sixth Sense for Republic's F-105

Republic's F-105 Thunderchief, the Air Force's new Mach 2 tactical fighter, is able to nail targets on the head, night or day, cloudy or clear—even if the targets are hidden deep in rugged mountains.

This remarkable capability stems from NASARR—the F-105's monopulse radar system—developed and manufactured by Autonetics for the AN/ASG-19 armament control system. Lightweight, compact NASARR provides radar functions for both low-level and high-level missions . . . air search, automatic tracking, air-to-ground ranging, ground mapping and terrain avoidance.

For more than a decade Autonetics has pioneered the way with monopulse radar systems like NASARR to provide America's pilots with a sixth sense.

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contracts

NASA

Hercules Powder Co., Wilmington, Del., for flight configurations of a retro-rocket motor. Subcontract from **Ford Motor Co.'s Aeronutronic Division.** Amount not disclosed.

Ryan Aeronautical Co., Ryan Electronics Division, San Diego, for an altimeter for use with the *Ranger* program. Subcontract from **Ford Motor Co.'s Aeronutronic Division.** Amount not disclosed.

$154,000—Reynolds Electrical and Engineering Co., Inc., Freeport, Tex., for continuous check-out and periodic maintenance and/or modification of electrical equipment at NASA-Marshall Center.

ARPA

$250,000—TRG, Inc.'s Antenna & Microwave Dept., Somerville, Mass., for design and construction of a mobile line source feed for the 1000-ft. spherical reflector antenna for the Arecibo Radio Observatory in Puerto Rico. Subcontract from **Cornell University.**

NAVY

General Electric Co., Santa Barbara, Calif., for investigating systems for the defense of the continental U.S. against attack by missile launching submarines. Amount not disclosed.

Datex Corp., Monrovia, Calif., for building two angle-measuring data handling systems for use at the Pacific Missile Range.

$3,200,000—Sylvania Electric Products, Inc., New York City, for electronic data processing equipment.

$1,247,000—General Electric Co., for prototype fabrication of new *Polaris* inertial guidance system for an advanced design.

$850,000—Manson Laboratories, Inc., Stamford, Conn., for research and development of high-frequency synthesization and advanced high-frequency communications.

$250,000—Aeronautics Division, Chance Vought, Dallas, for testing a new type of sonobuoy designed for detecting the movements of enemy subs.

$208,497—Computer Systems, Inc., Monmouth Junction, N.J., for design and fabrication of two of the largest plotting boards ever produced for missile range use.

$79,050—Consolidated Electrodynamics Corp., Arlington, Va., for tape recorder-reproducer systems and associated components.

$45,000—Hughes Aircraft Co., Microwave Tube Division, Los Angeles, for high power traveling wave tube.

AIR FORCE

Kidde Aero-Space Division of Walter Kidde & Co., Inc., Belleville, N.J., for study and feasibility testing of an integrated, cryogenic fueled power system incorporating secondary power, reaction control and environmental control systems. Amount not disclosed.

Bell Aerosystems Co., Buffalo, for miniature accelerometers for the GAM-87A *Skybolt*. Subcontract from **Nortronics Division of Northrop Corp.** Amount not disclosed.

$78,000,000—Lockheed Missiles and Space Division, Inglewood, Calif., for developing ground-space and communications and control systems for the *Discoverer, Samos* and *Midas* satellite programs.

$2,014,865—Tung-Sol Electric, Inc., Newark, N.J., for electron tubes.

$1,000,000—International Resistance Co., Philadelphia, for producing new high-stability, high-reliability resistor for the *Minuteman*. Subcontract from **North American Aviation, Inc.'s Autonetics Division.**

$525,000—The Siegler Corp.'s Hallamore Electronics Division, for design, fabrication and installation of instrumentation for the cold flow test facility used in the static testing of the *Titan II*.

$97,543—Ford Motor Co.'s Aeronutronic Division, Newport Beach, Calif., for a high-speed scanning device.

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ARMY

$8,486,025—Republic Aviation Corp., Farmingdale, N.Y., for AN/USD-4 short-range surveillance drone system.

$5,300,000—International Telephone & Telegraph's Federal Division, Clifton, N.J., for electronic "brains" for the *Lacrosse* missile. Subcontract from **The Martin Co.-**Orlando.

$4,000,000—Western Electric Co., New York City, for furthering work on the *Nike Zeus* antimissile missile. (Three contracts.)

$667,920—Western Electric Co., Inc., New York City, for *Nike* replenishment spare parts. (Five contracts.)

$200,000—Douglas Aircraft Co., Inc., Santa Monica, for research and development of *Honest John* rocket system.

$170,093—The Martin Co., Orlando, for replenishment spare parts for the *Lacrosse.*

$134,485—Namron Construction Corp., Oceanside, L.I., N.Y., for conversion to *Hercules, Nike* Battery 48.

$117,600—James Farina Corp., Newton, Mass., for conversion to *Hercules, Nike* Battery 05.

$27,000—Brown Engineering Co., Inc., Huntsville, for engineering services for *Pershing* weapon system.

—reviews—

DYNAMICS OF CONDUCTING GASES, edited by Ali Bulent Cambel and John B. Fenn, Northwestern University Press, Evanston, Illinois, 212 pp.

Since 1955, the American Rocket Society and Northwestern University have been having biennial symposia on specialized topics in gas dynamics. The present volume contains the papers and lecturers presented last year at the Third Gas Dynamics Symposium.

To the merit of the volume is that the material is topical and specialized. To the demerit, for those readers looking for a readable text, is that this is a book for experts and those familiar with mathematical physics.

The book is divided into four parts. Part One: Elementary processes and properties in ionized gases. Part Two: Theoretical considerations on the interaction of magnetic fields and flow of ionized gases. Part Three: Laboratory experience with flow of ionized gases. Part Four: Applications of magneto-gasdynamic effects.

U.S. ARMY RESEARCH AND DEVELOPMENT PROBLEMS GUIDE, Distributed to qualified private organizations through Ordnance District Offices which deal with U.S. industry.

A guide book for industry that spells out problem areas in the development of Army weapons, ammunition, guided missiles and rockets, combat and support vehicles has been published by the Ordnance Corps.

Companies possessing a secret clearance who have qualified to participate in the Ordnance Corps Qualitative Development Requirements Information Program may obtain copies of the Guide through the District Offices or directly from a Commodity Command or Arsenal with which they have signed a policy agreement.

Any civilian organization having an interest in such activity which is not participating in the QDRI program, may also qualify to receive the guide.

Propellant Briefs from Callery Chemical Company

Nitronium Perchlorate: Promising New Solid Oxidizer—Callery is now producing nitronium perchlorate (NO_2ClO_4) on a small scale for use in propellant development. Increased production will follow as applications develop.

Specific impulses, with shifting equilibrium, 1000 to 14.7 psia, are shown to compare nitronium perchlorate with ammonium perchlorate.

Fuel	Isp with NO_2ClO_4 Nitronium Perchlorate	Isp with NH_4ClO_4 Ammonium Perchlorate
H_2	349	287
BeH_2	346	340
AlH_3	305	302
B_5H_9	302	285
N_2H_4	295	265
UDMH	289	259
C_4N_2	276	258
CH_2	278	252

Nitronium Perchlorate is thermally stable to about 100°C, has a density of 2.22 g/cc and Δ Hf = +8 Kcal/mole (298°K). Vapor pressure is less than .05 mm Hg at 70°F. Reacts readily with water. Not shock sensitive when pure.

Nitronium perchlorate may prove useful in solid and hybrid rocket systems and in explosives. It can be used as a nitrating agent and possibly as an intermediate in other chemical syntheses.

Write for Bulletin C-1200.

New Fuel for Air Force: Pentaborane (B_5H_9)—Callery is now modifying the Government-owned plant at Muskogee, Oklahoma to produce pentaborane under a $9-million Air Force contract.

Pentaborane production begins this summer for Air Force requirements only. At the outset, at least, no pentaborane will be available for commercial development.

Potential of pentaborane as a fuel is evident in its high heat of combustion—29,000 BTU/lb.—and its high specific impulse with currently used oxidizers.

Write for Bulletin C-1300.

R and D on Fuels and Propellants—We have capabilities for subcontract research for defense programs in the propulsion, oxidizer, energy storage, explosive, and space manufacturing areas. We also have process development capabilities in these areas. Such diversification and technical versatility may help you.

For information or technical service: write Defense Products Dept., Callery Chemical Company, P.O. Box 11145, Pittsburgh 37, Penna.



CALLERY CHEMICAL COMPANY

Richard A. Carpenter
Manager, Washington Office
Callery Chemical Company

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Don't expect packaged space to come in a glass jar. But simulated environments are available from Vitro which can duplicate conditions millions of miles away. Using its proprietary high-intensity arc, Vitro is designing a solar radiation simulator for the Department of Defense. USAF scientists will use it to expose coatings slated for space vehicle application. The arc accurately represents the solar spectrum and energy distribution—importantly, from a single source. To date, this is Vitro's proven record of accomplishment: 11 major projects in which the simulation of unusual environment was vital.

Vitro

VITRO ENGINEERING COMPANY/A Division of Vitro Corporation of America/NEW YORK•WASHINGTON•LOS ANGELES•TORONTO/OVERSEAS: GENEVA•MILAN•BOMBAY

SS-11 Gets One-man Portable Control

by Bernard Poirier

France's Nord-Aviation has developed the first man-portable fire control system for use with lethal antitank missiles.

The Waist Belt Fire Control System is designed for Nord's *SS-10* and *SS-11* missiles. A particularly significant feature, say Nord spokesmen, is that it brings to the *SS-11* the high mobility already associated with the *SS-10*. The *SS-11* has a top range of 11,500 ft., twice that of its predecessor.

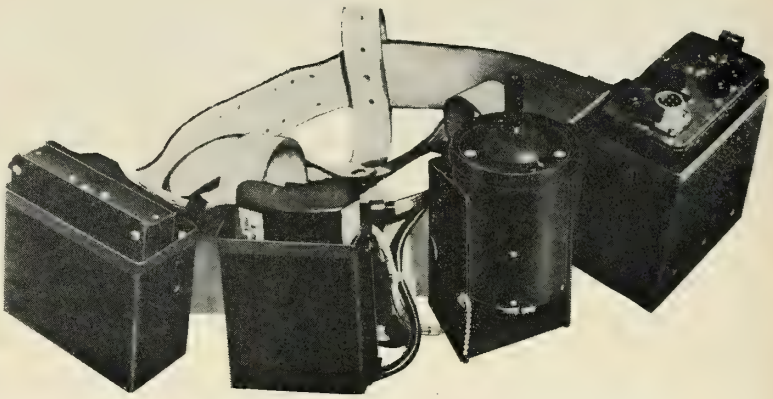
The equipment may be manufactured in the U.S. by General Electric under the same license agreement worked out with the French firm at the time the *SS-11* IR optical guidance was reported (M/R, May 2, 1960). Terms of this agreement are still under Pentagon scrutiny, reliable sources say.

Miniaturization of the 11½-lb. FCE (fire control equipment) was achieved with transistors in the command and signal circuits. The four FCE components include a small manual Joystick Unit (2 lbs.), a battery pack (1 lb. 2 oz.), a Control Unit (1 lb. 4 oz.) and an Electronic Generator (2 lbs. 4 oz.).

• **Visual pre-flight check**—The integrated Control Unit is 4 in. x 3½ in. by 6 in. and has a pre-fire check-out procedure which enables the gunner to check responses of the elevation and direction controls prior to the missile's ignition. Roger Fleury, head of Nord's New Products Division, and Mr. Dupuy, Head of the Electronics Group, have described the checkout as a system of small, briefly flashing lights on the Control Unit's face plate.

When the gunner tests the controls, the small "blink lights" flash to indicate satisfactory servo responses through the command and signal circuits between the Control Unit and the T 10 Electronic Generator to the missile.

The effective range of the Waist Belt FCE is believed to be more than triple the range possible with IR optical guidance, although both figures are kept classified. Also classified are the aerodynamic-type corrections featured in the *SS-11*.



LEFT TO RIGHT: T 10 electronic generator; battery pack; joystick unit, and control unit of Nord's miniaturized Waist Belt Fire Control System.

• **Tests revealed by** COUNTDOWN—The Waist Belt FCE was evaluated during secret missile tests reported by M/R on July 25. Five missiles, three with active warheads, were fired on May 11th in the Dauphine Alps near the town of Alpe d'Huez. Selected Alpine Troops carried *SS-11* missiles in shoulder packs while one trooper carried three warheads in a shoulder harness.

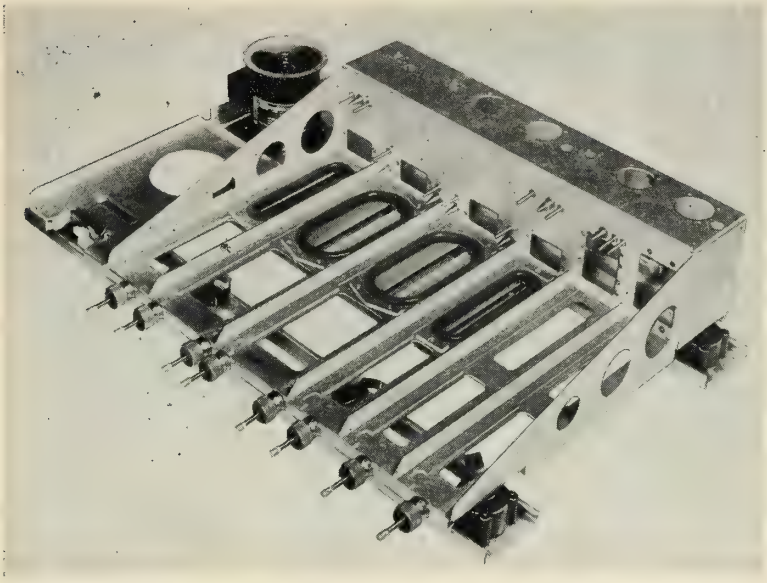
The Waist Belt apparatus was tested by Nord Personnel and by Alpine troopers. The actual launchings took place at a site 8692 ft. high. The lowest target was at 5904 ft. and the highest at 9348.



ONE TROOPER carries three live warheads; his comrade carries a single missile in a pack.



FOUR MEN carry a total of three missiles and three warheads. Eleven enlisted men were the total needed in the Alpine tests.



Vibration Damping Mounts

Elastomeric mounting systems are being produced by Lord Manufacturing Company to meet requirements of an aerospace design trend calling for integration of "black boxes" and protective structures. Elastomeric members are Lord BTR(r) (Broad Temperature Range) Mountings which provide all-attitude control of high-frequency vibration plus attenuation of shock and structure-borne noise from −65° to +300°F.

Lord BL-1909 base weighs 11 lbs., supports 51.7 lbs. of equipment including four ¼ ATR units, two 3/8 ATR units, computer, and blower. The system incorporates eight BTR elastomeric mountings for all-attitude shock/-vibration protection over the −65° to +300°F temperature range.

The base meets the shock and vibration requirements of MIL-E-5272C plus sustained accelerations of ±6.2 g vertically, ±1.9 g horizontally, ±2.4 g longitudinally.

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Vapor Dipole Indicator

A device for detecting and measuring vapor or gases which exhibit an electric dipole moment is being marketed by Conrad-Carson, Inc.

The Humistor can be tailored to individual application requirements in both read-out and automatic control circuitry.

Circle No. 226 on Subscriber Service Card

Time Delay Relay

A highly flexible, transistorized, printed circuit time delay relay for timing operations and other functions in undersea, air or space craft is available from Controls Division of the Leach Corp.

The relay is capable of either horizontal or vertical mounting within its package and, optionally, of outside timing adjustment.

The relay output is operated by a transistorized gate which is energized from an RC (resistor-capacitor) timing network. Accuracy is guaranteed by regulated power applied to the timing unit.

Circle No. 227 on Subscriber Service Card

Swift Digital Computer

Packard Bell Computer Corporation has produced an ultra-fast, general-purpose, digital computer. Designated the PB 250, it can be applied to an extremely broad range of scientific, industrial and military problems.

The PB 250 combines a large, expandable memory and a versatile command structure with computing speed in the microsecond range.

Specifications of the PB 250 qualify the computer for either on-line or off-line applications. It is a serial, binary, single-address computer with an internally stored program. A few of the features include: Microsecond Speed . . . Add/subtract—12 usec., multiply —276 usec., divide/square root—252 usec.

Circle No. 228 on Subscriber Service Card

Plastic Properties Tester

A "Plastechon" Universal Tester is being marketed by the Plas-Tech Equipment Corp.

The tester is capable of measuring tensile, flexural, and compressive properties of all types of materials at rates of loading ranging from 0.2 in./minute to 8000 in./minute. Stress-strain curves are obtained automatically via oscilloscope-camera techniques.

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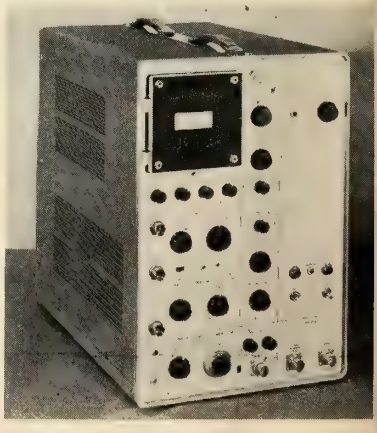
Two-Part Control Box

One control box in two multifaced parts is being marketed by Barber-Colman Co. The box has two special qualities—form-fitting design to match the space limitations inherent in missile applications and close operating tolerance. The box occupies less space than a four inch cube and controls temperature to less than ±0.03°F.

Circle No. 230 on Subscriber Service Card

Wide Band Oscilloscope

A calibrated, high-speed, laboratory oscilloscope designed for observation, measurement, and photographic recording of wide-band phenomena is being marketed by Tektronix, Inc. A 2 x 6 cm viewing area, coupled with 24 kv accelerating potential affords bright displays with excellent definition.



Performance features include: passband from dc to beyond 1000 mc, rise-time of 0.35 nsec, sensitivity of 10 v/cm, linear sweeps to 2 nsec./cm, and sweep delay to 35 nsec. All features (including a sensitive trigger system) are fully compatible with the signal bandwidth capabilities of the instrument.

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new literature

DECADE COUNTER TUBES—A counter tube handbook describing the construction, operating principles and applications of a wide variety of decade counter tubes used in computers and tabulating machines, radiation-measuring instruments, frequency dividers, and other electronic equipment, has been made available by Sylvania Electric Products Inc. The 12-page handbook contains illustrated sections on design procedures, specifications, and circuit information. In addition, new drive circuits for medium-speed and high-speed (100 kc) types are included.

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SDC



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MITRE, formed under the sponsorship of the Massachusetts Institute of Technology, is a system engineering organization engaged in the design, development and evaluation of large scale command and control systems. Its convenient location in suburban Boston offers excellent opportunities for advanced study under MITRE's liberal educational assistance program.

editorial . . .

Wanted: Optical Engineers

A NUMBER OF little-known facts about what is actually a little-known industry were revealed in a special report on optics in MISSILES AND ROCKETS' Aug. 22 issue.

The manufacture of precision optics had grown into a significant industry in this country after World War I, when we first discovered that Americans could build optics which were just as good as those built by the Germans and the Swiss, who theretofore had monopolized the field.

M/R's report revealed that the optics share of the missile/space industry will reach $75-85 million next year and is likely to double in the three to five years following; that the American industry is no longer dependent on European techniques; that the optics industry is getting more sophisticated, more competitive—and much larger.

The report also revealed that there is an acute and shocking shortage of trained optical engineers and of optical and photographic scientists in the United States.

There is an almost complete (one industrialist called it "shameful") lack of interest on the part of engineering schools in establishing good courses in optics. Moreover, the few good physicists in the field are not interested in everyday optical engineering.

Thus, just at the time when the Missile/Space Age is levying greater demands on an expanding industry, that expansion is almost certain to be held back and limited by the lack of people trained in optics.

Why? Blessed with 20/20 hindsight, we can easily spot the answer: almost complete lack of foresight and preparedness on the part of both educators and the industry.

For education is, of course, the solution. To educate, however, you must first have teachers. Then you must have students supplied with adequate courses and laboratories.

It seems apparent that the optics industry itself will have to provide these essentials if it is to have the trained people it needs. This can be done in part by financial support to the universities to set up and staff facilities. By means of scholarships promising students can be aimed in the right direction. Cooperative programs, which cost participating companies little, could produce relatively soon the beginning of the needed stream of competent personnel.

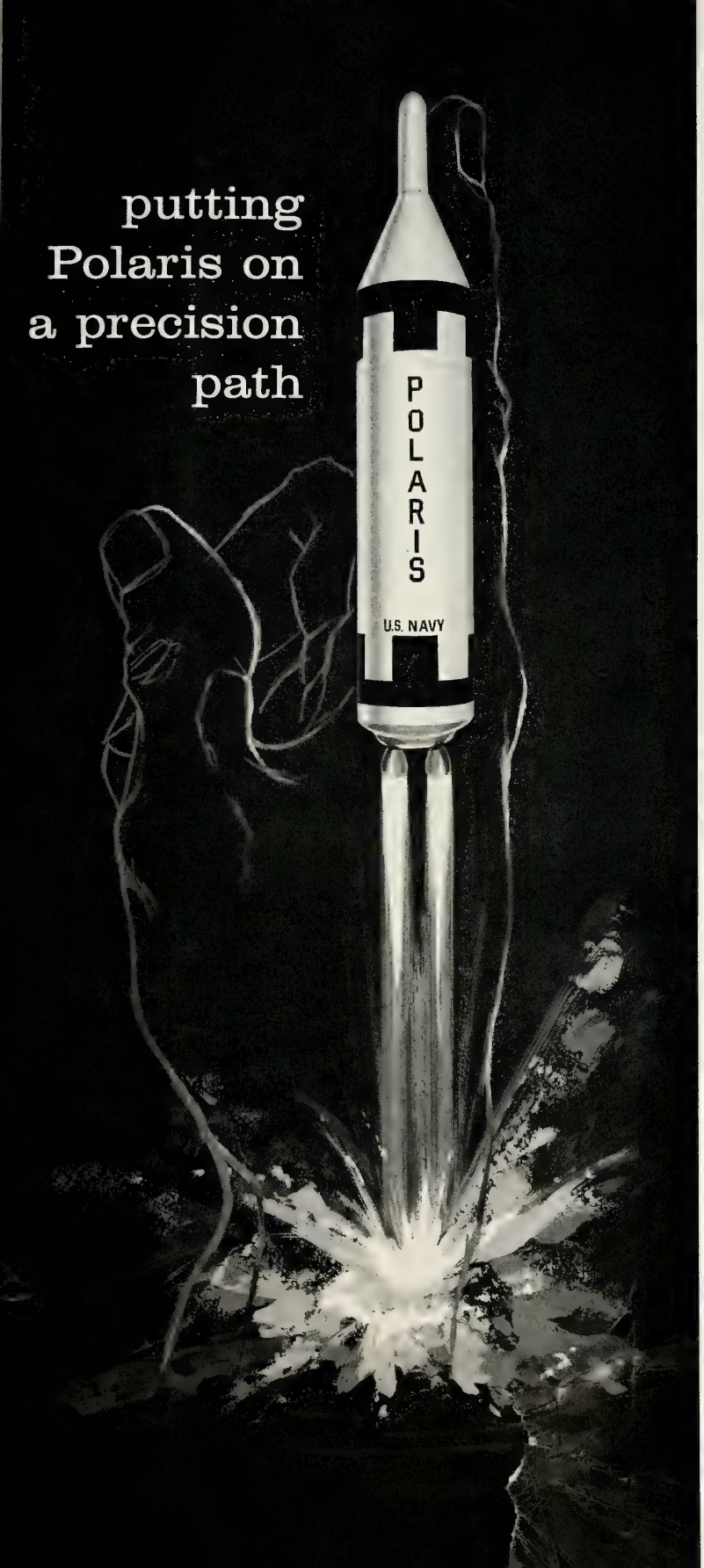
The textile industry in the South has followed such programs for years—with scholarships, school facilities and equipment—to provide the bright young men and women to meet the challenge of synthetics. Without the new ideas in manufacturing, industrial management and engineering contributed by these trained new minds, our natural-fiber textile industry probably would not exist at all today.

But this is still not enough. In the case of optics, education must go a step further. Pre-education is necessary, as well as advanced training. The industry must make our high school and early college students aware of the opportunities that exist in optics. The general public, too, should be educated to the importance of optics, its challenges and rewards.

A PARTIAL remedy for the present might be a higher development of computer techniques for optical design. Already finding limited use, computers can solve difficult lens problems and probably can be used for more complex design configurations. The immediate effect of this would be to free optics specialists from routine tasks, and permit them more time for advanced problems.

Optics is not the only industry which should take heed of the manpower shortage. Almost every other business in this Missile/Space Era of leap-frogging technological advancement would do well to look to its own house. Many have already found that lack of skilled technicians is their greatest problem. Obviously, this situation will spread in the future—if individual industries don't start to do something about it now.

Clarke Newlon



Several new contracts for research and development of computer and guidance components for the Polaris Missile have recently been awarded to the Hughes Engineering Division. As a result, a variety of openings have been created for graduate engineers and scientists who have a minimum of three years experience specifically related to:

- Inertial Components and Platforms
- Systems Design and Physical Design of Inertial Devices
- Digital Computers
- Servomechanisms
- Controls Systems Analysis
- Magnetic Drum and Magnetic Core Circuit Design
- Transistor Switching and Circuit Design

Polaris Guidance is but one of the many R&D programs which reflect the growing emphasis on space oriented projects at Hughes. The Engineering Division is also responsible for such projects as: Space Ferry Systems, Anti-ICBM Detection Systems, Infrared Search Systems, and Communications Satellites.

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Supervisor, Scientific Personnel
Hughes Engineering Division
Culver City 34, California

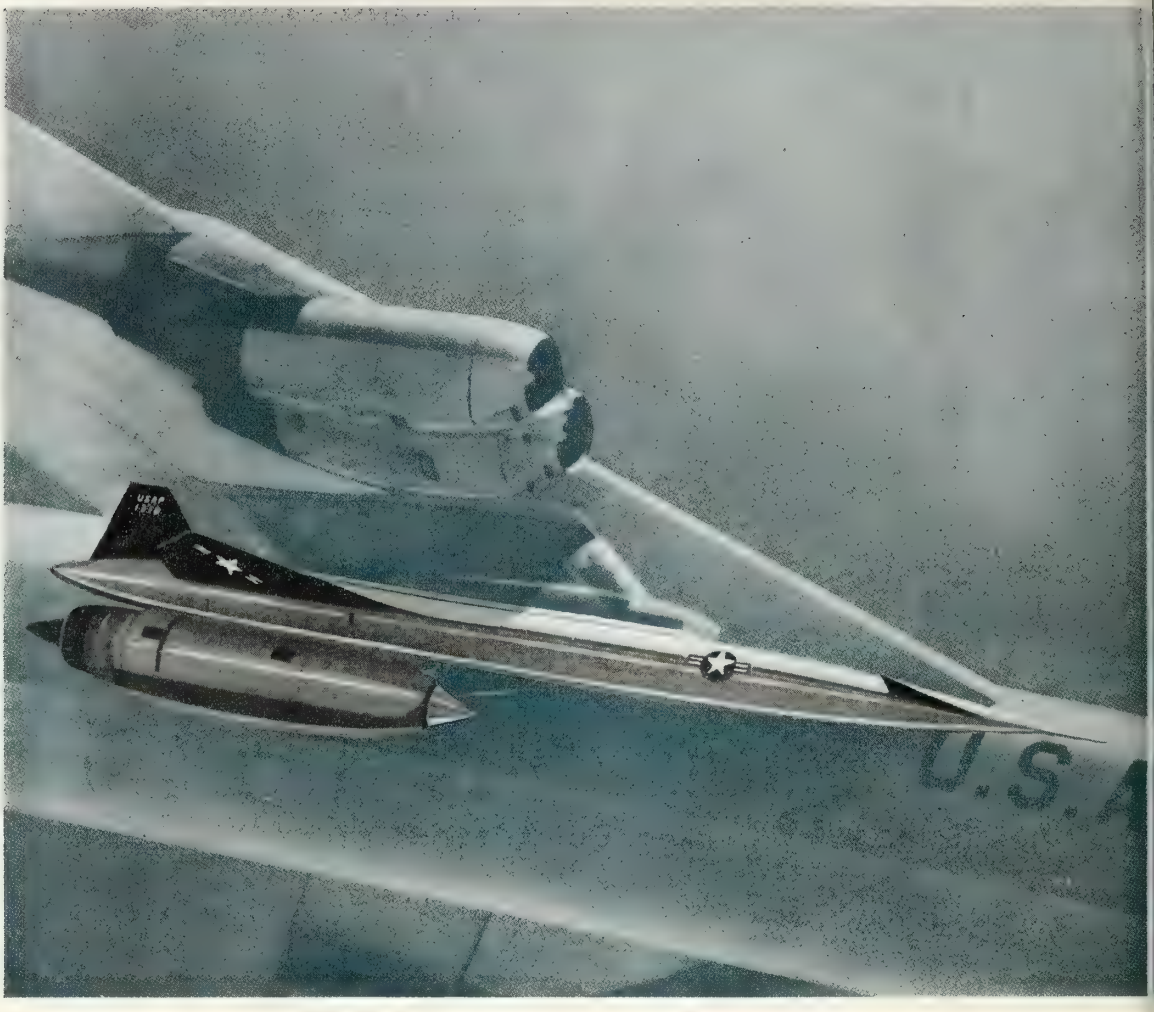
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